

WINTER 1978

Issue One

MATRIX MAGAZINE

1 EDITORIAL
2 ABOUT THE FIRST EDITION
5 THE WORK OF JAMES NEELY
James Neely 6 PROGRAMS: ASTRO 1, 2 & 3
Editor 18 HOROSCOPE PROGRAM
Dr. Theodor Landscheidt 23 COSMIC ORGANISMS
Robert Knight 28 ANGLES: AN ALGORITHM FOR HOROSCOPE CONSTRUCTION
John Van Zandt 36 PLANETARY HARMONICS/POSITIONAL DIFFERENCES
Stephen Erlewine 38 NON-LINEAR INTERPOLATION USING THE 2nd DIFFERENCE
Noel Tyl 40 ASPECT CALCULATION PROGRAM
Buz Overbeck 43 HARMONIC ASTROLOGY GUIDE
L. Titunik & C. Hocking 46 ASTROLOGICAL DATA PROCESSING: MIDPOINTS
Pat White & Robert Hand 48 THE NEW $600 COMPUTERS
Editor 53 THE PET & THE TRS-80 (A BIASED REVIEW)
Tim Smith 57 DIGICOMP'S DR-70: THE FIRST ASTROLOGICAL COMPUTER

59 OUTPUT
35 BOOK REVIEW Cosmecology Bulletin

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We would like to thank our contributors and subscribers for their warm support! In particular, we are grateful for the help we have received from James Neely and Robert Hand. Without their help, MATRIX might never have been possible.

This, our first issue, is kind of sketchy. We are still in the process of bringing this material together. We could use some help from our readers in the way of comments, criticism and contributions toward future issues. We need ideas for articles and departments we have overlooked. In particular, we have no member of our staff who knows HARDWARE concerns (like building computers) and none that is in control of STATISTICAL RESEARCH METHODS. Any takers?

This first issue has taken longer to get together than we had planned. Our apologies. The next issue is almost ready now, but we want to get our reader's response before going ahead. In fact, the next several issues should come forth quite soon. MATRIX is a periodical in the true sense of the word. We feel it important to get some of the programs and calculation methods involved in astrology into the public domain as soon as possible.

Our costs have run higher than expected (as we might have expected) and the future looks to be the same. I'm afraid we can't promise you financial relief in the form of a lower cost per issue in the near future. We are such a small group (about 70 as of press time) and our subject matter so special that we will have to be content with sharing our enthusiasm and programs with one another. The entire staff is very impressed with the quality of response we have received. It looks as if astrologers all over the world are learning computer skills, mathematics and astronomy— in a hurry. We hope that the pages of MATRIX can serve as a means for all of us to exchange information and meet one another.

Michael Erlewine

Contents

Our format is quite tenative at this point and this first issue is more of a "sounds like" than a definitive statement. NOW is the time for you to help shape the format of MATRIX into what all of us would like it to be. Please let us know of areas or categories we have overlooked where you desire more information. Here is a list of general topics to be covered in MATRIX.

Programmables

This section will include programs or listing for the various hand-programmable calculators. In particular, we need programs written for the Texas Instruments SR-52 and TI-59. Please include complete documentation and Key-Code and Step-Numbers.

4-Functions

This section is for astrological programs implemented on the four function hand calculators. It is important that those of us who can handle these machines write programs for them. Our next issue will include some useful 4-function material.

BASIC & FORTRAN

Programs written in FORTRAN and BASIC here published. We encourage that one of the new EXTENDED forms of BASIC be used if at all possible. PLEASE document and REMARK your programs. This includes listing the algorithms or formulae used, sources for these, flow-charts. One of the goals of MATRIX will be to develop some standards in regard to program documentation.

Radical Theory

The article in this issue by Dr. Theodor Landscheidt is a fine example of what we mean by RADICAL THEORY. Theory here is not equivalent to "speculation" but refers to new perspectives or ways of looking at the mass of established facts.

Features

Here are some ideas for regular columns in MATRIX that will appear as material accumulates.

What's New?

This section will list and describe new products and services of general interest. Our general policy will be to offer a one-time listing of new products. If you are aware of new developments and products, please describe them and provide us with information and addresses where we can obtain literature. If you are marketing a service or a product, please send us pictures and a sample if at all possible. Services and software must be accompanied by a sample or copy to be reviewed.

Letters

This section will print letters of general interest.

Book Reviews

Here we will do more than review the new publications that become available. We would like to describe and list the contents of all important "classic" works that relate to our subject matter. Our intent is to suggest which of the many astronomy, mathematical, statistical, etc. books are worth owning. We need our readers help in this department— in particular. If you have found books that are really essential, please let us know. We will review books on spherical astronomy in a forthcoming issue.

HARDWARE TIPS

This department will never live unless one of our readers cares to handle it. Your editor is as dumb as a stone when it comes to wires and soldering. We dont even know what is possible in this area and we hope some of you do. Contact us PLEASE.

Research Methods

Here is another area where the staff is, for the most part, ignorant. We would like to see a careful presentation of statistical and research methods as they relate to astrology as well as articles describing actual research projects and their results. Here is an opportunity for some of you to help out.

Output

Here we will present the HARD-COPY or PRINT-OUT, TABLES and what-not generated by all of our computations. We will, however, have to follow certain conventions. We will only accept copy that is ready for publication. This means 8½x11 inch format on high-quality typewriter or printer. However, we do have access to a selectric-based printer here in Ann Arbor and would be willing to help generate OUTPUT— if need be. In this case, please provide a complete description of what you have in mind plus the formulae or algorithm necessary to implement the idea. If possible, write us a program in BASIC that will compute your table (we can format it for you). OUTPUT is a place to share HARD-COPY results.

Input

On the other hand, INPUT is the place for the arm-chair reader to suggest ideas and projects that require implementation on computers. If INPUT is successful, we can cooperate and avoid duplication of effort where the need be. Again: our goal is to organize, communicate and cooperate.

BASIC Astrology

This section will contain subroutines and short programs written in the EXTENDED or ALTAIR BASIC. Often these will include algorithms used in the PROGRAMMABLES section translated into the BASIC language. What we are looking for are various tips, tricks and short-cuts for computing. Sorting routines, quadrant solutions, useful defined functions and the like.

Hand-Shaking

Our HAND-SHAKING department is our information exchange cooperative. Looking for an algorithm? an interface for your machine? a research partner? data? Here is where you can turn. Classified ads of a non-commercial nature will be run FREE here. You may charge for Xerox costs or for the price of an audio cassette and still be listed here. Again: the idea is exchange of information and materials of a non-profit nature.

Advertise

This section will include exchange ads as well as PAID advertising. The initial goal of MATRIX is to see that all necessary information of an astro-computing nature is in the public domain. After this is assured, we are very interested in encouraging commercial ventures in the astrological hardware and software directions. We would like to believe that publications like MATRIX can help to promote fair competition and a high standard of quality for commercial products. We feel that many of our readers will be writing the software for our future. No fixed advertising rates have been set at this time. Write us.

Neely's Notes

James Neely has proved to be one of your editor's most valuable natural resources. He has responded again and again to a deluge of questions. With his permission, we would like to make his knowledge and interest in the problems involved in calculation on smaller machines available to a wider audience. Please address questions in the area of celestial mechanics, computational methods and the like to the MATRIX address or to Neely himself. We have a fine article in the works from Neely on VECTORS, MATRICES, AND COORDINATE TRANSFORMATIONS.

MONEY

Last but not least, let us be clear on the financial status of MATRIX. The staff has worked for FREE, but would like to reach the "pizza and coke" level— at some point. Our cardinal rule is that we cannot afford to lose money. ASTROLOGY NOW magazine has a paid subscription of around 2500, MATRIX has around 50 interested readers at this point. What this means is that we must print thru the Xerox process rather than the Offset process. We will try to make MATRIX as attractive and practical as we are able. However, we must consider MATRIX more as a technical bulletin than as a mass publication. We must all share the cost of having a forum for our needs in the higher price-per-issue that this entails. The price may even have to go up if we find that we are losing money. The price will be different for different issues— depending upon the size of the issue. We will notify only those readers who have purchased the prior issue when the next issue is ready. You can help by responding at once, since we get a discount for larger quantities with the Xerox process too. The price for each issue includes postage, notification, mailer, etc. THANK YOU!

THE WORK OF JAMES NEELY

James Neely is a name you will see often in the pages of MATRIX. Neely is one of the very few astrologers who have a comprehensive working knowledge of computers and celestial mechanics. Altho he speaks fluent FORTRAN and is aware of the problems involved in large-scale computer use, what makes Neely's contribution unique is his desire to implement his knowledge on smaller machines such as the programmable hand-calculators. Most of the really knowing astrocomputers working in astrology today use large computers and computer techniques well beyond the experience (or pocketbook) of the average astrologer interested in computing.

Neely has written a large amount of material for the Hewlett-Packard HP-65 and HP-67/97 machines (10 out of 11 programs in the HP User Library ASTROLOGY booklet were authored by Neely). We have Neely's permission to publish the entire HP program collection and the first three programs appear in this issue. Texas Instruments fans will be glad to hear that Neely is in the process of translating many of the HP programs into the language of the new TI-59, and we hope to publish these as well in the future. James Neely has been as generous with his time as he has with his programs. He has responded to an endless stream of requests and questions from your ignorant editor, with careful explanations, hints, and when required, even short articles. In fact, his assistance has been so valuable that our staff considers him one of astrology's most useful natural resources and we will make him available to the astrological community thru the JAMES NEELY column in MATRIX. Readers may address questions relating to celestial mechanics, methodology and calculation proceedures to Neely himself or to the MATRIX address and we will publish the response— from time to time.

NEELY'S OUTER-BODY PROJECT

James Neely is a frequent contributor to PHENOMENA and has an article entitled AN ANALYSIS OF THE TRANSNEPTUNIAN PLANETARY EPHEMERIDES OF WITTE AND SIEGGRUN in the current issue of the NCGR JOURNAL OF GEOCOSMIC RESEARCH. We would like to introduce our readers to the quality of Neely's research by describing one current project in which he is involved that we feel will affect all astrologers.

Every astrologer who owns a programmable calculator or small micro system must dream of generating planetary positions from scratch that approach the accuracy of real ephemerides. At present, it is possible to get positions accurate to within a minute or so for the inner planets and, rougly speaking, for mars as well. However, positions for the outer bodies can lead or lag the true position by as much as 45 minutes of a degree— a little dissapointing we can agree. Neely is in the process of changing all this and we will present this exciting project in his own words as we have received them thru several progress reports.

" The main reason [for the lack of accuracy with outer planet calculation] is that the American Ephemeris and Nautical Almanac people, Simon Newcomb, Hill, Woolard, and CLemence were interested in accuracy but not, apparently, in consistancy of methodology. For this

reason the inner body computations use the method of Newcomb and the outer bodies, the method of Hill. The outer body method of Hill was found to suffer predictive accuracy and so was replaced by the numerical integration scheme [numerical integration= large computers and lots of memory] that is in use today. The upshot of all of this is that the Moon and inner body computations are well documented and are in a usable form; the outer body computations are also well documented but are not in a conveniently usable form for our purposes."

"..I am considering generating myself the 40 day positions of the outer bodies...and converting them to classical orbital elements (osculating)...and then curve fitting these elements over 5 to 7 year intervals for Jupiter and longer intervals for the more distant bodies, and then these elements could be used in a computer program or even on the handheld."

" I had decided to take the bull by the horns and program the numerical integration computations outlined in volume XII of the American Ephemeris and Nautical Almanac (AENA) supplements when somehow LLoyd Carpenter's NASA Techical Note D-3168, "Planetary Perturbations in Chebyshev Series", intruded upon my consciousness. I've spent numerous hours pouring over that paper and have decided that it is the best way to go on the outer bodies ... anyhow, I have all of this programmed ...and next week I'll try to see how it works"

" I've got phase I of my outer body project completed. All of the Carpenter tables have been coded and checked and I've generated... the 1950.0 heliocentric equatorial coordinates and velocites at 40 day intervals from 1898 through 2001. The agreement with the AENA volume XII is astounding! The next phase will be to precess the coordinates and then rotate them to the ecliptic and then convert them to classical orbital elements. When that is done I'll worry about the following phase. At least I'm a lot further along than I thought I'd be."

" The outer body project is proceeding well. I've got a routine working now that does the precession, conversion to ecliptic, and finally conversion to classical orbital elements. The results agree well with the osculating elements that are printed on page 217 of the AENA for the past 10 or so years. My next task will be to make plots of these elements so that I can get an eye-ball feeling of how they vary from 1900 to 2000...Anyhow, I'm a lot further along than I thought I'd be at this point in time."

" The 'Outer Body' project is progressing well. I have 1900-2000 year plots of each of the six orbital elements for each of the outer bodies plus similar plots in which the least squares linear contributions have been removed. The BEST linear elements for my HP-67/97 Planetary Program are enclosed. There is substantial improvement in Neptune, for example, and the elements are almost (but not quite) as good as those for the inner bodies. The next phase will be to do a harmonic analysis on the residuals produced by removing the linear contributions. This will lead to a set of formulas which [at best] should be good to about 1" (more or less depending upon how many terms the user can fit into his calculator).

" You should know that the heliocentric coordinates of the outer bodies that I've been computing are accurate to 0".001, and so the osculating elements that I've produced are quite good. In so far as the 1" for the outer bodies is concerned,[1" refers to accuracy] I must warn you that the 1" refers to the heliocentric position (and the 1" is still a HOPE). The geocentric position will be limited (if the 1" helio-position is achieved) by the accuracy of the solar position computation. In fact all of the geocentric positions (except lunar) depend upon the accuracy of the solar position. I can see this as a never ending problem. If the outer bodies and the sun are computed to 1", then we'll want to get the inner bodies to that accuracy too. Fortunately that work is available in the Simon Newcomb papers and so it is just a matter of getting enough storage space to do the computations."

"[]", bracketed material in the above are your editor's remarks.

Altho the Neely outer body project is not completed, the values we have so far received are worth applause. These values produce outer body positions that are, in general, accurate to within 2-4 minutes for all of the planets with the exception of Uranus (here the discrepancy can reach 18-19 minutes of a degree of zodiac longitude). This is a vast improvement over previous values and this program can be implemented on any of the larger hand-programmable calculators!

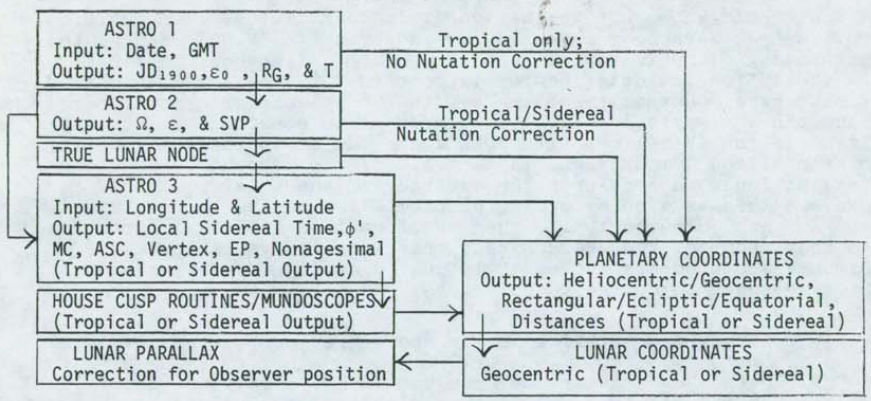
What this outer-body project could mean to astrologers around the world should, by now, be clear. Any astrologer will be capable of achieving quite adequate planetary positions for most research for a modest investment in a computing machine. These outer body values will influence how astrologers approach home computer systems too. As it stands now, purchasers of computer systems such as the PET and the TRS-80 cannot count on really accurate planetary position from their machines without the addition of expensive extra memory. This endless outside adding on can be depressing when the pocketbook cannot afford such additions. These Neely values for the outer planets will help to remove the "octopus" image of small computer systems. An astrologer not interested in large scale research will be able to have accurate planetary positions for an investment of around $250 (TI-59 programmable) or $800 for a PET or TRS-80 computer system. This is news!

Your editor has an adequate planetary program running on his new 8K PET computer. This program accepts the standard birth information as input and produces the ANGLES, heliocentric longitude and latitude, geocentric longitude and latitude (plus the Moon to within 2 minutes), Horizon coordinates for all planets, True Node of the Moon and Equatorial coordinates (right ascension and declination) for all planets. The same program also performs a variety of locality-shifts as well.

We will print the above mentioned BASIC program along with a number of other programs and approaches to planetary positions in our next issue. We have a fine BASIC program from Robert Hand that gives the Sun to ± 2", Moon to ± 3" and the Moon's latitude to ± 1" of arc, and James Neely's complete Planetary Coordinate program for the HP-67/97 which includes the NEW values for the outer bodies.

THE NEELY PROGRAMS

The Interrelation of the Neely Programs



THIS ISSUE: ASTRO 1, 2 & 3 implemented on the HP-97 programmable

Neely Programs to be published in future issues

PLANETARY COORDINATES
DISTANCE VALUES
RIGHT ASCENSION & LATITUDE FROM LONGITUDE & DECLINATION
RIGHT ASCENSION, LATITUDE, & LONGITUDE FROM MC & ASC
SOLSTICE POINTS
SPECULUM— SEMIARC, ASCENSIONAL DIFFERENCES & TIMES OF EVENTS
HOUSE CUSPS— ALCIBUTUS I (CLASSICAL) METHOD
HOUSE CUSPS— CAMPANUS METHOD
HOUSE CUSPS— CLASSICAL LOCI METHOD (PTOLEMY PER NOONAN)
HOUSE CUSPS— EQUAL HOUSE A (PTOLEMAIC) & M (MIDHEAVEN) METHODS
HOUSE CUSPS— KOCK (GOH) METHOD
HOUSE CUSPS— MERIDIAN (AXIAL, OR ALCIBUTUS II) METHOD
HOUSE CUSPS— MORINUS METHOD
HOUSE CUSPS— PLACIDUS APPROXIMATION METHOD
HOUSE CUSPS— PLACIDUS (EXACT) METHOD
HOUSE CUSPS— PORPHYRY METHOD
HOUSE CUSPS— REGIOMONTANUS METHOD
HOUSE CUSPS— TOPOCENTRIC METHOD
MUNDOSCOPE— CAMPANUS
MUNDOSCOPE— REGIOMONTANUS
LUNAR COORDINATES
TRUE LUNAR NODE
LUNAR PARALLAX
ASPECTS & MIDPOINTS I & II
ALMUCANTAR/ECLIPTIC INTERSECTION & NONAGESIMAL ALTITUDE
ASPECTS WITHIN ORB
& OTHERS

All of the Neely Material is implemented on the HP67/97 and is accompanied by very fine documentation. Neely programs on the new Texas Instruments machines ——in the works!

ASTRO 1: Mean Obliquity of the Ecliptic
Greenwich Sidereal Time
ASTRO 2: Moon's Ascending Node
Nutation of Obliquity
Synetic Vernal Point
Astro 3: Local Sidereal Time
Geocentric Latitude
Midheaven, Ascendant, Nonagesimal, East Point, Vertex

PROGRAM DESCRIPTION, EQUATIONS, VARIABLES:

(1) Compute the Number of Days from Jan 0, 1900 for any date since Jan 1, 4713 B.C. (dates prior to Oct. 15, 1582 are assumed to be Julian calendar). The calendar routine is authored by Richard C. Singleton:

IM=12(Y+4800)+M-3

THEN $JD(J)=\left[\frac{IM}{48}\right]+\left[\frac{365IM+2MOD(IM,12)+7}{12}\right]+D-32083$

IF JD(J)>= 2299171(Oct. 15, 1582), the Gregorian calendar is used:

$JD(G)=JD(J)+\left[\frac{IM}{4800}\right]-\left[\frac{IM}{1200}\right]+38$

WHERE: Y=Year, M=Month, D=Day, and [ARG] is the integer part of ARG.

[NOTE: The term [ARG] refers to that part of the equation inclosed by brackets([ ]) and the INTEGER portion only of the enclosed portion is to be used. The integer portion would be that portion of any result that precedes the decimal point. Thus the integer portion of 295.807 would be 295. The part of the above formula "2MOD(IM,12)" can also be written: 2•(IM-(INT(IM÷12)•12)) Editor]

THEN $JD_{1900}=J-2415020$

(2) Compute T, the number of Julian centuries from Greenwich Mean Noon, Jan 0, 1900:

$T=(t_g\div24+JD_{1900}-0.5)\div36525$, where t_g is the Greenwich Mean Time (GMT) of the observation.

(3) Compute the Mean Obliquity of the Ecliptic: $\varepsilon_o = 23°452294-0°013013T$

(4) Compute the Greenwich Mean Sidereal Time:

$R_G = t_G + (23925.836+8640184.542T+0.0929T^2)\div3600 (\text{mod}24)$

(5) Compute the Mean Longitude of the Moon's Ascending Node (Ω):

$\Omega = 259°10'59''.79 - 5^r134°08'31''.23T + 7''.48T^2$

WHERE T is as given above in (2) [NOTE: the expression "5^r" in the equation refers to five complete revolutions of 360° or 1800°-Editor]

(6) Compute the Differential Nutation of the Obliquity ($\delta\varepsilon$):

$\delta\varepsilon = 9''.21\cdot\cos\Omega+0.55\cdot\cos(2L)$, WHERE $2L = 559°23'36'' + 200^r1°32'16''T$

and the corrected obliquity then is $\varepsilon = \varepsilon_o + \delta\varepsilon$

(7) Compute the Synetic Vernal Point (SVP):

$SVP = -23°20'36\overset{''}{.}27 - \Delta\lambda$ WHERE $\Delta\lambda = (5025\overset{''}{.}64 + 1\overset{''}{.}11T)T - 17\overset{''}{.}23\sin\Omega - 1\overset{''}{.}27\sin(2L)$

(The precession plus nutation of the ecliptic longitude=$\Delta\lambda$)

(8) Compute Local Sidereal Time:

(a) Right Ascension of the Zenith Meridian (RAMC) or (α_{MC}):

$\alpha_{MC} = \alpha_G + \ell_N \pmod{360}$ degrees, WHERE ℓ_N is the Geographic Longitude (+ for East, − for West) $[\alpha_G = R_G \cdot 15]$

(b) Local Sidereal Time (LST)= $\alpha_{MC} \div 15$ hours

(9) Compute Geocentric Latitude (ϕ_c):

$\phi_c = \tan^{-1}(0.993305 \cdot \tan\phi_G)$, WHERE ϕ_G is the Geographic Latitude (+ for North, − for South). ϕ_G must be an input; The computation of ϕ_c is optional. Henceforth, either latitude will de denoted by ϕ.

(10) Compute Midheaven (Geocentric Ecliptic Longitude of the Zenith Meridian) λ_{MC}:

$$\lambda_{MC} = \tan^{-1}\left[\frac{\sin\alpha MC}{\cos\alpha_{MC} \cdot \cos\varepsilon}\right]$$

(11) Compute Ascendant(Geocentric Ecliptic Longitude of the Eastern Horizon), λ_{ASC}:

$$\lambda_{ASC} = \tan^{-1}\left[\frac{\cos\alpha MC}{-\sin\alpha_{MC} \cdot \cos\varepsilon - \tan\phi \cdot \sin\varepsilon}\right]$$

(12) Compute Nonagesimal= $\lambda_{ASC} - 90°$

(13) Compute East point = $\tan^{-1}\left[\frac{\cos\alpha MC}{-\sin\alpha_{MC} \cdot \cos\varepsilon}\right]$

(14) Compute Vertex = $\tan^{-1}\left[\frac{\cos(\alpha MC + 180°)}{-\sin(\alpha_{MC} + 180°) \cdot \cos\varepsilon - \sin\varepsilon \div \tan\phi}\right]$

REFERENCES:

(1)"Explanatory Supplement to the Astronomical Ephemeris and the American Ephemeris and Nautical Almanac", Her Majesty's stationary Office, London 1961.
(2) Stahl-Allen "Synetic Vernal Point Ephemeris", Solunar Research Publications, Bay City, Michigan, 1969
(3) Nonagesimal: Woolard and Clemence, "Spherical Astronomy", Academic Press, 1966.
(4) East Point and Vertex: Buz Overbeck and Golda Jones, "Transits in the Sidereal", THE CONSTELLATIONS, Vol. 2, No. 1, August 1976

NOTE: Comment on degree-minute-second rounding: Occasionally output such as 23°34'60" is encountered whereas the desired output should read 23°35'00". The desired output can be obtained by inserting the following three program steps: RND, 0, H.MS+, immediately following the code →H.MS . This additional code can be used in all of the Neely programs if desired.

USER INSTRUCTIONS FOR ASTRO 1, 2 & 3

ASTRO. I	INPUT	KEYS	OUTPUT
(1) ENTER PROGRAM CARD			
(2) ENTER DATE IN THE FORM MM.DDYYYY where MM is the month, DD is the day, and YY is the year (4 digits). MM and DD must be seperated by a decimal point. NOTE: see warning on B.C. dates given earlier.	MM.DDYYYY	A	JD_{1900}
(3) ENTER GREENW MEAN TIME	HH.MMSS	B	(DD.MMSS)
DISPLAY GREENW MEAN SIDEREAL TIME		R/S	HH.MMSS
DISPLAY T		R/S	X.XXXX

NOTE: For use with ASTRO. II and/or the Planetary Coordinate Program, steps 2 and 3 (KEY B) must be executed. The display of GMT and "T" are optional.

ASTRO. II			
(1) After ASTRO I is executed, ENTER ASTRO II (both sides)			
(2) START COMPUTATIONS	no input	A	
A DISPLAY Ω			DDD.MMSS
B DISPLAY ZODIAC SIGN		R/S	S.0000
C DISPLAY DEGREE IN SIGN		R/S	DD.MMSS
D DISPLAY 30° +SVP		R/S	DD.MMSS
Repeat from step 2A		R/S	Ω
(3) CORRECT OBLIQUITY FOR NUTATION		f E	$\varepsilon = \varepsilon_o + \delta\varepsilon$ DD.MMSS
(4) IF desired, REVIEW: 3A		C	Ω
3B		R/S	SIGN
3C		R/S	DEG-in-SIGN
3D		R/S	30°+ SVP

ASTRO. III			
(1) EXECUTE ASTRO I (and ASTRO II of corrected obliquity and/or sidereal zodiac is desired) and ENTER ASTRO III (both sides)			
(2) ENTER GEOGRAPHIC LONGITUDE IN D-M-S (+ for EAST, − for WEST)	DD.MMSS	A	Local Sidereal Time HH.MMSS
(3)A ENTER GEOGRAPHIC LATITUDE IN D-M-S (+ for North, − for South)	DD.MMSS	B	Latitude in Deg.
B IF REQUIRED, COMPUTE GEOCENTRIC LATITUDE	NONE	R/S	DD.MMSS
(4) SET MODE TO SIDEREAL or		f E	
SET MODE TO TROPICAL (DEFAULT)		f A	
(5) COMPUTE MIDHEAVEN, MC		C	DDD.MMSS
OPTIONAL- SIGN OF MIDHEAVEN		R/S	SS.0000
OPTIONAL- DEGREE-IN-SIGN of MIDHEAVEN		R/S	DD.MMSS
(6) COMPUTE ASCENDANT, ASC		D	DDD.MMSS
OPTIONAL- SIGN OF ASCENDANT		R/S	SS.0000
OPTIONAL- DEGREE-IN-SIGN of ASCENDANT		R/S	DD.MMSS
(7) COMPUTE NONAGESIMAL		f B	DDD.MMSS
(8) COMPUTE EAST POINT		f C	DDD.MMSS
(9) COMPUTE VERTEX		f D	DDD.MMSS

ASTRO 1, 2 & 3

SAMPLE PROBLEM: For 0148 GMT on April 20, 1976, Calculate:
Geographic Latitude 37°N20', Geographic Longitude 121°W55'

ASTRO 1

(1) JD_{1900} 4.201976 [A] 27869.000= JD_{1900}

NOTE: B.C. dates must be entered as negative quantities: 1 A.D.=1, 1 B.C.=0, 2 B.C.=−1, 3 B.C.=−2, etc. For example, Jan. 1, 6 B.C. is entered as −1.01005

(2) ε_0 = Obliquity of the Ecliptic 1.48 [B] 23.2633=ε_0 = 23°26'33"

(3) R_G = Greenwich Mean Sidereal Time [R/S] 15.4107 = R_G = 15h41m07s

(4) T = Number of Julian Centuries from Jan. 0, 1900 [R/S] 0.7630 = T

ASTRO 2 — First, execute ASTRO 1, then, using ASTRO 2, calculate:

(1) Ω, the Ascending Node [A] 223.2603 = Ω = 223°26'03"

(2) The Zodiac Sign of Ω (1= Aries, 2=Taurus, etc)

[R/S] 8.000 = 8th Sign (Scorpio—♏)

(3) The Degree-In-Sign of Ω, [R/S] 13.2603 = Degree-In-Sign = 13°♏26'03"

(4) 30°+SVP (Synetic Vernal Point) [R/S] 5.3516 = 30° + SVP = 5°35'16"

(5) Correct the Mean Obliquity ε_0 (obtained from ASTRO 1) for Nutation:

[f/E] 23.2626 = ε_0 + δε = ε = 23°26'26"

ASTRO 3— First execute both ASTRO 1 and ASTRO 2, then with ASTRO 3:

(1) Local Sidereal TIME (LST) −121.55 [A] 7.3327 = 7h33m27s LST

(2) Geocentric Latitude

37.20 [B] 37.2600 = Geographic Latitude; [R/S] 37.0852=37°N08'52" Geocentric Lat.

(3) Tropical Midheaven, λ_{MC}

λ_{MC} Tropical= [C] 111.3704=111°37'04" [R/S] 4.0000=4th Sign [R/S] 21.3704=21°♋37'04"

(4) Tropical Ascendant,

λ_{ASC}= [D] 199°0722=199°07'22" [R/S] 7.0000=7th Sign [R/S] 19.0722= 19°♎07'22"

(5) Tropical Vertex, [f/d] 51.2034=51°20'34" [R/S] 2=2nd Sign [R/S] 21.2034= 21°♉20'34"

(6) Tropical Nonagesimal,

[f/b] 109.0722=109°07'22" [R/S] 4=4th Sign [R/S] 19.0722= 19°♋07'22"

(7) Tropical East Point,

[f/c] 205.1238=205°12'38" [R/S] 7=7th Sign [R/S] 25.1238= 25°♎12'38"

SIDEREAL OUTPUT instead of TROPICAL OUTPUT:

[f/e] will change to Sidereal and PRESS same KEY SEQUENCE as given above

(3) Sidereal Midheaven λ_{MC}= 87.1220=87°12'20"=3rd Sign= 27°♊12'20"

(4) Sidereal Ascendant λ_{ASC}=174.4237=174°42'37"=6th Sign=24°♍42'37"

(5) Sidereal Vertex =26.5050=26°50'50"=1st Sign=26°♈50'50"

(6) Sidereal Nonagesimal =84.4237=84°42'37"=3rd Sign=24°♊42'37"

(7) Sidereal East Point =180.4754=180°47'54"=7th Sign=0°♎47'54"

ASTRO 1 : PROGRAM STEPS FOR THE HP-67/97

Step	KEY	Code		Step	KEY	Code	
001	*LBLA	21 11		057	X	-35	
002	0	00		058	+	-55	
003	STOØ	35 00		059	RCL5	36 05	
004	P↔S	16-51		060	÷	-24	
005	R↓	-31	UNPACK DATE	061	INT	16 34	
006	ENT↑	-21		062	RCL4	36 04	
007	ABS	16 31		063	+	-55	
008	÷	-24		064	RCL6	36 06	
009	STO8	35 08		065	4	04	
010	LSTX	16-63		066	8	08	
011	ENT↑	-21		067	÷	-24	
012	INT	16 34		068	INT	16 34	
013	STO3	35 03		069	+	-55	
014	−	-45		070	3	03	
015	EEX	-23		071	2	02	
016	2	02		072	0	00	
017	X	-35		073	8	08	
018	ENT↑	-21		074	3	03	
019	INT	16 34		075	−	-45	
020	STO4	35 04		076	2	02	
021	−	-45		077	2	02	
022	EEX	-23		078	9	09	
023	4	04		079	9	09	
024	X	-35		080	1	01	
025	RCL8	36 08		081	7	07	
026	X	-35	JULIAN DAY	082	1	01	
027	4	04		083	X↔Y	-41	
028	8	08	NUMBER	084	X<=Y?	16-35	TEST FOR
029	0	00		085	GTO9	22 09	JULIAN OR
030	0	00	COMPUTATION	086	RCL6	36 06	GREGORIAN
031	STO7	35 07		087	RCL7	36 07	CALENDAR
032	+	-55		088	÷	-24	
033	1	01		089	INT	16 34	
034	2	02		090	+	-55	
035	STO5	35 05		091	RCL6	36 06	
036	X	-35		092	4	04	
037	RCL3	36 03		093	X	-35	
038	+	-55		094	RCL7	36 07	
039	3	03		095	÷	-24	
040	−	-45		096	INT	16 34	
041	ENT↑	-21		097	−	-45	
042	STO6	35 06		098	3	03	
043	RCL5	36 05		099	8	08	
044	÷	-24		100	+	-55	
045	INT	16 34		101	*LBL9	21 09	
046	RCL5	36 05		102	2	02	
047	X	-35		103	4	04	
048	−	-45		104	1	01	
049	ENT↑	-21		105	5	05	
050	+	-55		106	0	00	
051	7	07		107	2	02	
052	+	-55		108	0	00	STORE
053	3	03		109	−	-45	JD_{1900}
054	6	06		110	STO2	35 02	
055	5	05		111	R/S	51	
056	RCL6	36 06		112	*LBLB	21 12	

ASTRO 1: PROGRAM STEPS FOR THE HP-67/97 (continued)

Step	KEY	CODE	
112	*LBLB	21 11	ENTER GMT
113	HMS	16 36	
114	STOC	35 13	
115	2	02	
116	4	04	
117	÷	-24	
118	RCL2	36 02	COMPUTE T
119	+	-55	
120	.	-62	
121	5	05	
122	—	-45	
123	3	03	
124	6	06	
125	5	05	
126	2	02	
127	5	05	
128	÷	-24	
129	STOA	35 11	STORE T
130	.	-62	
131	0	00	
132	1	01	
133	3	03	
134	0	00	
135	1	01	
136	3	03	
137	CHS	-22	
138	RCLA	36 11	
139	X	-35	COMPUTE AND
140	2	02	STORE ε_0
141	3	03	
142	.	-62	
143	4	04	
144	5	05	
145	2	02	
146	2	02	
147	9	09	
148	4	04	
149	+	-55	
150	STOB	35 12	----------
151	.	-62	COMPUTE R_G
152	0	00	
153	9	09	
154	2	02	
155	9	09	
156	RCLA	36 11	
157	X	-35	
158	8	08	
159	6	06	
160	4	04	
161	0	00	
162	1	01	
163	8	08	
164	4	04	
165	.	-62	
166	5	05	
167	4	04	
168	2	02	
169	+	-55	
170	RCLA	36 11	
171	X	-35	
172	2	02	
173	3	03	
174	9	09	
175	2	02	
176	5	05	
177	.	-62	
178	8	08	
179	3	03	
180	6	06	
181	+	-55	
182	3	03	
183	6	06	
184	0	00	
185	0	00	
186	÷	-24	
187	RCLC	36 13	
188	+	-55	
189	2	02	
190	4	04	
191	÷	-24	
192	FRC	16-44	
193	2	02	
194	4	04	
195	X	-35	
196	STO4	35 04	
197	0	00	
198	X<=Y?	16-35	
199	GTO1	22 01	
200	2	02	
201	4	04	
202	ST+4	35-55	04 ----------
203	*LBL1	21 01	
204	RCL4	36 04	COMPUTE AND
205	1	01	STORE α_G
206	5	05	
207	X	-35	
208	STOD	35 14	----------
209	*LBL2	21 02	
210	RCLB	36 12	
211	→HMS	16 35	
212	R/S	51	DISPLAY
213	RCL4	36 04	
214	→HMS	16 35	
215	R/S	51	DISPLAY R_G
216	RCLA	36 11	
217	R/S	51	DISPLAY T
218	GTO2	22 02	

ASTRO 1: LABELS USED= A, B, 1, 2, 9 DISPLAY= FIXED (4) ALL FLAGS OFF
REGISTER CONTENTS: R1= J R2= JD_{1900} R3= M R4= D R5= 12 R6= IM
R7= 4800 R8=±1 RA= T RB=ε_0 RC= t_G RD=α_G trig in degree mode

ASTRO 2: PROGRAM STEPS

STEP	KEY	CODE	
001	*LBLA	21 11	START Ω
002	7	07	COMPUTATION
003	.	-62	
004	4	04	
005	8	08	
006	RCLA	36 11	
007	X	-35	
008	6	06	
009	9	09	
010	6	06	
011	2	02	
012	9	09	
013	1	01	
014	1	01	
015	.	-62	
016	2	02	
017	3	03	
018	—	-45	
019	RCLA	36 11	
020	X	-35	
021	9	09	
022	3	03	
023	3	03	
024	0	00	
025	5	05	
026	9	09	
027	.	-62	
028	7	07	
029	9	09	
030	+	-55	
031	3	03	
032	6	06	
033	0	00	
034	0	00	
035	STO3	35 03	
036	÷	-24	
037	3	03	
038	6	06	
039	0	00	
040	STO4	35 04	
041	÷	-24	
042	FRC	16 44	
043	RCL4	36 04	
044	X	-35	
045	0	00	ADD 360° IF Ω
046	X≠Y?	16-35	NEGATIVE
047	GTO1	22 01	
048	RCL4	36 04	
049	+	-55	----------
050	*LBL1	21 01	
051	+	-55	STORE Ω
052	STO1	35 01	----------
053	2	02	COMPUT 2L
054	5	05	
055	9	09	
056	2	02	
057	0	00	
058	5	05	
059	5	05	
060	3	03	
061	6	06	
062	RCLA	36 11	
063	X	71	
064	2	02	
065	0	00	
066	1	01	
067	3	03	
068	8	08	
069	1	01	
070	6	06	
071	+	-55	
072	RCL3	36 03	
073	÷	-24	STORE 2L
074	STO2	35 02	----------
075	COS	42	COMPUTE Ω
076	.	-62	
077	5	05	
078	5	05	
079	X	-35	
080	RCL1	36 01	
081	COS	42	
082	9	09	
083	.	-62	
084	2	02	
085	1	01	
086	X	-35	
087	+	-55	
088	RCL3	36 03	STORE Ω
089	÷	-24	----------
090	STO5	35 05	COMPUTE
091	1	01	Δλ
092	7	07	
093	.	-62	
094	2	02	
095	3	03	
096	RCL1	36 01	
097	SIN	41	
098	X	-35	
099	1	01	
100	.	-62	
101	2	02	
102	7	07	
103	RCL2	36 02	
104	SIN	41	
105	X	-35	
106	+	-55	
107	1	01	
108	.	-62	
109	1	01	
110	1	01	
111	RCLA	36 11	
112	X	-35	
113	5	05	
114	0	00	
115	2	02	
116	5	05	
117	.	-62	
118	6	06	
119	4	04	
120	+	-55	
121	RCLA	36 11	COMPUTE
122	X	-35	SVP
123	—	-45	
124	8	08	
125	4	04	
126	0	00	
127	3	03	
128	8	08	
129	.	-62	
130	2	02	
131	7	07	
132	—	-45	
133	RCL3	36 03	
134	÷	-24	STORE SVP
135	STOE	35 15	----------
136	*LBLC	21 13	START
137	RCL1	36 01	DISPLAY
138	→HMS	16 35	
139	R/S	51	DISPLAY Ω
140	ENT↑	-21	
141	ENT↑	-21	
142	3	03	
143	0	00	
144	÷	-24	
145	INT	16 34	
146	1	01	
147	+	+55	
148	R/S	51	DISPLAY
149	1	01	SIGN
150	—	-45	
151	3	03	
152	0	00	
153	X	-35	
154	—	-45	
155	R/S	51	DISPLAY
156	RCLE	36 15	DEG-IN-SIGN
157	3	03	
158	0	00	
159	+	-55	DISPLAY
160	→HMS	16 35	30°+SVP
161	R/S	51	----------
162	GTOC	22 13	RE-DISPLAY
163	*LBL3	21 03	----------
164	0	00	ERROR
165	÷	-24	ROUTINE

ASTRO 2 (CONTINUED)

STEP	KEY	CODE	
166	GTO3	22 03	CORRECT ε_0
167	*LBLe	21 16 15	
168	F2?	16 23 02	
169	GTO4	22 04	PROTECT FROM EXTRA-
170	GTO3	22 03	NEOUS CORRECTION
171	*LBL4	21 04	
172	RCLB	36 12	
173	RCL5	36 05	
174	+	-55	
175	STOB	35 12	DISPLAY
176	HMS	16 35	$\varepsilon = \varepsilon_0 + \delta\varepsilon$
177	R/S	51	

ASTRO 2: LABELS IN USE:
A, C, e, 1, 3, 4

REGISTER CONTENTS:

R1 = Ω
R2 = 2L
R3 = 3600
R4 = 360
R5 = $\delta\varepsilon$
RA = T
RB = ε
RC = t_G
RD = α_G
RE = SVP

FLAG STATUS:

Flag 2 ON
Flags 0,1,3 OFF

TRIG MODE

DISPLAY= FIXED (4)

ASTRO 3: LABELS IN USE

LBLA = LONG LBLB = LAT
LBLC = MC LBLD = ASC
LBLa = TROP LBLb = NON.
LBLc = EP LBLd = VTX
LBLe = SID LBLØ = ERROR
LABELS 1, 2, 3, 5, 6 USED

REGISTER CONTENTS:

RA = T
RB = ε
RC = t_G/ϕ
RD = α_G/α_{MC}
RE = SVP
RØ = π
R8 = t_G
R9 = α_G

DISPLAY = FIXED (4)
TRIG in DEGREE MODE
FLAGS 0, 1, 2 USED (0 &2 ON, 1 OFF)

ASTRO 3: PROGRAM STEPS FOR THE HP-67/97

STEP	KEY	CODE	
001	*LBL1	21 01	STORE t_G & α_G
002	RCLC	36 13	
003	STO8	36 08	IN A NEW
004	RCLD	36 14	LOCATION.
005	STO9	35 09	KEY RO WITH π
006	π	16-24	
007	STO9	35 09	
008	R↑	16-31	
009	RTN	24	
010	*LBL3	21 03	----------
011	0	00	CONVERT NEG-
012	X<=Y?	16-35	ATIVE ANGLES TO
013	GTO4	22 04	POSITIVE
014	3	03	
015	6	06	
016	0	00	
017	+	-55	
018	*LBL4	21 04	----------
019	+	-55	
020	RTN	24	
021	*LBLA	21 11	
022	F2?	16 23 02	
023	GSB1	23 01	ENTER LONGITUDE
024	HMS→	16 36	& COMPUTE LOCAL
025	RCL9	36 09	SIDEREAL TIME
026	+	-55	
027	GSB3	23 03	
028	STOD	35 14	
029	1	01	
030	5	05	
031	÷	-24	
032	→HMS	16 35	
033	R/S	51	----------
034	GTOØ	22 00	ERROR ----------
035	*LBLB	21 12	
036	F2?	16 23 02	
037	GSB1	23 01	
038	HMS→	16 36	ENTER
039	STOC	35 13	GEOGRAPHIC
040	LSTX	16-63	LONGITUDE
041	R/S	51	----------
042	RCLC	36 13	CONVERT
043	TAN	43	GEOGRAPHIC
044	.	-62	LATITUDE TO
045	9	09	GEOCENTRIC
046	9	09	LATITUDE
047	3	03	
048	3	03	
049	0	00	
050	5	05	
051	X	-35	
052	TAN^{-1}	16 43	
053	STOC	35 13	
054	→HMS	16 35	

ASTRO 3 (CONTINUED)

STEP	KEY	CODE	
055	R/S	51	
056	GTOØ	22 00	
057	*LBLC	21 13	COMPUTE MC
058	RCLD	36 14	
059	1	01	
060	→R	44	
061	RCLB	36 12	
062	COS	42	
063	X	-35	
064	GTO5	22 05	----------
065	+LBLD	21 14	
066	RCLD	36 14	COMPUTE
067	1	01	ASCENDANT
068	→R	44	
069	RCLB	36 12	
070	1	01	
071	→R	44	
072	R↑	16-31	
073	X	-35	
074	X↔Y	-41	
075	RCLC	36 13	
076	TAN	43	
077	X	-35	
078	+	-55	
079	CHS	-22	
080	*LBL5	21 05	----------
081	→P	34	ROUTINE FOR
082	X↔Y	-41	MC & ASC.
083	F1?	16 23 00	
084	RTN	24	----------
085	*LBL6	21 06	TROP or SIDER ?
086	RCLE	36 15	
087	FØ?	16 23 00	
088	CLX	-51	
089	+	-55	
090	GSB3	23 03	
091	→HMS	16 35	
092	RND	16 24	
093	Ø	00	
094	HMS+	16-55	DISPLAY DEGREE
095	R/S	51	----------
096	ENT↑	-21	
097	ENT↑	-21	
098	3	03	
099	Ø	00	
100	÷	-24	
101	INT	16 34	
102	1	01	
103	+	-55	DISPLAY SIGN ----
104	R/S	51	
105	1	01	
106	—	-45	
107	3	03	
108	Ø	00	
109	X	-35	DISPLAY DEGREE-IN-SIGN
110	—	-45	
111	R/S	51	----------
112	GTOØ	22 00	ERROR ----------
113	*LBLa	21 16 11	
114	SFØ	16 21 11	SET SIDEREAL
115	R/S	51	----------
116	GTOØ	22 00	ERROR ----------
117	*LBLe	21 16 15	
118	CFØ	16 22 00	COMPUTE VERTEX
119	R/S	51	
120	GTOØ	22 00	
121	*LBLd	21 16 14	
122	RCLD	36 14	
123	1	01	
124	8	08	
125	Ø	00	
126	+	-55	
127	1	01	
128	→R	44	
129	RCLB	36 12	
130	1	01	
131	→R	44	
132	R↑	16-31	
133	X	-35	
134	X↔Y	-41	
135	RCLC	36 13	
136	TAN	43	
137	1/X	52	
138	X	-35	
139	+	-55	
140	CHS	-22	
141	GTO5	22 05	----------
142	*LBLc	21 16 13	
143	RCLD	36 14	
144	1	01	COMPUTE EAST POINT
145	→R	44	
146	X↔Y	-41	
147	CHS	-22	
148	RCLB	36 12	
149	COS	42	
150	X	-35	----------
151	GTO5	22 05	
152	*LBLb	21 16 12	
153	SF1	16 21 01	COMPUTE
154	GSBD	23 14	NONAGESIMAL
155	CF1	16 22 01	
156	9	09	
157	Ø	00	
158	—	-45	
159	GTO6	22 06	
160	R/S	51	

HP-97/67 ASTROLOGICAL CHART CONSTRUCTION

A ONE-CARD PROGRAM THAT INCORPORATES MANY OF THE FEATURES IN THE NEELY ASTRO I,II & III

The editors feel that some astrologers might enjoy some of the features in the Neely ASTRO I, II & III programs condensed to a single program card. Professional astrologers often need to run 15 or 20 charts thru their machines at a sitting and this makes it necessary to get as many calculations on a single program card as possible. Here is a one-card program that can be used to construct natal charts. It outputs the RAMC, the Midheaven, Ascendant and Vertex and interpolates planetary positions from a midnight ephemeris. The Neely features used in this routine include: Julian Day Numbers, Local Sidereal Time, Polar/Rectangular functions and Rounding D-M-S.

EQUATIONS, VARIABLES: The equations are identical to those given in the James Neely ASTRO programs elsewhere in this issue and will not be repeated here.

INPUT & OUTPUT: This program requires the following INPUT which is the standard Birth information used by astrologers: Birthdate & Year, Time and Place. This information is entered: Example: July 18, 1941 at 4:03 PM, Lancaster, PA (76W18, 40N02)

	STACK		Example	
(1) BIRTHDATE	(T)	MM.DDYYYY	07.181941	
(2) GMT	(Z)	HH.MMSS	21.03	(4:03 + 12h + 5h TIME ZONE)
(3) LONGITUDE (L)	(Y)	DDD.MMSS	76.18	(EAST longitudes "−" SIGN)
(4) LATITUDE (φ)	(X)	DD.MMSS	40.02	(SOUTH latitudes "−" SIGN)

Note: GMT, Geographic Longitude & Latitude are entered in H-M-S or D-M-S format and not in DECIMAL format. The GMT in this program consists of the birth or event time as measured from MIDNIGHT of the date used PLUS the TIME ZONE factor in HOURS. (EAST of Greenwich TIME ZONES will be subtracted, WEST of Greenwich TIME ZONES added) Also note that EAST Geographic Longitudes and SOUTH Geographic Latitudes must be entered with a MINUS SIGN ("−") in front of them (example: Canberra, Australia with a Geographic Longitude of 149°E08' would be entered: − 149.08; and a Geographic Latitude of 35°S19' would be entered: − 35.19). Here are the four possible cases you might encounter:

North Latitude East Longitude	South Latitude East Longitude	North Latitude West Longitude	South Latitude West Longitude
(T) MM.DDYYYY	(T) MM.DDYYYY	(T) MM.DDYYYY	(T) MM.DDYYYY
(Z) HH.MMSS	(Z) HH.MMSS	(Z) HH.MMSS	(Z) HH.MMSS
(Y) − DDD.MMSS	(Y) − DDD.MMSS	(Y) DDD.MMSS	(Y) DDD.MMSS
(X) DD.MMSS	(X) − DD.MMSS	(X) DD.MMSS	(X) − DD.MMSS

EXAMPLE INPUT:

(T) MM.DDYYYY	07.181941	
(Z) HH.MMSS	21.0300	
(Y) DDD.MMSS	76.1800	
(X) DD.MMSS	40.0200	

OUTPUT:

175.725382	RAMC in DECIMALS
175.2032	Midheaven in DDD.MMSS
248.0044	Ascendant in DDD.MMSS
112.0658	Vertex in DDD.MMSS

INTERPOLATION ROUTINE FOR PLANETS

After the ANGLES OUTPUT, the program is ready to interpolate planetary positions using any standard MIDNIGHT ephemeris. The CONSTANT factor used in this routine is stored in register 2 and the program automatically checks this register to determine whether there has been an overflow into the next ephemeris date listing. If there has been an overflow, the HP-97 will PRINT the number one (HP-67 will FLASH 1) and if no overflow has occurred, the number 1 will not be printed, but will be displayed on the calculator screen. If there has been an overflow: use the ephemeris listings for the NEXT date to that date entered in program INPUT. (the following date) For example, if there had been overflow on the July 18, 1941 input (given earlier), we would use the ephemeris listings for the 19th and 20th rather than for the 18th and 19th.

The CONSTANT in register 2 is adjusted automatically when overflow occurs. This routine also prints all retrograde planets with a "−" SIGN in front of them EXCEPT when no motion has occurred between the two ephemeris listings for the planet. If the retrograde-notation is required in these cases, the "−" SIGN must be entered with the planet listing.

The interpolation routine loops to a R/S instruction and may be used for any number of planetary positions.

OPERATING LIMITS AND WARNINGS:

Aside from the RETROGRADE warning (given above), the warnings are identical to those given in the Neely programs: Midheavens & Ascendants in the Polar latitudes may need 180° adjustment. B.C. dates must be entered as negative quantities: 1 A.D. = 1, 1 B.C. = 0, 2 B.C. = − 1, 3 B.C. = − 2, etc. For example, Jan 1, 6 B.C. is entered as − 1.010005.

DATA CARD

This program uses both sides of a DATA CARD which contains:

Storage Register		Storage Register	
0 =	USED	s0 =	USED
*1 =	36525	*s1 =	32083.0000 Julian Day Number Routine
2 =	Interpolation constant	*s2 =	365.000000 JDN
*3 =	− 0.0130125 Obliquity Routine	s3 =	USED
*4 =	23.45229444 Obliquity Routine	s4 =	USED
*5 =	360	*s5 =	12.0000000 JDN
*6 =	8640184.542 LST Routine	*s6 =	48.0000000 JDN
*7 =	23925.83600 LST Routine	*s7 =	4800.00000 JDN
8 =	USED	*s8 =	2299171.00 JDN
*9 =	3600.000000 LST Routine	*s9 =	2415020.00 JDN
A =	T	D =	Geographic Longitude
B =	Obliquity for date	E =	Geographic Latitude
C =	RAMC	* I =	0.09290000 JDN

Note: Those values marked with an asterisk (*) must be recorded on the DATA CARD.

Labels A, 9, 6, 5, 8 & B are used in this program. All flags are off at start.

This program can calculate any number of natal charts after program and data-card have been entered once (as long as the contents of the storage registers remains unaltered).

USER INSTRUCTIONS	DATA/INPUTS	
(1) ENTER PROGRAM CARD (both sides)		
(2) ENTER DATA-CARD (both sides)		
(3) ENTER DATE IN THE FORM MM.DDYYYY Where MM is the MONTH, DD is the DAY, and YYYY is the YEAR (4 digits). MM and DD must be separated by a decimal point.	MM.DDYYYY	(T) REGISTER
(4) ENTER GMT IN THE FORM HH.MMSS where GMT is measured from mid-night of date used above. GMT consists of the Event Time from midnight of date PLUS Time Zone in hours. (in the U.S.A. there are four Time Zones: Eastern =5h, Central = 6h, Moutain = 7h and Pacific = 8h)	HH.MMSS	(Z) REGISTER
(5) ENTER GEOGRAPHIC LONGITUDE IN DDD.MMSS Longitudes WEST of Greenwich are positive (left as is), while EAST longitudes are negative (preceeded by a minus "−" sign).	DDD.MMSS	(Y) REGISTER
(6) ENTER GEOGRAPHIC LATITUDE IN DD.MMSS Latitudes NORTH of equator are positive (left as is), while SOUTH latitudes are entered as negative values (preceeded by a minus "−" sign)	DD.MMSS	(X) REGISTER
(6) PRESS LABEL A will OUTPUT the following:	RAMC in Decimals DDD.Decimal MIDHEAVEN in DDD.MMSS ASCENDANT in DDD.MMSS VERTEX in DDD.MMSS	

SECTION TWO:

AFTER ANGLES OUTPUT, Program stops (after checking for DATE overflow) ready for interpolation INPUT as follows.

(1) ENTER EARLIER (Date used in above input) Planet Ephemeris Listing in Absolute Longitude or whole degrees from 0 to 360.....DDD.MMSS

(2) ENTER LATER (next date to above input) Planet Ephemeris Listing.....DDD.MMSS

(3) PRESS R/S will OUTPUT the interpolated planet position in DDD.Decimals

(4) ENTER remaining planet positions as ABOVE, repeating steps 1,2,3 of Section Two as often as desired.

Those of you who wish to tailor this program to your specific OUTPUT needs may want to delete the LABEL B sub-routine (steps 217 thru 224) and replace steps 150, 156 and 169 with a PRTX (PRINT) instruction. Output for MC, Ascendant and Vertex would then be in Decimal Fractions rather than .MMSS format. These freed-up steps could be used to INPUT the Universal to Ephemeris Time Correction (ΔT) into storage register 2, for those who feel a need for this factor. This could be inserted prior to step 171 by placing a R/S instruction after step 169 followed by these instructions: HMS→, 2, 4, ÷ , STO+2 if the ΔT correction is inserted in the .MMSS format (the ΔT correction for the 1941 example above would be entered .0025 since the factor for that year is listed as 25 seconds). HP-67s may want to use these extra steps to adapt the OUTPUT to their machines by inserting a R/S instruction where a PRTX has been used.

Step	KEY	Code	
001	*LBLA	21 11	
002	DSP6	-63 06	Store INPUT
003	PRST	16-14	for later use
004	HMS→	16 36	
005	STOE	35 15	
006	R↓	-31	
007	HMS→	16 36	
008	STOD	35 14	
009	R↓	-31	
010	HMS→	16 36	
011	STO8	35 08	
012	R↓	-31	
013	Ø	00	----------
014	STOØ	35 00	UNPACK DATE
015	P↔S	16-51	
016	R↓	-31	
017	ENT↑	-21	
018	ABS	16 31	
019	÷	-24	
020	STOØ	35 00	
021	LSTX	16-63	
022	ENT↑	-21	
023	INT	16 34	
024	STO3	35 03	
025	−	-45	
026	EEX	-23	
027	2	02	
028	X	-35	
029	ENT↑	-21	
030	INT	16 34	
031	STO4	35 04	
032	−	-45	
033	EEX	-23	
034	4	04	
035	X	-35	
036	RCLØ	36 00	
037	X	-35	
038	RCL7	36 07	
039	+	-55	
040	RCL5	36 05	
041	X	-35	
042	RCL3	36 03	
043	+	-55	
044	3	03	
045	−	-45	
046	ENT↑	-21	JULIAN DAY NUMBER
047	STO3	35 03	COMPUTATION
048	RCL5	36 05	
049	÷	-24	
050	INT	16 34	
051	RCL5	36 05	
052	X	-35	
053	−	-45	
054	ENT↑	-21	
055	+	-55	
056	7	07	

Step	KEY	Code	
057	+	-55	
058	RCL2	36 02	
059	RCL3	36 03	
060	X	-35	
061	+	-55	
062	RCL5	36 05	
063	÷	-24	
064	INT	16 34	
065	RCL4	36 04	
066	+	-55	
067	RCL3	36 03	
068	RCL6	36 06	
069	÷	-24	
070	INT	16 34	
071	+	-55	
072	RCL1	36 01	
073	−	-45	
074	RCL8	36 08	
075	X↔Y	-41	
076	X≤Y?	16-35	TEST FOR JULIAN OR
077	GTO9	22 09	GREGORIAN CALENDARS
078	RCL3	36 03	
079	RCL7	36 07	
080	÷	-24	
081	INT	16 34	
082	+	-55	
083	RCL3	36 03	
084	4	04	
085	X	-35	
086	RCL7	36 07	
087	÷	-24	
088	INT	16 34	
089	−	-45	
090	3	03	
091	8	08	
092	+	-55	JULIAN DAY NUMBER
093	*LBL9	21 09	
094	RCL9	36 09	
095	−	-45	
096	P↔S	16-51	
097	RCL8	36 08	
098	2	02	STORE PLANET CONSTANT
099	4	04	IN STO2
100	÷	-24	
101	STO2	35 02	
102	+	-55	COMPUTE T
103	.	-62	
104	5	05	
105	−	-45	
106	RCL1	36 01	
107	÷	-24	
108	STOA	35 11	STORE T
109	RCL3	36 03	
110	X	-35	COMPUTE OBLIQUITY
111	RCL4	36 04	
112	+	-55	

Step	KEY	Code	
113	STOB	35 12	STORE OBLIQUITY
114	RCLI	36 46	
115	RCLA	36 11	Compute RAMC at
116	X	-35	Greenwich
117	RCL6	36 06	
118	+	-55	
119	RCLA	36 11	
120	X	-35	
121	RCL7	36 07	
122	+	-55	
123	RCL9	36 09	
124	÷	-24	
125	RCL8	36 08	
126	+	-55	
127	1	01	
128	5	05	
129	X	-35	RAMC Greenwich
130	RCLD	36 14	Subtract Longitude
131	−	-45	
132	X<Ø?	16-45	
133	GSB8	23 08	CAST OUT CIRCLES
134	RCL5	36 05	
135	÷	-24	
136	FRC	16 44	
137	RCL5	36 05	
138	X	-35	
139	STOC	35 13	
140	PRTX	-14	PRINT DECIMAL RAMC
141	1	01	MIDHEAVEN ROUTINE
142	→R	44	
143	RCLB	36 12	
144	COS	42	
145	X	-35	
146	→P	34	
147	X↔Y	-41	
148	X<Ø?	16-45	
149	GSB8	23 08	
150	GSBB	23 12	PRINT MC DDD.MMSS
151	RCLC	36 13	
152	RCLE	36 15	ASCENDANT ROUTINE
153	GSB5	23 05	
154	X<Ø?	16-45	
155	GSB8	23 08	
156	GSBB	23 12	PRINT ASCENDANT DDD.MMSS
157	RCLC	36 13	
158	1	01	VERTEX ROUTINE
159	8	08	
160	Ø	00	
161	+	-55	
162	9	09	
163	Ø	00	
164	RCLE	36 15	
165	−	-45	
166	GSB5	23 05	
167	X<0?	16-45	
168	GSB8	23 08	
169	GSBB	23 12	PRINT VERTEX DDD.MMSS

Step	KEY	Code	
170	RCL2	36 02	
171	1	01	
172	X>Y?	16-34	CHECK PLANETARY CON-
173	GTO6	22 06	STANT FOR DAY OVER-
174	PRTX	-14	FLOW. IF OVERFLOW,
175	ST-2	35-45 02	PRINT "I"
176	*LBL6	21 06	
177	DSP2	-63 02	PLANETARY
178	R/S	51	INTERPOLATION
179	HMS→	16 36	ROUTINE
180	X↔Y	-41	
181	HMS→	16 36	
182	−	-45	
183	X<Ø?	16-45	RETROGRADE?
184	SF2	16 21 02	
185	LSTX	16-63	
186	X↔Y	-41	
187	RCL2	36 02	
188	X	-35	
189	+	-55	
190	F2?	16 23 02	
191	CHS	-22	
192	PRTX	-14	PRINT DECIMALS
193	GTO6	22 06	
194	*LBL5	21 05	ROUTINE USED IN
195	TAN	43	ASCENDANT & VERTEX
196	RCLB	36 12	
197	1	01	
198	→R	44	
199	R↓	-31	
200	X	-35	
201	R↓	-31	
202	X↔Y	-41	
203	CLX	-51	
204	1	01	
205	→R	44	
206	R↓	-31	
207	X	-35	
208	+	-55	
209	CHS	-22	
210	→P	34	
211	X↔Y	-41	
212	RTN	24	
213	*LBL8	21 08	
214	RCL5	36 05	ADD 360°
215	+	-55	
216	RTN	24	
217	*LBLB	21 12	PRINT ANGLES IN DDD.MMSS
218	DSP4	-63 04	
219	→HMS	16 35	(includes J. Neely's
220	RND	16 24	rounding routine)
221	Ø	00	
222	HMS+	16-55	
223	PRTX	-14	
224	RTN	24	

Cosmic Organisms

by Dr. Theodor Landscheidt

[Editor's note: Dr. Landscheidt was kind enough to translate this article himself and to sent it to us via audio cassette. If any of our readers read German and are interested in helping to translate more of Landscheidt's work and make it available in this country, please contact the editors. Our thanks to Barry J. Samuels who punctuated and arranged the transcribed tape.

Theodor Landscheidt is one of the very few modern astrologers who possess far-reaching and profound theoretical vision. His work is 'true' or prophetic. He can see and describe new horizons and opportunities for research that have not occurred to most of us and yet, which will occupy our complete attention in the years to come.]

Once upon a time, more than 13 billion years ago, all the matter and energy, forming the material base of our Universe, were confined to a sphere which could be circumscribed by the path of the Earth revolving around the Sun. Cosmic substance was in a primordial state of aggregation of high concentration, similar to the density of atomic nuclei. The Belgian astronomer, George Edward LeMaitre, called this proto-universe, appropriately, the Cosmic Egg. It did not only contain the substance for the future development of Cosmos, but also the seed, or information, guiding its structural differentiation. The Cosmic Egg is the universal mother common to all cosmic offspring. Supergalaxies, galaxies, fixed-stars, planets, as well as elementary particles— atoms, molecules, macro-molecules, living cells, and aggregated cell structures— are cosmic relatives of man. Their trajectories of development converge in the primary nucleus of the universe, paradisiacal state of undifferentiated union, comprising the potentiality of all future modes of cosmic existence, together with the structural laws governing their interaction. Paracelsus was right in claiming; " It is the knowledge of the upper firmament that enables us to know the lower firmament in man" and, that " the above acts on the below and the latter reacts upon the former". Another fitting description of the astrological conception of the universe is to be found in a translation of the Chinese book of life, The Secret of the Golden Blossom, edited by Carl Gustav Jung and Richard Wilhelm; " It is based on the premise that the Cosmos, and man, in principle, obey the same laws— that the individual is a cosmos in miniature, and there are no barriers keeping him apart from the great Cosmos. The same laws preside here, as well as there, inherent in the one condition is the approach to the other." This is in conformance with the universal relationship of all cosmic entities to the proto-nucleus of the universe.

Besides, this world view is more objective than the approach of a 20th century man having grasped the results of modern science only smatteringly, and arguing, therefore, that meso-cosmic man is not built up in analogy with the microcosm and macrocosm because it looks so

different. But this, as Hindu psychology already knew, is only due to the eclecticism of the human sense organs. Man is a cosmic aggregate consisting of atoms. And between the elementary particles, forming an atom, we find as much vacuum as between stars constituting a galaxy. Seen with the eyes of an atomic being endowed with sensorial perception, man would appear like a differentiated macrocosmic structure.

Human beings, as well as other cosmic entities, having the same cosmic primogeniture, are inextricably interwoven with a growing cosmic web extending into the future, built up by matter, energy, and structuring information. The measures of this web, whether huge or tiny, are built in conformance with the same morphological principles. William Blake expressed this lyrically, in saying; " To see a world in a grain of sand, and a heaven in a wildflower, hold infinity in the palm of your hand, and eternity in an hour."

According to the Russian astronomer Ambartsumian, the nuclei of galaxies and stars are still conserving some of the creative qualities of the existential substance of the cosmic egg. Astronomers begin to realize that the nuclei of galaxies are highly active and even capable to perform cosmic birth processes in ejecting material sufficient to build up whole galaxies. This is also true for the nucleus of the Supergalaxy around which our galaxy is revolving, together with 10,000 other galaxies. The radio source Virgo-A, at the supergalactic center, is ejecting a huge beam of star matter. The nuclei of stars, like our Sun, can be considered as loci of creativity too. They give birth to energy, are subject to eruptional activity similar to that in the central regions of galaxies, and are capable of creating planets.

The nuclei of living cells, appearing in quite another reach of the cosmic scale, fulfill creative functions too, in storing hereditary information, and guiding life processes in the cell periphery. It is consistent to surmise that all the other nuclei of cosmic entities, as for instance, atomic nuclei and planetary central regions, have similar functions. This should be true, even as to psychic nuclei, as the human Self, whose definition, given by the depth psychologist Carl Gustav Jung, indicates similar guiding functions, as we can find them, in macrocosmic or Self nuclei.

The creative tension between the nuclei of cosmic entities and the surrounding space, coming into existence by nuclear differentiation, has always fascinated meditative man. Mandala, a Buddhist symbol of the universe, projects this aspect into a circle, enveloping symbols of differentiation, centered by a symbolic nucleus. In depth psychology, as taught by Carl Gustav Jung, such mandala, appearing in dreams, releases psychodynamic functions, and accelerates the process of individuation, leading to the realization of the guiding matrix of personality, which is Self. The insight into cosmic morphology, won by mandala projection and by meditation, anticipates research results of astronomy, information theory, and cybernetics, in a similar way, as Hindu philosophy realized the energetic quantum concept long before modern physics revealed it in a more precise manner with the Planck quantity "h".

It would suggest, in the light of the correspondances between the functions of nuclei of animate and inanimate systems, to look at macrocosmic structures and bodies as entities functioning like organisms subjected to cybernetic regulation. If evidence for this assumption could be provided, it would be easier to accept that macrocosmic organisms are liable to influence meso-cosmic organic man as astrology asserts.

The concept outlined here, is new only as to the specific function of macrocosmic nuclei. The German scientist Fechner, a man of the 19th century, already treated astronomical bodies as psychosomatic entities, and abscribed soul-like dynamic fields to stars and the earth. Oliver Reiser, an American philosopher, is developing, since 1937, the hypothesis of Cosmecology, with the Sun as the psychophysical pacemaker of an evolution, involving the dynamics of the solar system, and eventually the entire Milky Way system. He writes:

> " The problem of finding a bridge between the micro level of the gene and the macro level of gross organic structures, and the further problem of relating the nervous system of Man to a hypothecated cosmic organism are only now being formulated. What I surmise is the existence of a more direct relation, such as a resonance of planetary, atomic and deoxyribonucleic-acid helix polarities. Moreover, and beyond that, there is no clear notion as to how the revolution of the spiral galaxy and the extra-galactic influences, to which it may be coupled, could influence biological evolution. But this hypothesis cannot be ruled out. I have a hunch that the coil of life, which supplies the architectural pattern for the fabrication of organisms, has something to do with the earth's rotation, and its magnetic polarities; with the sun, which bathes the earth, with its own fields and solar winds; with the cosmic ray showers which originate in the cosmotron, our spiral galaxy, and that radiates the earth and its population of plants and animals; and lastly with the helical coil of living letters which spell out the language of evolution. All this reflects the coercions of guiding fields of influence as they cascade down from the cosmic field, within which reside morphogenetic forms of the ladder of emergant evolution, the hierarchy of forms of material existence, in the world of space and time."

There are still other voices articulating this imaginative trend of thought. The French scientist Bergier holds the supposition: " If Ducrocq, Hoyle, Narlikar, and Costa de Beauregard are right, the universe is organized in the same manner, and as precise, as the deoxyribonucleic acid molecules within the cell nucleus. The genetic code being discovered, the next task is to find the atomic code." Similar thoughts are projected by the Russian scientist Avinadev Levit: "The universe can be looked at as a huge cybernetic system. If there exist informational contacts, and if it is right that gravitational fields are functioning as information channels, the degree of complexity of such an informational system would be immeasurably higher than the grade of complexity of living organisms."

These speculations seem to be fantastic. But they are pronounced by reputable scientists, and are a consistent extrapolation of the results of astronomy, cybernetics and information theory.

The projection of a human being into the center of a circle, mirroring the surrounding universe, and indicative of the nucleus of personality— a nativity in terms of astrology— is a mandala structure in the defined sense. If it really represents the color of the relations between the configurations of Cosmos and the moment of birth, and the native's personality nucleus, this function becomes easier to understand if it proves possible to delineate the morphogenetic relationship of cosmic nuclei on different levels including galactic structures, solar systems and Man.

Statistical investigations and my personal experience show that the cosmic hierarchy of nuclei is functioning. This is not only true for the Sun, as the center of our solar system, but also for the Galactic Center, as the nucleus of the Milky Way. If we want to work with the Galactic Center (GC) as an element of interpretation, we have to look for a symbolic analogy. As the GC is the nucleus of a system with regulation functions, and further, the center of gravity, and of stable equilibrium, this implies the interpretation: nucleus of the Individuality, equilibrium, and attractive power of the Personality— Self, as defined by the psychologist Carl Gustav Jung. The sun is also the nucleus of a system with similar functions as the Galactic Center. But the sun is only 4.7 billion years old, whereas the galaxy reaches an age of 12 billion years. Accordingly, the sun is correlated with the cerebrum and the intellectual potentials governed by this relatively young acquisition of nature, whereas the older nucleus of the galaxy symbolizes subconscious potentials, intuition, and the integrative psyche.

Configurations linked to the Galactic Center in the natal chart seem to be preponderant factors influencing the development of the basic structure of individuality. In the natal chart of the poet Herman Hesse, for instance, there was a conjunction of Jupiter and the GC with an opposition to Mercury. Another example the charts of the American presidents, MC-IC is to be found within ± 40° from the ecliptic position of the GC (26+° of Sagittarius of zodiac longitude, -5+° of latitude). This configuration occurs so frequently that it cannot be explained by coincidence. A chi-square test yields the result 8. This indicates the probability value 0.0047. A similar result came out with 600 famous men quoted in an encyclopedia. Even the positions of energetic flares on the sun are in relation to the direction of the Galactic Center.

A nativity should serve as a means to reveal the personality structure of the native, to indicate the goal of the personal development, and to show in which way the person, born under certain cosmic space-time conditions, can satisfy the needs of the Cosmos. As the Cosmos really needs the special individual faculties and qualities of each meso-cosmic entity, it seems to be important, that the nuclear symbol— Galactic Center— can be applied as an interpretational element in astrology, representing Self as the nucleus and

guding matrix of personality. But this is only a special aspect of the universal relatedness of all cosmic entities, the creative nuclei of which, stem from the cosmic egg. All this implies the existence of a hierarchy of informational centers beginning with cell nuclei or even atomic nuclei, and ascending over Selfs of animate beings; the core of planets, suns, earth; the nuclei of planetary systems, the Galactic Center, the nucleus of the Supergalaxy, to the center of the universe, still unknown, and perhaps, identical with the point Omega of Teilhard de Chardin. As these nuclei display highly energetic qualities, making them distinguishable from the environment at a high degree, the flux of information they are emanating, is correspondingly intense. The fire of solar flares and the light of Gnosis, brightening a mystic soul, seem to be emanating from the same source. Maybe the Sun and the GC are not only radiating physical energy but also psychical emanations. Living beings, that are prevented from dreaming, must die. We are perhaps in a special state of resonance while dreaming, and capable of receiving animating information. This is not uncontrolled speculation. Mathematical considerations, based on information theory, lead to the conclusion that an informational system must be fed continually with information, if it is not to break down. As information cannot be created, the necessary flow of information must come from an information transmitter outside the system, and higher up in the hierarchy of informational centers. But if we come to the highest site, the nucleus of the universe, there must be a source capable of violating the laws governing the within of the universe, and of generating information. And this information must flow continually, for we see that the order of the universe is not breaking down but still differentiating. There is no necessity to believe that we are mere particles of dust, lost in the desolation of an immense but desert-like universe, devoid of meaning. The knowledge provided by informational theory, combined with a modern astrological view, yields the solacing certainty: even the least entities in this huge universe are linked by a living informational chain to the Supreme source of Being.

PROGRAM TITLE: ANGLES— An algorithm for horoscope construction

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Program implemented on the Hewlett-Packard HP-25 programmable calculator

PROGRAM DESCRIPTION, EQUATIONS, VARIABLES:

ABSTRACT— ANGLES is an algorithm for computing ascendant, midheaven, vertex and local sidereal time of an event. Input parameters are longitude, latitude and time, which is specified as a modified Julian date. Results are computed to degrees, minutes and seconds of ecliptic longitude, except for local sidereal time, which is in degrees of right ascension. Radical, relocation, composite and progressed charts may be calculated by varying the input parameters. An extension to the program provides linear interpolation of planetary positions and other ephemeris data.

TIME CONVERSION— Since time advances at a uniform rate, we may avoid the tempermental irregularities of conventional calendar dates by using a time measure that increases in a consistent, linear manner. Such a measure is the Julian date, a successive numbering of days with each unit equal to a 24-hour mean solar day. Joseph Scaliger, a French chronologist, established the system of Julian day numbers in 1582 when he arbitrarily assigned day one to January 1, 4713 B.C., resulting in positive values for all dates since the age of Taurus.

Tables of Julian day numbers for the 0th of each calendar month[1] are available in Output-1 (at the end of the magazine) and from standard reference sources.[2] The Julian date is obtained by adding the day of the month to the value found in the table.

The conventional Julian day begins at noon, Greenwich Civil Time, so that Julian date 2415020.0 refers to 12h GMT, January 0, 1900. For our purposes, however, it is more convenient to determine the fractional part of the date according to the number of hours after midnight (0h GMT), rather than the obsolescent number of hours past noon. This conversion is accomplished by introducing a modified Julian date,

(1.1) $\quad ECB = \text{Julian date} + 0^d.5 - 2400000^d.0$

ECB stands for "Ephemeris Count of Bower," named after E.C. Bower, who proposed this modification in 1932. The addition of half a day to the Julian date means that we can now consider the values from the Julian day table as beginning at midnight GMT, rather than noon. Subtracting 2400000 from the date removes the two high-order digits that are common to all dates in the twentieth and late nineteenth centuries, and which are unnecessary for most computations. In the remainder of this paper we shall omit the leading digits; for example, J.D. 2415020.0 will be written as 15020.0.

In conjunction with the Julian day table, we may write:

(1.2) $\quad ECB = \text{base number for month} + \text{day of month} + (GMT/24h)$

where: GMT = decimal hours past midnight

= hours + [minutes + (seconds ÷ 60)] ÷ 60

Example: Compute the ECB for 4:31 PM EDT, October 12, 1977

Deducting one hour for Daylight Savings Time and adding five hours for the Eastern time zone, we have

t = 20:31 GMT, October 12, 1977

ECB = base number + day of month + (GMT÷24h)

= 43417 + 12 + (GMT÷24h)

= 43429 + [20 + (31÷60)] ÷ 24

= 43429 + (20.5167÷24)

ECB = 43429.85486

SIDEREAL TIME— Now that we have a linear time value, we may take advantage of the fairly constant ratio between solar time and sidereal time,

(2.1) $$a = \frac{\text{solar day}}{\text{sidereal day}} = 1.002737909$$

A solar day consists of 24 hours, while a sidereal day is the interval of time required for the earth to complete one 360° rotation. Equation 2.1 reveals that a sidereal day is slightly less than a solar day, and that in a 24-hour period the local meridian[3] will have advanced 360.9856472°. If we convert the extra 0.9856472° to hours[4], we obtain the familiar 3 minutes and 57 seconds, known in the astrological literature as the daily sidereal time acceleration.

In light of the above, we arrive at the following expression for local sidereal time (or right ascension of the midheaven):

(2.2) $$\theta = \theta_0 + [360° \cdot a \cdot (t - t_0)] - L_W$$

where: θ = Local RAMC, in degrees

θ_0 = RAMC at Greenwich at t

a = 1.002737909

t = ECB of event

t_0 = ECB of an arbitrarily chosen epoch

L_W = Longitude west of Greenwich, in degrees

A careful choice of t_0 will eliminate the first term of Equation 2.2. The author has chosen for t_0 a time at which the right ascension of the Greenwich meridian was 0°

(t_0 = 17:24:16.4 GMT, December 30, 1899; ECB = 15019.72519), reducing Equation 2.2 to:

(2.3) $\theta = [360° \cdot a \cdot (t - 15019.72519)] - L_W$

We may ignore the integral part of the product $[a \cdot (t-t_0)]$, since each whole sidereal day returns the Greenwich meridian to its original position. The product may be reduced to a value between 0 and 360° by multiplying its fractional part by 360°. Thus,

(2.4) $\theta = (360° \cdot \text{frac}[1.002737909 \cdot (t - 15019.72519)]) - L_W$

where: θ = Local RAMC
t = ECB of event
L_W = Longitude west of Greenwich (negative value "-" if East of Greenwich)

Equation 2.4 is preferred because it avoids truncation errors which may occur on some machines.

EXAMPLE: Compute the right ascension of the midheaven for Washington, D.C. (longitude = 77°01' west, latitude = 38°53' north) at 4:31 PM EDT October 12, 1977.

L_W = 77°01' = 77 + 1÷60 = 77°.01667
t = ECB 43429.85486 (from Example 1)
From Equation 2.4,
X = 1.00273909 • (43429.85486 - 15019.72519) = 28487.91402
frac(X) = 0.91402
θ = (360° • 0.91402) - 77.01667
θ = 252°.03053

MIDHEAVEN— The midheaven (the point at which the local meridian intersects the ecliptic) may be obtained from the classical equation:

(3.1) $MC = \tan^{-1}(\tan\theta \div \cos\varepsilon) + (180° \cdot k)$

where: MC = Ecliptic longitude of midheaven
ε = Obliquity of ecliptic (23°26'44".84 Epoch 1950.0)
θ = Local RAMC
$k = \begin{cases} 0 \text{ if } \cos \geq 0 \\ 1 \text{ if } \cos < 0 \end{cases}$

ASCENDANT— Spherical trigonometry provides the following formula for the ascendant (the point where the horizon intersects the ecliptic):

(3.2) $ASC = \tan^{-1} \dfrac{\cos\theta}{-(\tan\phi \cdot \sin\varepsilon + \sin\theta \cdot \cos\varepsilon)}$

Where: ASC = Ecliptic longitude of ascendant

Where: ASC = Ecliptic longitude of ascendant
θ = Local RAMC
ϕ = Northern latitude
ε = Obliquity of ecliptic

If the machine used to evaluate Equation 3.2 does not provide direct rectangual to polar conversion, the signs of the numerator and denominator must be noted to place the ascendant in the proper quadrant.

Numerator	+	+	−
Denominator	+	−	+
Quadrant	0-90°	90-180°	270-360°

VERTEX— The vertex, the point at which the prime vertical intersects the ecliptic, may be computed according to Equation 3.2, with the following substitutions:

$\theta' = \theta + 180°$
$\phi' = 90° - \phi$

INTERPOLATION— Planetary and other ephemeris positions may be obtained with the standard formula for linear interpolation:

(4.1) $p = p_0 + \Delta p\left(\dfrac{t - t_0}{\Delta t}\right)$

where: p = Interpolated position
p_0 = Position at t_0
p_1 = Position at t_1
Δp = Motion during interval = $p_1 - p_0$
t_0 = Start of interpolation interval
t_1 = End of interpolation interval
Δt = Interpolation interval = $t_1 - t_0$
t = ECB of event

All times are expressed as ECBs. The interpolation interval, Δt for a daily ephemeris, is 1.0 days. For a midnight ephemeris, t_0 and t_1 are integral values; for noon ephemerides, t_0 and t_1 have fractional values of 0.5.

Greater precision is possible for lunar and solar positions by using the method of second-difference interpolation, when accuracy to the nearest second is desired. For most planetary positions, however, linear interpolation is adequate for values to the nearest minute of arc. The method of second-difference interpolation is explained in Reference 4.

EXAMPLE: Compute the midheaven, ascendant and vertex for the event specified in the previous examples. (October 12, 1977, 4:31 PM EDT, Washington, D.C.)

From example 2: $\theta = 252^{\circ}03053$

$\cos\theta = -0.30851$

$k = 1$

From Equation 3.1,

$$MC = \tan^{-1}(\tan\theta \div \cos\varepsilon) + (k \cdot 180^{\circ})$$
$$= \tan^{-1}(3.08327 \div 0.917437) + 180^{\circ}$$
$$= 73^{\circ}42947 + 180^{\circ}$$

MC = 253°42947 = 13°26' Sagittarius

Given the latitude of Washington, D.C., $\phi = 38°53'$, and the obliquity of the ecliptic, $\varepsilon = 23°26'44''.84$ and using equation 3.2,

$$ASC = \tan^{-1}\left(\frac{\cos\theta}{-(\tan\phi \cdot \sin\varepsilon + \sin\theta \cdot \cos\varepsilon)}\right)$$
$$= \tan^{-1}\left(\frac{-0.30851}{-[(0.8064 \cdot 0.39788) + (-0.95122 \cdot 0.91744)]}\right)$$
$$= \tan^{-1}\left(\frac{-0.30851}{+0.55183}\right)$$

ASC = 330°79188 = 0°48' Pisces

Substituting $\theta' = \theta + 180^{\circ} = 432^{\circ}03053 = 72^{\circ}03053$ and

$\phi' = 90^{\circ} - \phi = 51^{\circ}116667$,

$$\text{Vertex} = VX = \tan^{-1}\left(\frac{\cos\theta'}{-(\tan\phi' \cdot \sin\varepsilon + \sin\theta' \cdot \cos\varepsilon)}\right)$$
$$= \tan^{-1}\left(\frac{0.30851}{-[(1.24 \cdot 0.39788) + (0.95122 \cdot 0.91744)]}\right)$$
$$= \tan^{-1}\left(\frac{0.30851}{-1.36606}\right)$$

VX = 167°27385 = 17°16' Virgo

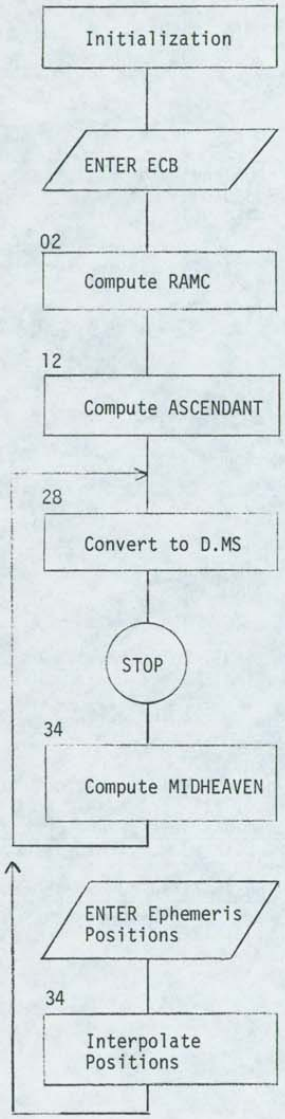
NOTES (superscript) to text:

(1) The 0th day of the month is, of course, the day before the first; thus January 0, 1900 is equivalent to December 31, 1899.

(2) These include The American Ephemeris and Nautical Almanac (U.S. Naval Observatory) and The Sun is Shining: Heliocentric Ephemeris 1653-2050 (Michael Erlewine, Heart Center/Circle Bks.). Regretably, most astrological ephemerides do not yet include Julian day numbers.

(3) The local meridian is the great circle passing over the observer and thru the north and south poles.

(4) Where possible, avoid expressing sidereal time in hours, minutes and seconds of time (H-M-S) by referring to equivalent right ascension of the midheaven (RAMC) in degrees of arc along the Equator. RAMC = sidereal time x 15°/hr



APPENDIX

The accompanying diagram is a FLOWCHART for the Angles program as implemented by the author on the HP-25 programmable calculator. The program may be expanded on other models in the HP series of programmable calculators or adapted for other computing systems.

OPERATING INSTRUCTIONS

1. Load the program listed in this appendix.
2. Initialize the following registers:
   r1 = Western longitude r5 = 23.44578889
   r2 = Northern latitude r6 = 360
   r4 = 1.002737909 r7 = 15019.72519
3. Enter the ECB of the event.
4. Clear program (f PRGM).
5. Depress R/S. Program will display d.mmss of ascendant.
6. Depress R/S. Program will display d.mmss of midheaven.
7. Interpolation of Planetary Positions:
   a. Load interpolation routine into locations 34-44.
   b. Return to RUN mode and depress GTO 34.
   c. Enter d.mmss of first ephemeris position.
   d. Enter d.mmss of second ephemeris position.
   e. Depress R/S. Program will display d.MMss of position interpolated according to ECB that was stored in step 3.
   f. Repeat steps 7c-7e as required.
8. Vertex calculation:
   a. Add 180 to the contents of r3.
   b. Subtract from 90 the contents of r2 and store the result in r2.
   c. GTO 12
   d. Depress R/S. Program displays d.mmss of vertex.

NOTES: * If a noon ephemeris is used for interpolation, subtract 0.5 from the ECB stored in r0.
* An ECB previously stored in r0 may be preserved by replacing step 4 with "GTO 02".
* Angular values are stored as decimal degrees.

APPENDIX (Cont'd.)

Line	Code	Entry	X
00			ECB
01	23 00	STO 0	
02	24 07	RCL 7	
03	41	−	
04	24 04	RCL 4	
05	61	X	
06	15 01	g FRAC	
07	24 06	RCL 6	
08	61	X	
09	24 01	RCL 1	Longitude
10	41	−	Local RAMC
11	23 03	STO 3	
12	24 05	RCL 5	Obliquity
13	01	1	
14	14 09	f→R	
15	24 03	RCL 3	Local RAMC
16	01	1	
17	14 09	f→R	
18	22	R↓	
19	61	X	
20	21	X↔Y	
21	24 02	RCL 2	Latitude
22	14 06	f TAN	
23	61	X	
24	51	+	
25	32	CHS	
26	15 09	g→P	
27	22	R↓	Ascendant
28	15 51	g X≥0	Angle
29	13 32	GTO 32	
30	24 06	RCL 6	360
31	51	+	
32	14 00	f H.MS	Normalized
33	74	R/S	angle
34	24 03	RCL 3	Local RAMC
35	14 06	f TAN	
36	24 05	RCL 5	Obliquity
37	14 05	f COS	
38	15 09	g→P	
39	34	CLX	
40	24 03	RCL 3	Local RAMC
41	14 05	f COS	
42	15 51	g X≥0	
43	13 27	GTO 27	
44	34	CLX	
45	01	1	
46	08	8	
47	00	0	
48	41	−	
49	13 28	GTO 28	

PROGRAM: ANGLES AUTHOR: Robert Knight
Date Written: January, 1976
System: Hewlett-Packard HP-25 (may also be implemented on HP-25C, 19C, 29C, 67 & 97

REGISTER USAGE:

r0 = ECB of Event
r1 = Western longitude
r2 = Northern latitude
r3 = Local RAMC
r4 = 1.002737909
r5 = Obliquity of ecliptic*
r6 = 360.0
r7 = 15019.72519

* Mean obliquity for 1950.0 Epoch
ε = 23° 26' 44".84

INTERPOLATION ROUTINE

Line	Code	Entry	X
34	15 00	g→H	Second position
35	21	X↔Y	First position
36	15 00	g→H	
37	41	−	Daily motion
38	14 73	f LASTX	First position
39	21	X↔Y	Daily motion
40	24 00	RCL 0	ECB
41	15 01	g FRAC	
42	61	X	Actual motion
43	51	+	Interpolated position
44	13 28	GTO 28	

REFERENCES

1. Blanco, V.M. and McCusky, S.W., Basic Physics of the Solar System; Reading, Mass,: Addison Wesley, 1961
2. Erlewine, Michael, The Sun is Shining Heliocentric Ephemeris 1653-2050; Ann Arbor, Mich.: Heart Center/Circle Books, 1975
3. Herrick, Samuel, Astrodynamics, Vol. 1; London, Van Nostrand Reinhold, 1971
4. Michelsen, Neil, The American Ephemeris and Book of Tables (1931-80), Pelham, N.Y.: Astro Computing Services, 1976
5. U.S. Naval Observatory, The American Ephemeris and Nautical Almanac; Washington, D.C.: Government Printing Office, 1977

Book Reviews

One of the concerns of MATRIX will be to direct attention to activities and publications (of a technical or research nature) that maintain a very high qualitative level.

COSMECOLOGY BULLETIN

Cosmecology Bulletin is the publication of The Association for Research in Cosmecology (ARC) and is under the direction of Charles and Vivia Jayne. There is little doubt that some of the most important theoretical and research articles to appear in recent years can be found in the pages of the publication.

Cosmecology has been defined as the study of the adaptation of the Earth and its life to the surrounding Cosmic environment. ARC seeks to provide a forum via its bulletin and occaisional symposia for the exchange of research results in the field of cosmecology. ARC is the successor to ARA (Astrological Research Associates) which published the first international journal IN SEARCH, from 1958 to 1962. The current Board of Directors of ARC includes such distinguished names as Zipporah Dobyns, Neil F. Michelsen and James Williamsen. Here are just a few of the many fine articles that have appeared in recent issues of the COSMECOLOGY BULLETIN:

Robert Hand: A NEW APPROACH TO TRANSITS (this is Hand's original article on parans)
Thomas Shanks: RESEARCH REPORT— SUN/M.C. ASPECTS IN THE GAUQUELIN PROFESSIONAL DATA
John H. Nelson: 1971 RESEARCH ON MIDPOINTS
James S. Williamsen: DIRECTIONS AND OPPORTUNITIES IN ASTROLOGICAL RESEARCH.
Neil F. Michelsen: PLANETARY PATTERNS OF PROFESSIONAL AND PATHOLOGICAL PEOPLE
Charles A. Jayne: FOUNDATIONS OF ASTROLOGY IN COSMIC STRUCTURE

COSMECOLOGY BULLETIN is available to subscribers at $5.00 per year (two consecutive issues) and current or back issues are $2.90 POSTPAID. New subscribers will receive the prior issue unless they request otherwise (back issues are well worth owning). Write:

Association for Research in Cosmecology (ARC)
5 Old Quaker Hill Rd.
Monroe, New York 10950

Charles and Vivia Jayne have done pioneer work in the writing and promotion of high quality astrological research. Other publications soon to be reviewed in MATRIX include THE JOURNAL OF GEOCOSMIC RESEARCH, PHENOMENA and SIRIUS.

NEWSNOTE: As were going to press, English astrologer Roger Elliot calls to say that his English PET computer has arrived— after only 30 days waiting time!

PROGRAM TITLE: PLANETARY HARMONICS/POSITIONAL DIFFERENCES

PROGRAM AUTHOR: John Van Zandt, 24 Colorado, Highland Park, MI 48203

PROGRAM DESCRIPTION: (Implemented on the HP-67 Programmable Calculator)

Program one calculates the Nth Harmonic of any Zodiacal position. The Sign must be entered as a number: Aries= 1, Taurus= 2, Gemini= 3, etc.

EXAMPLE: Calculate the FIFTH HARMONIC of 24° LEO 07'.

	ENTER HARMONIC	5	PRESS KEY A	= 5.000000
	ENTER DEGREES/MINUTES	24.07	PRESS KEY B	= 24.070000
(LEO=5)	ENTER ZOD. SIGN #	5	PRESS KEY C	= 0.350001

= 0= 0 DEGREES

[0.350001 = 35 MINUTES, 00 SECONDS of the FIRST SIGN] =.3500 = 35 MINNUTES 00 SEC.

= .NNNN01 = ARIES

Program two calculates the exact positional difference between any two positions. This expedites investigation of aspects and relationships that are not commonly found in an aspect chart. For example, positional differences of 72° (Quintile), 51°30' (Septile), 36° (Decile), 24° (Quin-Decile), 18° (Virgintile) and their multiples can be easily found and/or calculated.

OPERATING LIMITS AND WARNINGS:

Program one does not ROUND OUT degrees, minutes and seconds, Example: FIFTH Harmonic of 12° Capricorn 12'. Answer reads 0.596012. This is the same as 1° PISCES 00'.

USER INSTRUCTIONS:

	INPUT	KEY	OUTPUT
1. ENTER PROGRAM CARD			
2. ENTER DESIRED HARMONIC "N"	NN	A	NN.000000
3. ENTER DEGREE IN SIGN POSITION	DD.MMSS	B	DD.MMSS
4. ENTER SIGN AS NUMBER [ARIES=1, TAURUS=2, GEMINI=3, CANCER=4, LEO =5, VIRGO=6, LIBRA=7, SCORPIO=8, SAGITTARIUS=9, CAPRICORN=10, AQUARIUS=11, PISCES=12]	NN	C	NN.NNNNNN
5. ANSWER APPEARS AFTER KEY 'C' is PRESSED. NOTE: The INTEGER part of the answer is the Harmonic degree position. The DECIMAL part of the answer is the minutes and seconds of the new position and the new sign position, indicated by the last two digits.			

PART TWO

1.ENTER DD.MMSS of position one	DD.MMSS	ENTER	
2.KEY IN Sign (1,2,etc) as indicated above	NN.	D	
3.REPEAT same procedure for second position (Press KEY E after entry)	DD.MMSS	ENTER	
	NN.	E	DDD.MMSS
4. If positional difference 1 is greater than 180°, the shorter distance may be calculater by pressing f E KEYS. (Position Diff.2)	NONE	f E	DDD.MMSS

[This allows comparatice data on approachin/seperating aspects of any size]

PLANETARY HARMONICS/POSITIONAL DIFFERENCES: PROGRAM STEPS HP-67

STEP	KEY	CODE		
001	fLBLA	31	25 11	STORE HARMONIC
002	STO3	33	03	
003	hRTN	35	22	
004	fLBLB	31	25 12	STORE DD.MM
005	STO1	33	01	
006	hRTN	35	22	
007	fLBLC	31	25 13	STORE SIGN
008	STOØ	33	00	
009	ENT↑		41	BEGIN COMPUTATION
010	fGSB1	31	22 01	
011	RCL3	34	03	HARMONIC
012	X		71	CALCULATION
013	3		03	
014	6		06	
015	Ø		00	
016	÷		81	
017	gFRC	32	83	
018	3		03	
019	6		06	
020	Ø		00	
021	X		71	
022	3		03	
023	Ø		00	
024	÷		81	STORE HARMONIC
025	STO4	33	04	DECIMAL DEGREE
026	fINT	31	83	
027	1		01	CALCULATE
028	+		61	AND STORE
029	DSP6	23	06	HARMONIC SIGN
030	1		01	
031	Ø		00	
032	Ø		00	
033	Ø		00	
034	Ø		00	
035	Ø		00	
036	Ø		00	
037	÷		81	
038	STO5	33	05	
039	RCL4	34	04	
040	gFRC	32	83	HARMONIC DEGREE
041	3		03	CALCULATION
042	Ø		00	TO _D.MM
043	X		71	
044	g→HMS	32	74	
045	RCL5	34	05	
046	+		61	
047	hRTN	35	22	
048	fLBL1	31	25 01	SIGN TO DEGREE
049	1		01	SUBROUTINE
050	—		51	
051	3		03	
052	Ø		00	
053	X		71	
054	RCL1	34	01	
055	+		61	
056	fHMS←	31	74	END PART ONE
057	hRTN	35	22	
058	fLBLD	31	25 14	CALCULATE AND STORE
059	DSP4	23	04	DECIMAL DEGREE
060	hF?3	35	71 03	POSITION ONE
061	fGSB2	31	22 02	
062	STO8	33	08	
063	hRTN	35	22	
064	fLBLE	31	25 15	CALCULATE AND STORE
065	hF?3	35	71 03	DECIMAL DEGREE
066	fGSB2	31	22 02	POSITION TWO
067	STO9	33	09	
068	RCL8	34	08	
069	—		51	
070	fX<0?	31	71	NEGATIVE DEGREE?
071	GTO5	22	05	
072	g→HMS	32	74	POSITIONAL DIFFERENCE
073	hRTN	35	22	ONE
074	fLBL2	31	25 02	
075	1		01	DECIMAL DEGREE
076	—		51	SUBROUTINE
077	3		03	
078	Ø		00	
079	X		71	
080	hX↔Y	35	52	
081	+		61	
082	fHMS←	31	74	
083	hRTN	35	22	
084	fLBL5	31	25 05	
085	3		03	ROUTINE TO
086	6		06	ELIMINATE
087	Ø		00	NEGATIVE
088	+		61	DEGREES
089	g→HMS	32	74	
090	hRTN	35	22	
091	gLBLe	32	25 15	POSITIONAL
092	RCL8	34	08	DIFFERENCE
093	RCL9	34	09	
094	—		51	
095	3		03	
096	6		06	
097	Ø		00	
098	+		61	
099	g→HMS	32	74	POSITIONAL DIFFERENCE
100	hRTN	35	22	TWO

REGISTERS USED: 0, 1, 3, 4, 5, 8, 9

LABELS USED: A, B, C, D, E, e, 1, 2, 5

FLAGS OFF, FIXED NOTATION

PROGRAM TITLE: Non-Linear Interpolation Using the 2nd Difference
PROGRAM AUTHOR: Stephen Erlewine, 2727 Elmwood, Ann Arbor, MI 48104
PROGRAM DESCRIPTION:

This program calculates a planet's position with greater precision than the more commonly used linear interpolation procedures which do not account for a planet's acceleration or de-acceleration. It is normally useful only when a planet's longitude is given in degrees, minutes, and seconds which means, for most ephemerides, only the Sun and Moon. It is no less accurate of course when the longitude is given only to the minute but, since you can't add precision that isn't there to begin with, the normal linear interpolation would probably serve as well. Accuracy, using longitudes given to the second and listed for every 24 hours, should be better than 6 seconds even for something as inconstant as the moon. If you modify the program to handle positions 12 hours apart, your accuracy should improve to about one second or less.

FORMULA:

$$Y = Y_0 + (\Delta Y_0 \cdot S) + (\Delta^2 Y_0 \cdot S_2)$$

Note: "·"= multiplication

WHERE:

X = Time of wanted position — Y = Wanted position
X_0 = Time of previous position — Y_0 = Position listed for X_0
X_1 = Time of following position — Y_1 = Position listed for X_1
X_2 = Time of next following position — Y_2 = Position listed for X_2

$\Delta x = X_1 - X_0$ — $\Delta Y_0 = Y_1 - Y_0$

$S = \frac{X - X_0}{\Delta x}$ — $\Delta Y_1 = Y_2 - Y_1$

$S_2 = \frac{S(S-1)}{2}$ — $\Delta^2 Y_0 = \Delta Y_1 - \Delta Y_0$

In the case of planetary positions found from an ephemeris with listings every 24 hours: Δx would be 24 hours. ΔY_0 would be the daily motion for the day of birth; ΔY_1 would be the daily motion for the day after the birth— both daily motions are first differences and the difference between them, $\Delta^2 Y_0$, is the second difference.

IMPLEMENTATION: Hewlett-Packard HP-25 programmable pocket calculator.
INSTRUCTIONS: Planetary positions entered from a Oh (midnight) ephemeris in D-M-S (degree-minute-second) format. Answer given in D-M-S. Enter all longitudes and times in 360° (absolute longitude) and 24 hour notation with minutes and seconds.

Non-Linear Interpolation with 2nd Difference: HP-25 Program

Step	Code	Key
01	15 00	g→H
02	23 00	STO Ø
03	22	↓
04	15 00	g→H
05	23 01	STO 1
06	21	X↔Y
07	15 00	g→H
08	31	ENTER
09	22	↓
10	21	X↔Y
11	41	−
12	23 02	STO 2
13	22	↓
14	15 00	g→H
15	21	X↔Y
16	41	−
17	24 02	RCL 2
18	41	−
19	24 00	RCL Ø
20	02	2
21	04	4
22	71	÷
23	23 03	STO 3
24	31	ENTER
25	31	ENTER
26	01	1
27	41	−
28	61	X
29	02	2
30	71	÷
31	61	X
32	24 02	RCL 2
33	24 03	RCL 3
34	61	X
35	51	+
36	24 01	RCL 1
37	51	+
38	14 00	f→H.MS

INSTRUCTIONS: Enter all longitudes and times in 360° and 24 hour notation with minutes and seconds.

ENTER:
(T) $LONG^3$ = position 48 hours after $LONG^1$
(Z) $LONG^2$ = position 24 hours after $LONG^1$
(Y) $LONG^1$ = ephemeris position before birth
(X) TIME = interval between $LONG^1$ and birthtime. Use GMT (Greenwich Mean Time) in 24 hour notation for Oh ephemeris.*

Numerical Example:
(T) $LONG^3$ = 94°56'23" (enter HP-25 as 94.5623)
(Z) $LONG^2$ = 80°34'54"
(Y) $LONG^1$ = 66°39'22"
(X) TIME = 16.00 hours

RUN: Answer = 75°53'30".3 (HP-25 format= 75.53303)

*NOTE: FOR NOON EPHEMERIS: The "time" must be the interval from the NOON before birth to the GMT of birth. IE: 6 AM GMT would be entered as 18h and $LONG^1$ would be for the day previous to birthday.

MODIFICATIONS:

Since this is a basic interpolation program it can be useful for many different tasks and it can be modified to suit personal needs. Registers 0,1,2 and 3 are used by the Program and that leaves the remaining four available for other uses. There are eleven program steps unused and since there are no GOTO instructions within the program it is possible to add commands at the beginning or end without disturbing the basic functioning.

The simplist modification, if you wished to calculate an entire chart with this method, would be to add a "RCL 4" at the beginning and then store the time in R4 thus saving the need to enter the time with each new planet.

If you wished to interpolate the moon's position from listings at Ohrs and 12 hrs you would need to change steps 20 & 21 from 2 and 4 for 24 hours to 1 and 2 for 12 hours. At the same time you would need to be careful that the entered "time" represents the interval between the first position and the birthtime, and that longitude positions are 12 hours apart.

If you use a Table of Houses that lists the cusps for every four minutes of Sidereal Time, you can modify this program to interpolate the exact cusp positions by storing ".04" in R7 (for 4 minutes) and then changing step 20 to read "RCL 7" and step 21 to "g→H". The time used in this instance would again be the interval established by taking the Sidereal Time of birth and subtracting from it the listed Sidereal Time that immediately precedes it.

To save time when calculating planet's positions it is not always necessary to convert longitudes to 360° notation, if you remember to add 30° when entering a new sign. Thus for a moon given as 8° Taurus, 22° Taurus, and 6° Gemini you could enter it as 8°,22° and 36°, and remember if the answer is greater than 30° to subtract 30°and call that Gemini.

PROGRAM TITLE: ASPECT CALCULATION PROGRAM

PROGRAM AUTHOR: Noel Tyl, The River House, Suite A-709, 1600 South Joyce Street, Arlington, Virginia 22202

PROGRAM DESCRIPTION: [implemented on the HP-67 programmable calculator]

All of us for whom computer technology is not a way of life know well the enormous challange to put that technology to work within astrology: not only is the computation burden lessened but as well our understanding and learning increased many times.

Personally, I had found aspect computation laborious and timeconsuming. It was with measuring the aspects, the obvious and the subtle, that I found mental fatigue to be centered, especially when working on a large volume of charts. But, at first thought, the computer didn't seem to offer an answer: the HP-67 couldn't scan the planetary positions and pick out which were in aspect. It was futile until what understanding and learning I had accumulated in my new computer experience came together and put me on the right track: the machine need not scan or discover aspects; the brain can do that easily if the exact distance between all planetary pairs is reliably and quickly determined. The orb (or distance) became the answer to programming aspects, not the aspects themselves.

An operational problem was presented: which arc should be used, the long or the short, or does this really matter? The answer is simple: all aspect relationships must be within a 180° arc. The program must direct its measurement within that hemisphere arc either way, and steps 023 thru 046 take care of it.

The program works rapidly as submitted, and beginners may wish to substitute the "f -x-" instruction twice for the two "h PAUSE" notations at step 042 and 046 to slow things down until they are familiar with the program.

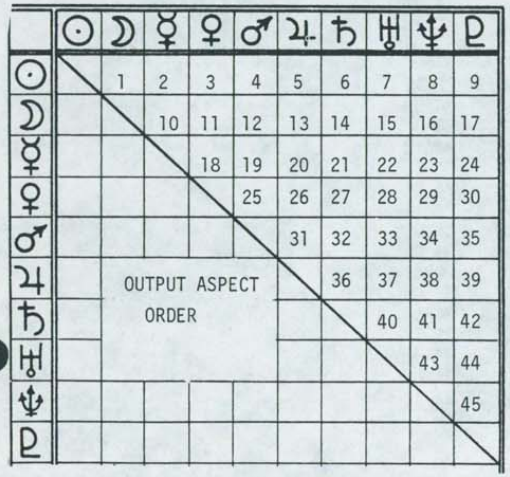
USER INSTRUCTIONS: Natal planetary positions are stored in registers 0 thru 9 as follows: Sun-0, Moon-1, Mercury-2, Venus-3, Mars-4, Jupiter-5, Saturn-6, Uranus-7, Neptune-8, Pluto-9. NOTE: Planet positions are in 360°-Notation or Absolute Longitude (from 0°-360°) AND minutes and second. For example: Venus at 24° Pisces 16'34" would be stored in register 3 as 354.1634 and so forth.

IF Absolute or 360°-Notation is not familiar to you, then you may load storage registers 0 thru 9 with the correct 360° positions by using the following routine: LABEL D ROUTINE: First, load storage registers 0 thru 9 with planet's positions in the traditional 30° notation. For example: Sun at 6° Taurus 13' would be stored in register '0' as 6.13, Moon at 3° Leo 11' as 3.11, Venus at 24° Pisces 16'34" as 24.1634 and so forth. NEXT, Press LABEL D and procede as follows;

LABEL D (continued)

This program portion increments planetary positions by number of completed signs in order to bring the positions into 360° notation. For planets from Sun thru Pluto: INPUT the number of completed zodiac signs and then press R/S.
For example: Sun at 6° Taurus 13', press "1" and then R/S. Moon at 3° Leo 11', press "4" and then R/S. Continue thru Pluto. (If planetary positions are already in 360° notation, simply ignore program portion "D")

LABEL A : ASPECT CALCULATION— Pressing LABEL A will automatically display exact orb of every aspect in aspect-grid order, Sun-Moon thru Neptune-Pluto (see illustration of sequence). As each aspect is displayed, note the orb distance and/or notate on the grid the presence of any bonafide aspect.
CAUTION: Make sure planets are stored in registers 0 thru 9 in the correct form: in 360° notation or in 30°-notation (to which LABEL D routine must be added).



STEP	KEY	CODE	
001	fLBLD	31 25 14	
002	fGSBC	31 22 13	INCREMENTING TO
003	ST+0	33 61 00	360° NOTATION
004	fGSBC	31 22 13	
005	STO+1	33 61 01	
006	fGSBC	31 22 13	
007	STO+2	33 61 02	
008	fGSBC	31 22 13	
009	STO+3	33 61 03	
010	fGSBC	31 22 13	
011	STO+4	31 61 04	
012	fGSBC	31 22 13	
013	STO+5	31 61 05	
014	fGSBC	31 22 13	
015	STO+6	31 61 06	
016	fGSBC	31 22 13	
017	STO+7	31 61 07	
018	fGSBC	31 22 13	
019	STO+8	31 61 08	
020	fGSBC	31 22 13	
021	STO+9	31 61 09	
022	hRTN	35 22	
023	fLBLB	31 25 12	ARC CONTROL
024	gX≤Y	35 52	
025	GTOØ	22 00	SUB-ROUTINE
026	hX↔Y	35 52	
027	fLBLØ	31 25 00	AND ORB
028	CHS	42	MEASUREMENT
029	hHMS+	35 83	
030	1	01	
031	8	08	
032	Ø	00	
033	gX>Y	32 81	
034	GTO2	22 02	
035	1	01	
036	8	08	
037	Ø	00	
038	hHMS+	35 83	
039	CHS	42	
040	hHMS+	35 83	
041	CHS	42	
042	hPAUSE	35 72	
043	hRTN	35 22	
044	fLBL2	31 25 02	
045	hX↔Y	35 52	
046	hPAUSE	35 72	
047	hRTN	35 22	
048	fLBLC	31 25 13	SUB-ROUTINE FOR
049	R/S	84	
050	3	03	INCREMENTING
051	Ø	00	
052	X	71	
053	hRTN	35 22	
054	fLBLA	31 25 11	
055	RCL0	34 00	ASPECTS
056	RCL1	34 01	

STEP	KEY	CODE
057	fGSBB	31 22 12
058	RCLØ	34 00
059	RCL2	34 02
060	fGSBB	31 22 12
061	RCLØ	34 00
062	RCL3	34 03
063	fGSBB	31 22 12
064	RCLØ	34 00
065	RCL4	34 04
066	fGSBB	31 22 12
067	RCLØ	34 00
068	RCL5	34 05
069	fGSBB	31 22 12
070	RCLØ	34 00
071	RCL6	34 06
072	fGSBB	31 22 12
073	RCLØ	34 00
074	RCL7	34 07
075	fGSBB	31 22 12
076	RCLØ	34 00
077	RCL8	34 08
078	fGSBB	31 22 12
079	RCLØ	34 00
080	RCL9	34 09
081	fGSBB	31 22 12
082	RCL1	34 01
083	RCL2	34 02
084	fGSBB	31 22 12
085	RCL1	34 01
086	RCL3	34 03
087	fGSBB	31 22 12
088	RCL1	34 01
089	RCL4	34 04
090	fGSBB	31 22 12
091	RCL1	34 01
092	RCL5	34 05
093	fGSBB	31 22 12
094	RCL1	34 01
095	RCL6	34 06
096	fGSBB	31 22 12
097	RCL1	34 01
098	RCL7	34 07
099	fGSBB	31 22 12
100	RCL1	34 01
101	RCL8	34 08
102	fGSBB	31 22 12
103	RCL1	34 01
104	RCL9	34 09
105	fGSBB	31 22 12
106	RCL2	34 02
107	RCL3	34 03
108	fGSBB	31 22 12
109	RCL2	34 02
110	RCL4	34 04
111	fGSBB	31 22 12
112	RCL2	34 02
113	RCL5	34 05
114	fGSBB	31 22 12
115	RCL2	34 02
116	RCL6	34 06
117	fGSBB	31 22 12
118	RCL2	34 02
119	RCL7	34 07
120	fGSBB	31 22 12
121	RCL2	34 02
122	RCL8	34 08
123	fGSBB	31 22 12
124	RCL2	34 02
125	RCL9	34 09
126	fGSBB	31 22 12
127	RCL3	34 03
128	RCL4	34 04
129	fGSBB	31 22 12
130	RCL3	34 03
131	RCL5	34 05
132	fGSBB	31 22 12
133	RCL3	34 03
134	RCL6	34 06
135	fGSBB	31 22 12
136	RCL3	34 03
137	RCL7	34 07
138	fGSBB	31 22 12
139	RCL3	34 03
140	RCL8	34 08
141	fGSBB	31 22 12
142	RCL3	34 03
143	RCL9	34 09
144	fGSBB	31 22 12
145	RCL4	34 04
146	RCL5	34 05
147	fGSBB	31 22 12
148	RCL4	34 04
149	RCL6	34 06
150	fGSBB	31 22 12
151	RCL4	34 04
152	RCL7	34 07
153	fGSBB	31 22 12
154	RCL4	34 04
155	RCL8	34 08
156	fGSBB	31 22 12
157	RCL4	34 04
158	RCL9	34 09
159	fGSBB	31 22 12
160	RCL5	34 05
161	RCL6	34 06
162	fGSBB	31 22 12
163	RCL5	34 05
164	RCL7	34 07
165	fGSBB	31 22 12
166	RCL5	34 05
167	RCL8	34 08
168	fGSBB	31 22 12
169	RCL5	34 05
170	RCL9	34 09
171	fGSBB	31 22 12
172	RCL6	34 06
173	RCL7	34 07
174	fGSBB	31 22 12
175	RCL6	34 06
176	RCL8	34 08
177	fGSBB	31 22 12
178	RCL6	34 06
179	RCL9	34 09
180	fGSBB	31 22 12
181	RCL7	34 07
182	RCL8	34 08
183	fGSBB	31 22 12
184	RCL7	34 07
185	RCL9	34 09
186	fGSBB	31 22 12
187	RCL8	34 08
188	RCL9	34 09
189	fGSBB	31 22 12
190	hRTN	35 22

PROGRAM TITLE: HARMONIC ASTROLOGY GUIDE

PROGRAM AUTHOR: Buz Overbeck, 9470 Forest Springs, Suite 196, Dallas, TX 75243

PROGRAM DESCRIPTION: [implemented on the HP-97 programmable calculator]

This program performs various operations of use to those investigating the use of harmonics in astrology. The program can:

(1) For any angle, program will calculate the closest harmonic and multiple, and display the relative error.

(2) Program will convert any decimal to its harmonic equivalent.

(3) Calculate the equivalent arc length for any harmonic.

(4) Print where, in the 360° circle, a harmonic and all its multiples fall.

EQUATIONS:

Let A = Any angle within the 360° circle [NOTE: Angles less than 0°20' or greater than 359°38' will cause a blinking display. This indicates an improper fraction (H). This is also true of extremly large or small decimals.]

Then, H= YYY.XXX = $\frac{A}{360}$ to fraction (D# = 3)

Where H = Harmonic; YYY = the $Y^{\underline{th}}$ multiple of the $XXX^{\underline{th}}$ Harmonic

And D# = maximum denominator length.

Then, the exact angle (A_e) = $\frac{YYY}{360}$ 360°

And equivalent arc length = 1/H 360° = α

Then the location within the 360° circle of a Harmonic and its multiples ($m_1 \ldots m_n$) equals $m_1\alpha+\alpha(m_2)+\ldots (m_n)$

SAMPLE PROBLEMS: The angle (aspect) between the Sun and the Moon in a Horoscope is 235°24'16". Determine the closest Harmonic and its multiple.(I)

(I) ENTER 235.2416 Press [B] = 461.705 (461^{st} multiple of the 705^{th} harmonic)

(II) Press [R/S]= 235°24'15" (A) [converts the Harmonic to its exact length]

(III) Press [R/S]= 235°24'16" (A_o) PAUSE [compares the exact arc to the original and determines the relative error]
= 235°24'15" (A_e) PAUSE
= 0.0001 (relative error)

– Convert the decimal fraction 0.85762 to its Harmonic equivalent:

ENTER 0.85762 [C] = 771.899 (the 771^{st} multiple of the 899^{th} harmonic)

– Find the equivalent arclength for the Harmonic found in problem I (harmonic= 705^{th})

ENTER 705 [D] = 705 PAUSE
= 0.3038 or 0°30'38"

– Find where, in the 360° circle, the 5th Harmonic and its multiples lay:

ENTER 5 [E] [PRINTED OUTPUT HERE]= 5 (the harmonic), 72, 144, 216, 288, 360

HARMONIC ASTROLOGY GUIDE USER INSTRUCTIONS:

STEP	INPUT	KEYS	OUTPUT
1. LOAD CARD (BOTH SIDES) 2. INITIATE PROGRAM		A	0.0000
IN ANY ORDER			
3A CONVERT ANGLE TO HARMONIC	°°°.''""	B	YYY.XXX
3B CONVERT DISPLAYED HARMONIC TO EXACT ANGLE (A_e)		R/S	A_o (Pse)
3C COMPARE ORIGINAL ANGLE (A_o) with A_e and DIPLAY RELATIVE ERROR		R/S	= A_o (Pse) = A_e (Pse) = RELATIVE ERROR
4. CONVERT DECIMAL FRACTION TO HARMONIC	0.ddd...	C	YYY.XXX
5. CONVERT HARMONIC TO EQUIVALENT ARC LENGTH	H	D	= H (Pse) = °°°.''""
6. LOCATE WHERE, WITHIN THE 360° CIRCLE, THE HARMONIC AND ITS MULTIPLES FALL	H	E	= H(PRINT) = m_1°°°.''"" = m_2°°°.''"" ETC. m_n

REGISTERS USED: 0,1,2,4,5,6,8,A & I

LABELS USED: A,B,C,D,E,Ø,1,2 & 7

ALL FLAGS OFF, TRIG IN DEGREES, DISPLAY= FIXED (4)

STEP	KEY	CODE	
001	*LBLA	21 11	INITIATE
002	3	03	
003	1Ø^x	16 33	D# MAX
004	STO4	35 04	
005	SFØ	16 21 00	
006	3	03	
007	6	06	
008	Ø	00	
009	STOØ	35 00	360°
010	CLX	-51	
011	R/S	51	----------
012	*LBLB	21 12	CONVERT ANGLE (A)
013	STOA	35 11	TO BEST
014	HMS→	16 36	HARMONIC
015	RCLØ	36 00	360°
016	÷	-24	
017	GSBØ	23 00	
018	R/S	51	DISPLAY H
019	INT	16 34	----------
020	RCL8	36 08	CONVERT DISPLAYED
021	÷	-24	HARMONIC TO
022	RCLØ	36 00	EXACT ANGLE
023	X	-35	
024	→HMS	16 35	
025	DSP4	-63 04	DISPLAY EXACT
026	R/S	51	ANGLE
027	RCLA	36 11	DISPLAY ORIGINAL ANGLE
028	PSE	16 51	
029	HMS→	16 36	
030	X↔Y	-41	
031	PSE	16 51	DISPLAY EXACT ANGLE
032	HMS→	16 36	
033	X↔Y	-41	
034	%CH	16 55	DISPLAY RELATIVE
035	R/S	51	ERROR----------
036	*LBLC	21 13	CONVERT DECIMAL
037	GSBØ	23 00	TO H
038	R/S	51	----------
039	*LBLD	21 14	CONVERT H TO EQUIVILENT
040	DSPØ	-63 00	ARC LENGTH----------
041	PSE	16 51	
042	1/X	52	DISPLAY H
043	RCLØ	36 00	1/H 360°
044	X	-35	
045	→HMS	16 35	
046	DSP4	-65 04	DISPLAY ARC LENGTH
047	R/S	51	
048	*LBLE	21 15	LOCATE H & MULTIPLES
049	DSPØ	-63 00	WITHIN 360° CIRCLE
050	SPC	16-11	----------
051	PRTX	-14	PRINT H
052	DSP4	-63 04	

HARMONIC ASTROLOGY GUIDE (PROGRAM STEPS)

STEP	KEY	CODE	
053	STOI	35 46	STORE H
054	1/X	52	
055	RCLØ	36 00	1/H 360°
056	X	-35	
057	→HMS	16 35	
058	DSZI	16 25 46	
059	ENT↑	-21	
060	ENT↑	-21	
061	ENT↑	-21	
062	*LBL2	21 02	----------
063	PRTX	-14	PRINT m_1
064	HMS+	16-55	$m_1 + m_1$
065	DSZI	16 25 46	
066	GTO2	22 02	LOOP
067	RND	16 24	
068	Ø	00	
069	HMS+	16-55	
070	PRTX	-14	PRINT m_2... m_n
071	R/S	51	----------
072	*LBLØ	21 00	DECIMAL
073	STO1	35 01	TO
074	STO2	35 02	FRACTION
075	Ø	00	
076	STO6	35 06	
077	EEX	-23	
078	5	05	
079	FØ?	16 23 00	
080	RCL4	36 04	
081	STO4	35 04	
082	1	01	
083	STO8	35 08	
084	1	01	
085	8	08	
086	CHS	-22	
087	STOI	35 46	
088	RCL2	36 02	
089	FRC	16 44	
090	X=Ø?	16-43	
091	GTO1	22 01	
092	1/X	52	
093	STO2	35 02	
094	INT	16 34	
095	RCL6	36 06	
096	X↔Y	-41	
097	RCL8	36 08	
098	STO6	35 06	
099	X	-35	
100	+	-55	
101	RCL4	36 04	
102	X Y?	16-35	
103	GTO1	22 01	
104	R↓	-31	
105	STO8	35 08	
106	GTOi	22 45	
107	*LBL1	21 01	
108	RCL8	36 08	
109	ENT↑	-21	
110	LOG	16 32	
111	INT	16 34	
112	1	01	
113	+	-55	
114	RCL6	36 06	
115	X≠Ø?	16-42	
116	R↓	-31	
117	STOI	35 46	
118	10×	16 33	
119	÷	-24	
120	FRC	16 44	
121	STO5	35 05	
122	DSPØ	-63 00	
123	RCL8	36 08	
124	RCL1	36 01	
125	X	-35	
126	RND	16 24	
127	CF3	16 22 03	
128	ENT↑	-21	
129	LOG	16 32	
130	INT	16 34	
131	1	01	
132	+	-55	
133	RCLI	36 46	
134	+	-55	
135	1	01	
136	Ø	00	
137	.	-62	
138	5	05	
139	X>Y?	16-34	
140	GTO1	22 01	
141	RCL8	36 08	
142	R↑	16-31	
143	R/S	51	
144	*LBL1	21 01	
145	R↓	-31	
146	R↓	-31	
147	RCL8	36 00	
148	X>Y?	16-34	
149	SF3	16 21 03	
150	R↓	-31	
151	+	-55	
152	ENT↑	-21	
153	R↑	16-31	
154	RCL1	36 01	
155	INT	16 34	
156	X	-35	
157	—	-45	
158	INT	16 34	
159	X=Ø?	16-43	
160	SF3	16 21 03	
161	LSTX	16-63	
162	RCL1	36 01	
163	INT	16 34	
164	R↑	16-31	
165	DSPi	-63 45	
166	F3?	16 23 03	
167	RTN	24	
168	F1?	16 23 01	
169	RTN	24	
170	PSE	16 51	
171	PSE	16 51	
172	R↓	-31	----------
173	*LBL7	21 07	
174	DSPØ	-63 00	IMPROPER
175	PSE	16 51	FRACTION?
176	X↔Y	-41	
177	DSPi	-63 45	
178	PSE	16 51	
179	GTO7	22 07	
180	R/S	51	

PROGRAM TITLE: ASTROLOGICAL DATA PROCESSING
SUBROUTINE: MIDPOINTS

PROGRAM AUTHORS: Luci Titunik and Charles S. Hocking
1301 Morningside Dr. 2727 Antietam Court
Ann Arbor, MI 48103 Ann Arbor, MI 48105

PROGRAM DESCRIPTION: [implemented in the BASIC language]

This is the first in a series of articles that will put together a package of programs and subroutines for processing astrological data. It is assumed that the general language available to computer owners is BASIC with string manipulation. Variables that will be used in these programs will be limited to symbols composed of one letter and one digit. Variables used in a subroutine will not be the same as variables used in the main calling program except where values are being passed to and from the subroutine. Also, line numbers used in the subroutines will be different from those in the main program (for BASIC systems that do not have the renumbering feature).

In each article, a description of the program will be given with problem areas pointed out. A flow diagram of the program will also be included. A summary of the characteristics of each subroutine will be included along with the program listing to facilitate quick reference.

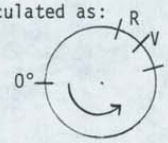
There is an overall package outline for various labels and line number groupings that will de detailed later as some of the main programs are presented.

The data for the subroutines is in decimal form rather than in astrological Sign notation (25° Aries, etc.). This is defined as the position of an object, in degrees, from 0° Aries thru 360° (360°-notation or Absolute Longitude). To convert from the traditional Sign representation to the "decimal" form, use the formula:

Degrees + [(SIGN number)-1]·30 + minutes÷60 + seconds÷3600

EXAMPLES: 14°Virgo15' = 14+(6-1)·30 + 15÷60 + 0÷3600 = 164.25°
9°Aries10' = 9+(1-1)·30 + 10÷60 + 0÷3600 = 009.166°

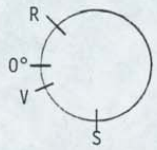
Assume two data points are given as R and S in decimal form with the midpoint represented as V. The midpoint is calculated as:



$$S + \frac{R-S}{2} = V$$

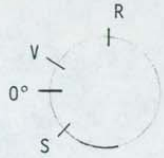
or: $$\frac{S+R}{2} = V$$

The above formulae works for R-S less than 180°. For greater than 180°, use:



$$\frac{R+S}{2} - 180° = V$$

If the position of V is



$$\frac{R+S}{2} + 180° = V$$

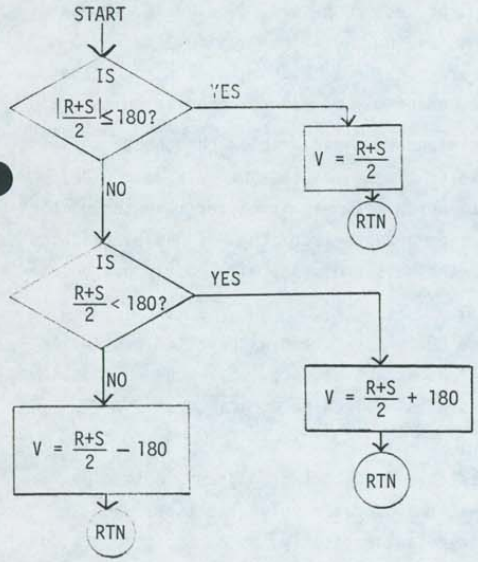
Therefore, the following formulae are the set to be used to calculate a midpoint:
(The symbol "| |" means absolute value, no sign)

If $|R-S| \leq 180$ then $V = \frac{R+S}{2}$

If $|R-S| > 180$ and $\frac{R+S}{2} \geq 180$ then $V = \frac{R+S}{2} - 180$

If $|R-S| > 180$ and $\frac{R+S}{2} < 180$ then $V = \frac{R+S}{2} + 180$

The FLOW DIAGRAM for this subroutine is given below:



The program listing in BASIC is:

```
9060 REM SUBROUTINE MIDPOINTS
9061 REM VERSION FEB 19, 1976
9062 LET W = 0
9063 LET X = ABS(R-S)
9064 IF X <= 180 THEN GOTO 9072
9066 LET W = +180
9068 IF (R+S)/2 < 180 then GOTO 9072
9070 LET W = - 180
9072 LET V = (R+S)/2 + W
9074 RETURN
```

The subroutine summary is:

Other subroutines called: none
ENTRY at 9060
Input Variables R, S (360°- decimal not.)
Output Variable V
Temporary Variables used: W, X
Arrays Dimensioned: none
Arrays requiring Dimensioning: none
Last statement number at 9074

The New $600 Computers: A Boon for Astrologers?

by Pat White & Robert Hand

Last summer, Commodore Business machines announced a full-fledged home computer for $595, and soon afterward the ubiquitous Radio Shack came up with a similar system for $599.95. Not only are these computers low-priced, they are also ready to use, needing no programming or electronics expertise for most applications.

What, you might ask, can these machines do for astrologers? Neither the Commodore nor the Radio Shack systems in their $600 form are capable of putting up horoscopes from scratch. But with the extra memory and other optional features which are planned within the year (and which will considerably add to their cost), they will be.

The PET vs. the TRS-80

As a physical unit, Commodore's PET-2001 ("Personal Electronic Transactor") is the neater of the two, with regulated power supply, processor, memory, tape drive, keyboard, and TV-screen display all housed in one elegant, 44-lb., 14"-high machine, The Radio Shack TRS-80, on the other hand, houses comparable features in four units strung together by wires. Adding the extra features to either machine may mean more separate units.

The typewriter-like keyboard of the TRS is standard-sized with a good touch, while the PET's is cramped together, which would make it tiring to use. Numerals on the PET are arranged calculator-style off to the right, which may make it easier to enter numbers-only data. The TRS's numerals are at the top as on a typewriter. The PET has 64 graphics characters which take up the shift portions of the keys and which will mostly not be useful to astrologers.

The TRS's TV screen is 12" diagonally. The PET's is 9", but with better resolution (fineness of detail). The TRS can display 1024 characters at once, while the PET displays 1000. Both screens can plot graphs (useful in statistical or harmonics work).

Both machines use standard audio tape cassettes for storing programs. Both tape drives are software-controlled, which means that the computer tells the tapes when to stop and start. Hopefully, programs can be changed automatically, as horoscope operations are long, and it is easier to write several short programs and string them together than to write one long program.

Programming Languages

Unlike most computers, which will work in any programming language, the PET and the TRS are primarily intended to work in BASIC, a language which is both widely used and very easy to learn. Each machine has a built-in BASIC interpreter, a program that converts English-like commands to the binary code ("machine language") used by the computer. (Both systems will, however, also be programmable in machine or assembly languages for those who can or want to.)

Commodore advertises its 12K BASIC (by Micro Soft) to be 20% faster-running than other companies', and it contains all the functions (including trig functions) necessary for calculating a horoscope from scratch. It uses 10 significant digits, probably enough to get the Sun accurate to the second and the Moon to the minute of arc over a one-century span (error increases as you get more remote in time).

The 4K BASIC which Radio Shack is offering right now has no trig functions, making orbital and house calculations from scratch impossible. Also it does not use the 8 to 13 significant digits necessary for acceptable accuracy. But an extended BASIC more than adequate for astrological calculations should be available very soon.

Memory Capacity

The important differences between the two machines may lie in the ultimate size of their random-access memory ("RAM"). Memory size is important because every letter or numeric character takes up a byte (1/1096th of a kilobyte or K) of memory, and the English-like commands in BASIC use up more letters than the abbreviated codes of other programming languages.

Programs in BASIC that do charts from scratch require at least 20-30k of memory, depending on how much additional output you want besides planet and house-cusp longitudes. Memory beyond 30K can be used for aspectarians, midpoint sorts, asteroids and hypothetical planets, chart comparison, parans, etc., or possibly for formatting a wheel-shaped chart to save your hand-drawing one.

Right now, for $595 the PET gives you 14K of ROM (or read-only memory , which is not programmable by the user but is necessary to operate the machine) and 4K of RAM (which is user-programmable and quickly available). This is barely adequate for simple astrological work. For an extra $200, however, you can get a PET with an 8K RAM.

The $599 TRS gives you 4K of ROM and 4K of RAM, which seems even less adequate. But for $99.95 extra you can have an 8K RAM and for $289.95 you can have a 16K RAM.

Eventually, the TRS will be expandable to 60 or 62K, while the PET's ultimate capacity is only 48K. If you are the type who wants the machine to take over as much chart calculation and analysis as possible, or who likes to keep trying new programs and techniques, or who has ambitious plans for research, the TRS may turn out to be the better machine for you.

Future Options

Random-access memory can be gotten at almost instantaneously, but the cost per

byte is relatively high. Therefore, most computers have bulk-storage devices which take longer to get at but which can hold vast quantities of data that is not constantly in use.

The tape drives in the present PET and TRS machines are one form of bulk-storage memory device. A single tape drive is mainly useful for feeding programs into the machine, but an extra tape drive would be handy for storing data files. Accordingly, additional tape drives are being offered by both companies in the near future. [standard on the PET: a ready-to-go jack for second tape drive— editor]

Tape drives are notoriously slow, however, because in order to get at a certain piece of data, a great deal of tape has to be searched. For this reason, some people are going to want to pay more for the faster access offered by a floppy disk drive.

Floppy disks are flexible disks of plastic coated with the same magnetizable oxides as magnetic tape. Though a lot cheaper than the rigid disks used by large machines, they will still double the price of the $600 system. Both companies plan to sell disk drives. Radio Shack's 90k microfloppy is expected to be lots faster than a cassette but slower than regular floppy disks.

Since disk and tape drives have moving parts (they whirl around), they are more subject to breakdowns than the purely electronic parts of the system. One can only hope that the new all-electronic Bubble Memories and charged-couple devices will soon be available for low-cost home computers.

Printers

Right now, the only easy way to copy off all the data that one of these computers can generate is to photograph the TV output (a rather crude solution!). But very soon both Commodore and Radio Shack will market printers for their machines. Commodore's will probably be about $600, and Radio Shack will have a dot-matrix impact printer for hobbyists in the same price range, as well as a $1200 or $1500 model for businesses. Inpact printers use ribbons and ordinary paper and are preferable to thermal printers, which use expensive coated paper that curls maddenly and darkens with heat or age.

Communicating with Other Machines

Something to consider is how your machine could possibly exchange data and programs with other types of equipment once the astrological community decides on conventions for doing this. The possibility of an interface that would make it possible to plug in a wide variety of other-brand peripherals (like a standard-format tape recorder or a paper-tape puncher or reader), or just the medium of exchange that everyone decides on, is one that needs to be explored for both the PET and the TRS.

Meanwhile, both machines will eventually have modems, or attachments that convert computer signals to beeps that can be transmitted by phone.

Software

Unless you have the time and knowledge to do programming, of course, none of the above will be useful until the proper software is developed. Both companies plan to sell cassettes containing programs for all the popular uses (games, personal finance, arithmetic teaching, etc.).

Whether any of these will be astrological isn't known. [the editors have already approached Commodore concerning a series of astrological programs and have been encouraged to submit the finished package for approval] But Commodore, at least, wants to set up a program exchange similar to the ones Texas Instruments and Hewlett-Packard have for their calculators, as astrologers will no doubt be contributing to it soon. Also publications like MATRIX will include programs for the PET and the TRS machines.

Further Info

Both machines are only just beginning to trickle onto the market, and few people have had more than a brief brush with them at a computer fair or second-hand knowledge from ads or articles in magazines like Popular Electronics, Kilobaud or Byte.

For the latest details on the PET and TRS, keep in touch with their manufacturers: Commodore, PET Division, 901 California Ave., Palo Alto, CA 94304; and Radio Shack, Dept. TRS-80, 205 N.W. 7th St., Ft. Worth, TX 76101.

What This Means for Astrology

The PET and TRS are clearly only the beginning. Even now, Sears, JS&A and other firms are beginning to come out with competitive machines, and Heathkit has one for about $900. With wider marketing and further progress in microcircuitry, prices will continue to drop and sophistication will continue to increase. Already industry people are predicting the $100 computer, and by the 1980s Scientific American predicts that the personal computer will be a familiar home appliance like a radio or TV.

" A computer in every household" means not only that astrologers will be able to put up charts in record time. It will also affect the development of astrology, which up to now has been largely shaped by what it's possible to do without an enormous number of calculations. Now, lots of people will be able to do large-scale tests of complicated techniques, and, if they work, use them routinely in their practices.

Also, grass-roots research (where some feel the real creatively lies) will once more be really feasible. When all computers costed millions (a bare 15 years ago) such

research could only have gone on in large, establishment-dominated institutions, but now it is within reach of anyone with the will to master the necessary research techniques. [end]



TRS-80

[editor's NOTE: Within a year, programs for the PET or TRS-80 will be available covering all phases of astrology. No longer will we have to buy $$$ in books on a new technique, spend a fortune in time learning that technique, only to find that the results are not interesting to us. A $5.00 cassette on say... Progressions & Directions will enable us to test at once the various techniques on charts and examples well known to us. Each cassette will have built-in prompting and instructions for input.]



PET

The PET and the TRS-80 (a biased review)

[Readers should be aware that what follows is very much a biased review and is prejudiced in favor of the PET and not-so in favor of the TRS-80. We would like to have an article by a TRS-80 user for our next issue. The facts and specifications are correct— to the best of our knowledge.]

Over the last several months, your editor has taken the plunge from programmable calculators into the world of microcomputers— very much with the help and encouragement of Robert Hand who made the transition a year or so earlier. All of this was, of course, precipitated by the advent of the PET & TRS-80 home-computer systems and the fact that these systems came temptingly close in cost to where I might stretch my budget. I am no computer expert and am not competent to pass judgement on many facets of computer life. My remarks should be sensible to many of you— in particular, those of you who will be approaching computers via the route of the programmable calculator.

There are to me some ideological differences involved in a comparison of the PET and the TRS-80. The TRS-80 is the first inexpensive "hobbyist" computer system— a system of four components strung together by cables (three of which must be plugged into AC outlets). The PET, on the other hand, is the first of the "appliance" computer systems— one piece systems that you plug-in and switch on. I could not understand the intense resistance to the PET from experienced computer-oriented individuals that I met at the local hobbyist-computer stores. In time, I could see that the average hobbyist computer owner (much like the stereo component owner of the early 1960s) is hardware oriented and not (as are most calculator owners) primarily interested (or addicted to) in software: programming. Unlike the astrologer, the hobbyist has little pressing need for what a computer can do (and this is a taboo subject around the computer store) and, by and large, their interest is directed to upgrading the individual components of their systems (a better keyboard, etc.) and to the life-support of these systems thru dedication and the soldering gun. In general, the hobbyist-computer system is an octopus-like affair that sprawls in one corner of the basement or den.

It should be clear why the PET met with ridicule rather than praise from this group (at first). The PET is a one-piece unit that does not lend itself to upgrading (in the traditional sense), and more important, user-maintenance is very much discouraged by the manufacturer in the same way that calculator manufacturers discourage users tampering with their machines (Commodore is one of the world's largest manufacturers of inexpensive calculators). The PET is <u>not</u> a <u>real</u> computer in the eyes of a hobbyist...as I have been told again and again by these individuals. However, it looked real enough to me, and whats more, did a lot more than my HP-97 programmable calculator (which cost almost as much as the 8K PET!) and, last but not least, the PET required no assembly, technical knowledge or owner maintenance (thank God!). In fact, it had a 1K diagnostic system built in and all three of it's main boards snap-out for service and/or replacement (I dont have to send the whole computer in for repair— in most cases). The same features that, to the hobbyist, were "limiting" in the PET were, to me, a relief.

To my judgement, the computer hobbyist (altho they fortold all of this ages ago) cannot read the "writing on the wall". They assume that mass-use of computers will be both hardware-oriented and component oriented. They write articles about integral units like the PET, but persist in their day-to-day conversation in imagining a future for their friendly octopus-systems. It appears that the computer hobbyist, as a type, will design and maintain computer hardware. A new, and much larger group of individuals, is now emerging (many encouraged by the programmable calculator industry) whose sole interest appears to be software. They will program computers and write software for a third (and very much larger yet) group of individuals who are just now beginning to stir and to find an interest in computers. This third group will neither design, manufacture, service or write software for computers. They will plug it in and use it as they do any other convenience. Astrologers, as a group, will be numbered among this third group. I believe that the readers of this magazine (and ones like it) will write the software to be used in the years to come. Many of us prefer the appliance-like approach in owning a computer. With the above thoughts in mind, your editor's bias towards the PET may be more pardonable.

MONEY, MONEY, MONEY: Money is a good place to begin since if we had a lot of it we could afford the $8000 system that Robert Hand has or even the $50,000 (estimate) system of Neil Michelsen. The $600 price tag for a PET or TRS-80 is, for astrologers, not real. The $600 4K PET is virtually unavailable and the $600 TRS-80 is unusable for astrological work. What then are we talking about— in terms of cash output for a system fit to do some astrology. The answer has to be $800 for the 8K PET or $989 for the TRS-80 with LEVEL II BASIC and 16K of memory (Radio Shack has withdrawn the 8K option for their machine and there is no middle-ground between the 4K and 16K options). At $800, the 8K PET is ready for plug-in use of a 2nd cassete (available now at $100), a dot-matrix impact printer (available now at $600— uses the IP 120 Integral Data printer) and dual-floppy disks (not yet available from Commodore but possible thru S-100 interface which is available). Memory for the PET is now available thru S-100 interface/motherboards and at a price as reasonable as Radio Shack's additional memory.

The TRS-80 (at $989 version) cannot take their printer, floppy-disk or memory expansion (beyond 16K) without the purchase of their Expansion Interface at a cost of $300 (this interface includes a real time clock and an additional PC board). My feeling about all of this is that Radio Shack is pricing itself into the lower-level of the complete hobby computer systems and out of the one-piece appliance computer market. The PET appears the only machine (at present) that is geared to that third group we spoke of earlier: the mass market. Both the PET and TRS-80 are fit to do astrological work and both systems are quite expandable and appear to be supported by all kinds of peripheral devices from smaller companies. For instance: aside from the S-100 interface for the PET, there is a PET/RS-232 interface and both Motorola and Intel have announced new ICs that will make it easy to interface the IEEE-488 bus that is resident in the PET.

I want to mention some of the really attractive qualities of the TRS-80 machine. First of all their second level BASIC appears to be super! It is from Microsoft (the same people who made the Altair and the PET BASICs), is larger than the PET BASIC and has 16.8 digit double precision (uses 8 bytes) as well as 7.1 digit precision (uses 4 bytes). In most respects, the BASIC in the PET and the TRS-80 are about equal.

The PET has 10 digit precision (prints 9) which is about adequate for astrological work. Radio shack has a full-sized keyboard and a decent manual (PET has yet to produce anything I would call a comprehensive manual). On the other hand, an article appearing in the March-April issue of People's Computers is very negative in regard to the TRS-80. In particular they have encountered real problems with the audio tape cassette and have found that (aside from being quite slow), the recorder demands a very wide bandwidth and this contributes to the recording problems (loading and saving programs) they outline. The same article declares that Radio Shack has used a "stepped-up" TV rather than the video-monitor (finer resolution) type display. They also object to the fact that the audio cassette is only partially under software control; requiring plugging and un-plugging a tiny jack to the recorder during operation. This may be taken care of with LEVEL II of Radio Shack's BASIC.

In the area of pins to external devices, there is little comparison between the two machines. The TRS-80 has a single, non-standard 40 pin bus to connect peripherals and expansion memory (this is alleviated thru their $300 expandor interface). The PET has a 40 line connector to the internal bus for memory expansion. It has a standard IEEE-488 bus that allows for multiple intelligent peripherals (floppies, printer, etc) and an 8 bit parallel I/O port with handshaking for user projects like heat or light control around the house. It also has a separate 6 position port for the 2nd cassette interface (makes file management easier). This is all standard equipment on the 8K PET.

The PET uses the 6502 chip for it's CPU and the TRS-80 has the Z-80. Both are great chips altho the Z-80 has a more advanced instruction set than does the 6502. The PET has a 1 Mhz clock and thus can perform a load immediate instruction in 2 microseconds while the TRS-80 with a 1.776 Mhz clock will take 3.4 microseconds. The PET runs the benchmark tests listed in issue #10 of Kilobaud about twice as fast as the 4K TRS-80 (no speed on the LEVEL II BASIC is now available but it should be quick).

The keyboard of the PET is cramped and is one of it's worst features. However the separate number pad (calculator style) works fine and is easy to use. The Radio Shack machine has a fine standard keyboard altho in the 4K BASIC it does not possess 2 key rollover (the PET does) which makes fast typeing impossible (LEVEL II has 2 key rollover). The TRS-80 has a tape counter on the audio cassette while the PET does not. The PET loads 68 characters per second and a 4K program would load in 60 seconds while the TRS-80 with 25 CPS would load 4K in 160 seconds. The PET has a very high quality redundant recording scheme and this results in error-free loading and instant tape error detection. The TRS-80 does not have a port for a 2nd cassette in their 4K version (dont know about the expansion interface).

The PET has a 9' but very high resolution CRT or video display that is memory mapped and separate from BASIC and data memory. The PET employs 1K of video RAM and has a 1000 character display (25 lines of 40 characters). A character cell on the PET is an 8x8 dot matrix and each character is contiguous to the surrounding characters which makes solid areas, lines possible. The PET has a set of 64 pseudo-graphic characters (lines, circles, etc) that can be used to create graphs and pictures. Graphics can be inserted (along with text) in PRINT statements and all characters can be displayed in "reverse field"(black-on-white instead of white-on-black).

The TRS-80 has .875K of video RAM, a 1024 character screen (16 lines of 64 characters each) and a 12' video screen. The TRS-80 prints 8 characters to the inch... but type appears larger on the PET's 9' screen since PET prints only 7 characters to the inch. Both have winking cursors and automatic scrolling of text. The TRS-80 uses a 5x7 dot matrix character set in a 6x12 field and also possesses limited graphics. The graphics field on the TRS-80 is 48x128 points of oblong shape that be set using X,Y coordinates.

The TRS-80 is expandable to 62K memory workspace while the PET is limited to 48K (PET has an additional 16K block for RAM or ROM beyond the advertised 32K). As mentioned, the TRS-80 is not expandable beyond 16K without the purchase of the expansion interface. A plug-in S-100 interface/motherboard is available at $160 and ready to take any of the inexpensive memory boards on the market(for the PET).

The PET has limited editing features in the 8k model including: full cursor control by program, character insertion & deletion, line elimination by RETURN instruction, and file names up to 80 characters in length. Programs on the PET can be chained together and brought in under program control. Variables can be passed from program to program as well. Both PET and the TRS-80 support machine and assemply language or other languages like: FORTRAN. The PET can save and load programs written in machine language.

MATRIX sent letters of inquiry to Heath, Commodore and Radio Shack in the late summer of 1977. MATRIX contributor Charles Hocking has purchased and built a Heath H-8 and we will try to get a user-report from him soon. The Heath machine has been ignored in this article since most of our readers would not trust themselves to build their own computer. We welcome some articles on this subject. I heard, at once, from Heath and Commodore but received,very many weeks later, almost the same printed ad that I had first encountered from Radio Shack. Calls to local Radio Shack stores for information, for the most part, helped not at all (they knew almost nothing about the TRS-80). What information I have collected on the TRS-80 has been slow to come and hard won.

And that is my report, to date, on these systems. Both machines are doing very well and demand far exceeds supply at this point. Within the year both the TRS-80 and the PET should be able to be purchased off the shelf. Software companies as well as peripherals for these machines are springing up all over.

I have pages of specifics on the PET. Would any of you care to write us a good specific article on the TRS-80? We are in the process of obtaining a printer for our PET and perhaps some extra memory. I will list my BASIC program (see Neely article on outer bodies elsewhere in this issue for details) for planetary positions in the next issue. I plan to use the PET for business work too.

And last but not least, my family loves our new PET. The kids love to play games on it or just doodle with the graphics. My wife and I enjoy the rather-neat (if I may say so) rendition of the I-Ching I have put together even tho Star-Trek is a little hard for me to get excited about (so far). I really do love it and it opens new worlds beyond my HP-97. Robert Hand pointed out a very encouraging fact with which I have found agreement: programming on the HP programmables is not unlike programming in machine language on the micros. In other words: If you have mastered the HP, BASIC will be easy!

DIGICOMP'S DR-70: THE FIRST ASTROLOGICAL DESKTOP COMPUTER

by Tim Smith

[Editor's note: Tim Smith is the astrologer-programmer who developed the DR-70. The DR-70 is a non-programmable integral unit containing a 10,000 year ephemeris of planetary positions that extends from 3000 B.C. to 7000 A.D. Accuracy is to within one minute for any date from between 1850 thru 2000 (accuracy is to within 2 seconds of arc for the Sun).

The DR-70 offers heliocentric and geocentric planetary positions, tropical or sidereal (with user-defined ayanamsha); six house systems: Placidus, Campanus, Meridian, Koch, Porphory and Regiomontanus; primary, secondary and tertiary (also converse) directions; solar and lunar returns; midpoint and Cosmobiological functions built-in; recall and comparison of any two horoscopes using automatic aspect scanning for preset orbs; standard arithmatic functions plus memory (base 10 and base 60) and more.

The DR-70 with a six month guarantee on all parts (service contract optional) retails at $2595.]



DIGICOMP'S DR-70

The DR-70 is a stand-alone desktop microcomputer whose keyboard, display and firmware are entirely dedicated to astrological functions. This portable computer is manufactured by Digicomp Research Corporation, and is scheduled for delivery in March of this year. The heart of the DR-70 is a high speed 8-bit microprocessor CPU. The programs for this unit are resident on 28K bytes of metal-mask ROM, which is accompanied by 1K bytes RAM scratch pad and user storage area. For the sake of speed and compactness, the majority of the programming was done in assembly language. Digicomp Research developed its own high speed floating point routines, which effectively reduced the planetary computation time. The DR-70 uses several different interrupt service subroutines that are conditional with respect to a keyboard status indicator. This allows the microprocessor to alternately refresh the LED display panel, parse the keyboard, continue projected calculations, and transfer information to the printer. By a complex parsing/interrupt interface, the DR-70 software is able to anticipate the key sequence in advance of the user, thus beginning the calculation requested before the user has finished entering it from the keyboard. This noticeably reduces turnaround time on most entries. Of course, this technique has a cross-check to the full keyboard entry, so that the user need never worry about the computer misreading the key sequence.

From the astrological point of view, the DR-70 keyboard and display have been designed to present results in an astrological framework

by using the familiar signs and symbols of astrology wherever they are needed to identify values. If the postions of the natal sun is desired, the user simply presses NATAL ☉; for the progressed sun, the entry becomes SECondary ☉.

For persons familiar with computers and computer science, the keyboard offers a tremendous flexibility in accessing the available data. Since the history of the previous keyboard entries is maintained as long as the machine is on, the experienced user may minimize all key sequences so that they implicitly incorporate keys set in earlier sequences. On the other hand, for the astrologer who is unfamiliar with flags, bits, and bytes, all the internal information is easily available to him through straight-forward, common sense entries. In either case, the display panel is engineered to indicate the status of all internal banks and registers at the touch of a button.

Because of the wide range of uses, Digicomp Research has spent considerable time developing the instruction manual. This has been written in a self-teaching style, with the more complex possibilities being presented a step at a time. The astrological and computer terminologies are defined as introduced, and the techniques have been illustrated with example horoscopes. In the back of the manual, there are two reference sections, one for common key sequences, and one for the more complex entries.

The DR-70 weighs six pounds, is 10" x 13½ x 5½", and requires 115 Vac ± 10V, 60 Hz connected thru the supplied power cord. All internal components are powered by a single 5 volt supply and cooled by a small fan mounted in the rear of the case. It is shipped inside a specially designed luggage case, which can be adjusted to carry the printer as well.

The companion printer for the DR-70 is scheduled for production in July. This unit interfaces with the microcomputer through a single cable, and has its own power supply. Its functions range from sorting and listing all the various chart information to simply generating hard copy of all keyboard entries. Further information on the printer and its capabilities are available from:

Digicomp Research
Terrace Hill
Ithaca, New York 14850
Phone 1-607-273-8779

Obliquity of the Ecliptic: 1800-2000 (not corrected for Nutation)

YEAR	1800s	1900s	YEAR	1800s	1900s
	° ' "	° ' "		° ' "	° ' "
00	23 27 55.11	23 27 08.26	50	23 27 31.68	23 26 44.84
01	23 27 54.64	23 27 07.79	51	23 27 31.21	23 26 44.37
02	23 27 54.17	23 27 07.32	52	23 27 30.75	23 26 43.90
03	23 27 53.70	23 27 06.86	53	23 27 30.28	23 26 43.43
04	23 27 53.24	23 27 06.39	54	23 27 29.81	23 26 42.96
05	23 27 52.77	23 27 05.92	55	23 27 29.34	23 26 42.49
06	23 27 52.30	23 27 05.45	56	23 27 28.87	23 26 42.03
07	23 27 51.83	23 27 04.98	57	23 27 28.40	23 26 41.56
08	23 27 51.36	23 27 04.51	58	23 27 27.94	23 26 41.09
09	23 27 50.89	23 27 04.04	59	23 27 27.47	23 26 40.62
10	23 27 50.42	23 27 03.58	60	23 27 27.00	23 26 40.15
11	23 27 49.96	23 27 03.11	61	23 27 26.53	23 26 39.68
12	23 27 49.49	23 27 02.64	62	23 27 26.06	23 26 39.21
13	23 27 49.02	23 27 02.17	63	23 27 25.59	23 26 38.75
14	23 27 48.55	23 27 01.70	64	23 27 25.12	23 26 38.28
15	23 27 48.08	23 27 01.23	65	23 27 24.66	23 26 37.81
16	23 27 47.61	23 27 00.77	66	23 27 24.19	23 26 37.34
17	23 27 47.14	23 27 00.30	67	23 27 23.72	23 26 36.87
18	23 27 46.68	23 26 59.83	68	23 27 23.25	23 26 36.40
19	23 27 46.21	23 26 59.36	69	23 27 22.78	23 26 35.94
20	23 27 45.74	23 26 58.89	70	23 27 22.31	23 26 35.47
21	23 27 45.27	23 26 58.42	71	23 27 21.85	23 26 35.00
22	23 27 44.80	23 26 57.95	72	23 27 21.38	23 26 34.53
23	23 27 44.33	23 26 57.49	73	23 27 20.91	23 26 34.06
24	23 27 43.86	23 26 57.02	74	23 27 20.44	23 26 33.59
25	23 27 43.40	23 26 56.55	75	23 27 19.97	23 26 33.12
26	23 27 42.93	23 26 56.08	76	23 27 19.50	23 26 32.66
27	23 27 42.46	23 26 55.61	77	23 27 19.03	23 26 32.19
28	23 27 41.99	23 26 55.14	78	23 27 18.57	23 26 31.72
29	23 27 41.52	23 26 54.67	79	23 27 18.10	23 26 31.25
30	23 27 41.05	23 26 54.21	80	23 27 17.63	23 26 30.78
31	23 27 40.58	23 26 53.74	81	23 27 17.16	23 26 30.31
32	23 27 40.12	23 26 53.27	82	23 27 16.69	23 26 29.84
33	23 27 39.65	23 26 52.80	83	23 27 16.22	23 26 29.38
34	23 27 39.18	23 26 52.33	84	23 27 15.76	23 26 28.91
35	23 27 38.71	23 26 51.86	85	23 27 15.29	23 26 28.44
36	23 27 38.24	23 26 51.40	86	23 27 14.82	23 26 27.97
37	23 27 37.77	23 26 50.93	87	23 27 14.35	23 26 27.50
38	23 27 37.31	23 26 50.46	88	23 27 13.88	23 26 27.03
39	23 27 36.84	23 26 49.99	89	23 27 13.41	23 26 26.56
40	23 27 36.37	23 26 49.52	90	23 27 12.94	23 26 26.10
41	23 27 35.90	23 26 49.05	91	23 27 12.48	23 26 25.63
42	23 27 35.43	23 26 48.58	92	23 27 12.01	23 26 25.16
43	23 27 34.96	23 26 48.12	93	23 27 11.54	23 26 24.69
44	23 27 34.49	23 26 47.65	94	23 27 11.07	23 26 24.22
45	23 27 34.03	23 26 47.18	95	23 27 10.60	23 26 23.75
46	23 27 33.56	23 26 46.71	96	23 27 10.13	23 26 23.29
47	23 27 33.09	23 26 46.24	97	23 27 09.66	23 26 22.82
48	23 27 32.62	23 26 45.77	98	23 27 09.20	23 26 22.35
49	23 27 32.15	23 26 45.31	99	23 27 08.73	23 26 21.88
50	23 27 31.68	23 26 44.84	00	23 27 08.26	23 26 21.42

Formula Obliquity of the Ecliptic (ε): (T= time interval from Epoch in Julian centuries of 36525 ephemeris days)

$$\varepsilon = 23°27'08''.26 - 46''.845T - 0''.0059T^2 - 0''.00181T^3$$

Epoch: Jan. 0.5, 1900 ET(JED 2415020.5)

JULIAN DAY NUMBER

DAYS ELAPSED AT GREENWICH NOON, A. D. 1900–1950

Year	Jan. 0	Feb. 0	Mar. 0	Apr. 0	May 0	June 0	July 0	Aug. 0	Sept. 0	Oct. 0	Nov. 0	Dec. 0
1900	241 5020	5051	5079	5110	5140	5171	5201	5232	5263	5293	5324	5354
1901	5385	5416	5444	5475	5505	5536	5566	5597	5628	5658	5689	5719
1902	5750	5781	5809	5840	5870	5901	5931	5962	5993	6023	6054	6084
1903	6115	6146	6174	6205	6235	6266	6296	6327	6358	6388	6419	6449
1904	6480	6511	6540	6571	6601	6632	6662	6693	6724	6754	6785	6815
1905	241 6846	6877	6905	6936	6966	6997	7027	7058	7089	7119	7150	7180
1906	7211	7242	7270	7301	7331	7362	7392	7423	7454	7484	7515	7545
1907	7576	7607	7635	7666	7696	7727	7757	7788	7819	7849	7880	7910
1908	7941	7972	8001	8032	8062	8093	8123	8154	8185	8215	8246	8276
1909	8307	8338	8366	8397	8427	8458	8488	8519	8550	8580	8611	8641
1910	241 8672	8703	8731	8762	8792	8823	8853	8884	8915	8945	8976	9006
1911	9037	9068	9096	9127	9157	9188	9218	9249	9280	9310	9341	9371
1912	9402	9433	9462	9493	9523	9554	9584	9615	9646	9676	9707	9737
1913	9768	9799	9827	9858	9888	9919	9949	9980	*0011	*0041	*0072	*0102
1914	242 0133	0164	0192	0223	0253	0284	0314	0345	0376	0406	0437	0467
1915	242 0498	0529	0557	0588	0618	0649	0679	0710	0741	0771	0802	0832
1916	0863	0894	0923	0954	0984	1015	1045	1076	1107	1137	1168	1198
1917	1229	1260	1288	1319	1349	1380	1410	1441	1472	1502	1533	1563
1918	1594	1625	1653	1684	1714	1745	1775	1806	1837	1867	1898	1928
1919	1959	1990	2018	2049	2079	2110	2140	2171	2202	2232	2263	2293
1920	242 2324	2355	2384	2415	2445	2476	2506	2537	2568	2598	2629	2659
1921	2690	2721	2749	2780	2810	2841	2871	2902	2933	2963	2994	3024
1922	3055	3086	3114	3145	3175	3206	3236	3267	3298	3328	3359	3389
1923	3420	3451	3479	3510	3540	3571	3601	3632	3663	3693	3724	3754
1924	3785	3816	3845	3876	3906	3937	3967	3998	4029	4059	4090	4120
1925	242 4151	4182	4210	4241	4271	4302	4332	4363	4394	4424	4455	4485
1926	4516	4547	4575	4606	4636	4667	4697	4728	4759	4789	4820	4850
1927	4881	4912	4940	4971	5001	5032	5062	5093	5124	5154	5185	5215
1928	5246	5277	5306	5337	5367	5398	5428	5459	5490	5520	5551	5581
1929	5612	5643	5671	5702	5732	5763	5793	5824	5855	5885	5916	5946
1930	242 5977	6008	6036	6067	6097	6128	6158	6189	6220	6250	6281	6311
1931	6342	6373	6401	6432	6462	6493	6523	6554	6585	6615	6646	6676
1932	6707	6738	6767	6798	6828	6859	6889	6920	6951	6981	7012	7042
1933	7073	7104	7132	7163	7193	7224	7254	7285	7316	7346	7377	7407
1934	7438	7469	7497	7528	7558	7589	7619	7650	7681	7711	7742	7772
1935	242 7803	7834	7862	7893	7923	7954	7984	8015	8046	8076	8107	8137
1936	8168	8199	8228	8259	8289	8320	8350	8381	8412	8442	8473	8503
1937	8534	8565	8593	8624	8654	8685	8715	8746	8777	8807	8838	8868
1938	8899	8930	8958	8989	9019	9050	9080	9111	9142	9172	9203	9233
1939	9264	9295	9323	9354	9384	9415	9445	9476	9507	9537	9568	9598
1940	242 9629	9660	9689	9720	9750	9781	9811	9842	9873	9903	9934	9964
1941	9995	*0026	*0054	*0085	*0115	*0146	*0176	*0207	*0238	*0268	*0299	*0329
1942	243 0360	0391	0419	0450	0480	0511	0541	0572	0603	0633	0664	0694
1943	0725	0756	0784	0815	0845	0876	0906	0937	0968	0998	1029	1059
1944	1090	1121	1150	1181	1211	1242	1272	1303	1334	1364	1395	1425
1945	243 1456	1487	1515	1546	1576	1607	1637	1668	1699	1729	1760	1790
1946	1821	1852	1880	1911	1941	1972	2002	2033	2064	2094	2125	2155
1947	2186	2217	2245	2276	2306	2337	2367	2398	2429	2459	2490	2520
1948	2551	2582	2611	2642	2672	2703	2733	2764	2795	2825	2856	2886
1949	2917	2948	2976	3007	3037	3068	3098	3129	3160	3190	3221	3251
1950	243 3282	3313	3341	3372	3402	3433	3463	3494	3525	3555	3586	3616

JULIAN DAY NUMBER

DAYS ELAPSED AT GREENWICH NOON, A. D. 1950–2000

Year	Jan. 0	Feb. 0	Mar. 0	Apr. 0	May 0	June 0	July 0	Aug. 0	Sept. 0	Oct. 0	Nov. 0	Dec. 0
1950	243 3282	3313	3341	3372	3402	3433	3463	3494	3525	3555	3586	3616
1951	3647	3678	3706	3737	3767	3798	3828	3859	3890	3920	3951	3981
1952	4012	4043	4072	4103	4133	4164	4194	4225	4256	4286	4317	4347
1953	4378	4409	4437	4468	4498	4529	4559	4590	4621	4651	4682	4712
1954	4743	4774	4802	4833	4863	4894	4924	4955	4986	5016	5047	5077
1955	243 5108	5139	5167	5198	5228	5259	5289	5320	5351	5381	5412	5442
1956	5473	5504	5533	5564	5594	5625	5655	5686	5717	5747	5778	5808
1957	5839	5870	5898	5929	5959	5990	6020	6051	6082	6112	6143	6173
1958	6204	6235	6263	6294	6324	6355	6385	6416	6447	6477	6508	6538
1959	6569	6600	6628	6659	6689	6720	6750	6781	6812	6842	6873	6903
1960	243 6934	6965	6994	7025	7055	7086	7116	7147	7178	7208	7239	7269
1961	7300	7331	7359	7390	7420	7451	7481	7512	7543	7573	7604	7634
1962	7665	7696	7724	7755	7785	7816	7846	7877	7908	7938	7969	7999
1963	8030	8061	8089	8120	8150	8181	8211	8242	8273	8303	8334	8364
1964	8395	8426	8455	8486	8516	8547	8577	8608	8639	8669	8700	8730
1965	243 8761	8792	8820	8851	8881	8912	8942	8973	9004	9034	9065	9095
1966	9126	9157	9185	9216	9246	9277	9307	9338	9369	9399	9430	9460
1967	9491	9522	9550	9581	9611	9642	9672	9703	9734	9764	9795	9825
1968	9856	9887	9916	9947	9977	*0008	*0038	*0069	*0100	*0130	*0161	*0191
1969	244 0222	0253	0281	0312	0342	0373	0403	0434	0465	0495	0526	0556
1970	244 0587	0618	0646	0677	0707	0738	0768	0799	0830	0860	0891	0921
1971	0952	0983	1011	1042	1072	1103	1133	1164	1195	1225	1256	1286
1972	1317	1348	1377	1408	1438	1469	1499	1530	1561	1591	1622	1652
1973	1683	1714	1742	1773	1803	1834	1864	1895	1926	1956	1987	2017
1974	2048	2079	2107	2138	2168	2199	2229	2260	2291	2321	2352	2382
1975	244 2413	2444	2472	2503	2533	2564	2594	2625	2656	2686	2717	2747
1976	2778	2809	2838	2869	2899	2930	2960	2991	3022	3052	3083	3113
1977	3144	3175	3203	3234	3264	3295	3325	3356	3387	3417	3448	3478
1978	3509	3540	3568	3599	3629	3660	3690	3721	3752	3782	3813	3843
1979	3874	3905	3933	3964	3994	4025	4055	4086	4117	4147	4178	4208
1980	244 4239	4270	4299	4330	4360	4391	4421	4452	4483	4513	4544	4574
1981	4605	4636	4664	4695	4725	4756	4786	4817	4848	4878	4909	4939
1982	4970	5001	5029	5060	5090	5121	5151	5182	5213	5243	5274	5304
1983	5335	5366	5394	5425	5455	5486	5516	5547	5578	5608	5639	5669
1984	5700	5731	5760	5791	5821	5852	5882	5913	5944	5974	6005	6035
1985	244 6066	6097	6125	6156	6186	6217	6247	6278	6309	6339	6370	6400
1986	6431	6462	6490	6521	6551	6582	6612	6643	6674	6704	6735	6765
1987	6796	6827	6855	6886	6916	6947	6977	7008	7039	7069	7100	7130
1988	7161	7192	7221	7252	7282	7313	7343	7374	7405	7435	7466	7496
1989	7527	7558	7586	7617	7647	7678	7708	7739	7770	7800	7831	7861
1990	244 7892	7923	7951	7982	8012	8043	8073	8104	8135	8165	8196	8226
1991	8257	8288	8316	8347	8377	8408	8438	8469	8500	8530	8561	8591
1992	8622	8653	8682	8713	8743	8774	8804	8835	8866	8896	8927	8957
1993	8988	9019	9047	9078	9108	9139	9169	9200	9231	9261	9292	9322
1994	9353	9384	9412	9443	9473	9504	9534	9565	9596	9626	9657	9687
1995	244 9718	9749	9777	9808	9838	9869	9899	9930	9961	9991	*0022	*0052
1996	245 0083	0114	0143	0174	0204	0235	0265	0296	0327	0357	0388	0418
1997	0449	0480	0508	0539	0569	0600	0630	0661	0692	0722	0753	0783
1998	0814	0845	0873	0904	0934	0965	0995	1026	1057	1087	1118	1148
1999	1179	1210	1238	1269	1299	1330	1360	1391	1422	1452	1483	1513
2000	245 1544	1575	1604	1635	1665	1696	1726	1757	1788	1818	1849	1879



Summer 1978

Issue Two

MATRIX MAGAZINE

James Neely 2 THE DETERMINATION OF PLANETARY VELOCITIES AND RETROGRADE MOTION

Editors 6 AN INTRODUCTION TO ORBIT DETERMINATION

James Neely 8 ASTROLOGICAL ROUTINES FOR THE TI-59 PROGRAMMABLE (PLANETARY & LUNAR COORDINATES)

Neely & Editor 28 MEAN ORBITAL ELEMENTS— A DISCUSSION

James Neely 35 THE ORBITAL ELEMENTS FOR THE MAJOR ASTEROIDS

James Neely & Malcolm Dean 36 THE ORBITAL ELEMENTS FOR CHIRON

James Neely 37 PLANETARY & LUNAR COORDINATES ON THE HP-67/97 PROGRAMMABLE CALCULATORS

Editors 52 A BASIC PROGRAM FOR PLANETARY & LUNAR COORDINATES (PLUS OPTIONAL LOCALITY ADJUSTMENTS)

Editors 58 AN INTRODUCTION TO THE COMPUTER LANGUAGE BASIC (BASIC FOR ASTROLOGERS, PART I)

Front Cover HANDSHAKING DEPARTMENT

60 ERRATA

Back Cover ADS

1 EDITOR'S NOTES

Editors: Michael & Margaret Erlewine

1041 North Main Street ✧ Ann Arbor, Michigan 48104

Hand-Shaking

Here are some of the letters we received from readers to start off our HANDSHAKING department.

Dear MATRIX,

I'm disappointed that the first issue contained no TI-59 programs but I'm sure that time will rectify that. In fact, that fact leads to a suggestion of future program standards. In the first issue are programs for two different calculators and one BASIC language routine. All are sufficiently documented for adaptability and the suggestion applies only to future issues. Since readers may not have nor be familiar with the particular machines for which programs are written, they must have sufficient information to adapt them to their own (in my case, to a TI-59). I suggest that as a minimum, all program writeups contain (in addition to the program)

1. A description of the method of the program
2. A worked example.

Neely's is outstanding in this respect. This should enable all readers to verify their copying and/or reprogramming. Truthfully, it appears you already had this in mind.

Most enthusiastically yours,
Sanford Greenfarb
US ARMY Admin Survey Det
Fort Meade, MD 20755

Dear Editor,

I am studying physics at the 'Federal Institute of Technology' in Zurich and during the last two years I have specialized myself to 'Celestial Mechanics'. I am the author of an astrological service called ASTRODATA which includes almost everything offered by Neil Michelsen along with special methods used in Europe exclusively. A novelty is the three-color plotter which is part of the system (WANG VP 2200, 10 Mbyte disk, 32 Kbyte memory). It automatically plots the whole horoscope in slightly more than 5 minutes. The accuracy of the positions of Sun, Moon and planets is 1 second of arc from 1800 to 2000.

As a response to the 'outer-planet-project' of Neely I will give you two references which represent a very high standard in Fourier-development of the positions of the outer planets:

J.L. Simon, P. Bretagnon: Astronomy & Astrophysics Supplement Series, Vo. 22, 107-160 (1975 (results of first order perturbations of the four giant planets— Jup, Sat, Ura, Nep)

Sh.G.Sharaf, N.A.Budnikova:
Theory of motion of the planet pluto
Part one and two
NASA Technical Translation

However, I have not implemented these theories in the program mentioned above, but Lloyd Carpenters Chebychev series.

Kind regards
Alexander Borg
Tagernstr. 8
8127 Forch , Switzerland

I have been a practitioner of Ebertin's Cosmobiology for several years and am curious to exchange information regarding this system with like minded individuals. Also am searching for missing issues of COSMOBIOLOGY INTERNATIONAL (xeroxes fine)

Charles Chesney
2675 SW Fairmont
Corvallis, Oregon 97330

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How would I get a copy of the Appendix to the American Ephemeris and Nautical Almanac? U.S. Governement publications does not list it.

- James Hegenndeffe, Bellevue NEB

[Editor's note: The Supplement to the A.E.N.A is a British publication and can be ordered from the following book vendor for $19.90 POSTPAID. This company offers a nice booklist upon request.]

Vintage Book Company
Box 16182
St. Paul, MN 55116

Dear Michael,

I knew there must be people "out there" doing what I had been struggling with in isolation, but the joy it brings when that first contact is really made!

In Loving brotherhood,
Phil Reitz
122 Eaglecroft Rd.
Westfield, NJ 07090

Dear Michael,

...we need some statistical analysis help. I write to you asking if you know of any organizations that we could approach for financial assistance or for statistical analysis help via computer, or who might be interested in carrying on the research from our starting point.

Given: daily temperatures on magnetic tape for computer output.
Desired: fourier analysis of the temperature data
Looking for: A Pluto-moon aspect cycle of 9 1/9 days, which may be related to cool temperatures.

Energetically,
Buryl Payne, Ph.D.
126 Harvard St.
Brookline, Mass. 02146

Dear Michael,

MATRIX is great...
, ...I suggest that MATRIX might evaluate the various programmable calculators, pro and con.

- Charles Jayne, Monroe NY

[Good idea! Would any of our readers care to undertake to do this? — Editor]

Dear Michael,

About MATRIX: it's very good, clear, nicely presented, with a friendly editorial voice that doesn't get pompous. I like the introduction to the Neely programs, giving the formulae, except that you caused me needless heartarche for HOURS because 10th line up from the bottom of page 9, in the formula, you give 7 instead of 9, and in the 6th line up, you leave out the $(^2)$ in the final term. (I suggest you publish such errata, and try to proofread line by line as you type, however boring it is; for MATRIX will be read and re-read, for many years to come, and such details matter.

It seems to me very important that an elaborately clear analysis of programs is needed. You have set a fine standard in issue 1, particularly with the Neely lot, and I'm praying that you do likewise (if not better) with the all-important planetary programs in issue two. Formulae, explanations, notes about shortcuts, etc. are essential, because many of us will be adapting the basic formulae to our own devious purposes rather than using them straight. The more you treat MATRIX as a partwork encyclopaedia, the more pleased I shall be.

— Roger Elliot, England

EDITOR'S NOTES, NEWS AND LAST MINUTE COMMENTS

Here is MATRIX TWO finished at last! Thanks for all the support. We have between 100-125 readers at this point...most VERY enthusiastic about astro-computation.

A quick look at the author column on our cover will let you know who we owe some thanks to... a certain Mr. James Neely from California. He has been helpful in about every way I can imagine. BRAVO JAMES NEELY!

We have many more fine Neely programs and articles coming soon. In fact, the next several issues will be filled with great material. Here is a peek at some of the coming attractions: From Thomas Shanks (Neil Michelsen's partner) we have a very large FORTRAN package that has been developed for the purpose of carrying out statistical analysis of astrological data. This is an incrediably powerful series of programs for the research astrologer. From the Toronto Islands and Ian McKinnon we have programs for the HP-67/97 that will do the planets from Mercury thru Mars to about 5 seconds of arc! He has also sent along complete equations and documentation so that the programs may be adapted to other machines. Your editor is writing them up into BASIC for the micro fans. James Neely is putting together a major article on Coordinate Rotation and Transformation that is beautiful— to say the least. Theodor Landscheidt sends us equations to calculate the Geocentric Nodes and permission to quote from his book on that subject. Also many more single programs for various smaller machines. How does that sound?

We plan to have MATRIX THREE out in the middle of this coming Autumn. You will notice that we have arrived at a $5 per issue (60 pages) format for the time being. We lost money trying to make MATRIX available at our earlier price. Your editors are working hard on each issue and it is not worth the perpetual 'penny pinching' hassle to worry all the time about cutting every last corner. At $5, we dont have to worry and readers are getting at least their money's worth in software alone. Of course contribution from donors are welcome and will be used to bring down the price-per-issue.

NEW PRINTER

We now have a re-furbished heavy-duty I/O Selectric based terminal up and running with our Commodore PET. The HP-67/97 listings and the BASIC programs listings were done on this machine. It will help to avoid errors in code and we will have some word processing running by the next issue. Our next goal is to get some more memory...so that large programs can be worked upon.

THE POSTAL SERVICE

The U.S. Postal Service is slow. There is little difference in speed between THIRD and FOURTH class speed of delivery...but quite a lot in PRICE. We will be sending out MATRIX by FOURTH CLASS rates. If any of you want your copy rushed FIRST CLASS, enclose one dollar extra and we will do that. Also, many of our readers are from foreign countries. Please send us U.S. funds only and PLEASE include extra postage if your want your copy sent AIR MAIL PRINTED MATTER rather than by boat. What some of our foreign readers do is send a lump sum (say $20) and we keep track of expenses and notify them when it is time to send more money.

What do you think of the REDUCED size of some of the pages in this issue? We are considering reducing all articles and instruction pages but not the program listings themselves. Feedback?

PROGRAMS NOT IN THIS ISSUE

If you are wildly looking for the exact Sun-Moon program from Robert Hand...look no more in this issue. We ran out of space and will have that program in our next issue. Also the program by Tim Smith of Digicomp arrived too late for this issue and will appear in our next issue.

READER HELP NEEDED

We need some HELP! on a project that could be useful to us all. MATRIX would like to prepare and publish a set of standard astrological problems and their solutions. This could be made available as part of MATRIX or as a supplement.

For instance: accurate Angle and House Cusp routines for all possible geographic longitude and latitude compbinations, accurate planet computation with intermediate values listed, etc. Readers could help by thinking about this project and submitting what they feel would be use-examples, lems. How many times have you wished you had a standard set of worked problems to test out some new program? Feedback please?

NEW COMPUTERS

Both the PET and TRS-80 microcomputers are available off-the-shelf at this point. The new Level II BASIC for the TRS-80 is being delivered and is very nice indeed. PET has a new printer of very high quality (dot matrix) that can print both upper & lower case and the complete set of PET graphics. Both machines are doing fine, altho there is some problem (temporary I hope) in getting service on the PET is some areas of the country. Will try to have an update by next issue as well as other new machines coming on the market.

PLANETARY PROGRAMS

How about the planetary programs in this issue? At last astrologers can have the programs needed to calculate planet's positions. We have received many letters from readers who are waiting for this material...machines running.

TUTORIAL APPROACH FOR MATRIX

Noel Tyl called to encourage MATRIX to provide more beginning articles and programs. He has a good point indeed..and I'm afraid this issue is not much help in that regard. We have felt it important to get some of the more advanced material into the public domain. Also would some readers care to write some astrology on the 4-function machines for MATRIX? I have intended to do this myself but have had all I can do to get the BASIC stuff working right. We really do need some help in this department.

NEW & INTERESTING ITEMS/SERVICES

Received from Edwin Kammerer and TELEPSYCHE INC. a very beautiful computer service. This consists of a 20x26 multi-colored wall chart upon which the radix planet's positions are drawn. The Transits for one year are represented in a graphic-ephemeris type manner. Two bound computer generated booklets are included: one is a very original exposition of the technique and two is a list of the transits for the year. The whole thing costs $25 and is very well done indeed. For information, contact TELEPSYCHE, P.O. Box 114, Bedford, MASS 01730

Running out of space I see..so it's goodbye until MATRIX THREE in the fall. Let us know what you would like to see in these pages and how we might change what we have now.

— Michael & Margaret Erlewine

The Determination of Planetary Velocities and Retrograde Motion

by James Neely

Astrological charts are used to depict the positions of the planetary bodies at the time of an event. Such charts are static in that they do not depict the actual motion of the bodies. The only attempt to describe dynamic characteristics is a statement of whether the motion of a body is direct or retrograde. Many computer enthusiasts are now writing programs to determine planetary positions, house cusps, aspects, progressions, etc., and there is now a need to determine whether motion is direct or retrograde.

This paper describes the mathematics, suitable for computer implementation, of determining whether motion is direct or retrograde. As a by-product this method can be used to determine the actual motion of a body in heliocentric or geocentric right ascension and declination, or heliocentric or geocentric longitude and latitude. To the author's knowledge such detailed motions have not been previously considered in astrological delineations; thus this methodology may open a new field of investigation.

By its nature, this material is written for the computer enthusiasts who are capable of translating mathematics into computer programs. It is assumed, therefore, that the reader is familiar with methods of solving the problems of two-body motion (such as the author's "Planetary Coordinates" program 00211D for the Hewlett-Packard HP-67/97 listed elsewhere in this issue). Since motion is involved, we must compute the elements of motion to augment the usual determinations of the elements of position.

The details follow. We will let the single quote symbol (') denote the time derivative or the time-rate-of-change of the quantity to which the quote has been attatched. For example, E' denotes the time derivative of the eccentric anomaly E.

Compute the eccentric anomaly E from Kepler's equation in the usual manner. Then compute

$$E' = \frac{k\sqrt{\mu}}{a^{3/2}\,(1 - e\cos E)}$$

where

$k = 0.01720209895$

a = the semimajor axis

e = the eccentricity, and

$\mu = 1 + m_B$, where m_B is the mass of the body in solar mass units. (If computer space is at a premium, little accuracy is lost by setting $m_B = 0$)

Next compute the perifocal coordinate velocities

$$x_\omega' = -aE' \sin E$$

and

$$y_\omega' = aE'\sqrt{1-e^2}\cos E$$

The heliocentric ecliptic rectangular coordinates of the body's velocity are then

$$\begin{bmatrix} x_H' \\ y_H' \\ z_H' \end{bmatrix} = R_3(-\Omega)\,R_1(-i)\,R_3(-\omega) \begin{bmatrix} x_\omega' \\ y_\omega' \\ 0 \end{bmatrix}$$

where

$$R_3(-\theta) = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

and

$$R_1(-\theta) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta \\ 0 & \sin\theta & \cos\theta \end{bmatrix}$$

and θ is one of the rotation angles Ω, i, or ω.

Let x_S', y_S', and z_S' denote the geocentric components of the solar velocity. The geocentric rectangular ecliptic components of the body are given by

$$x_G' = x_H' + x_S'$$

$$y_G' = y_H' + y_S'$$

$$z_G' = z_H' + z_S'$$

If desired, the rectangular ecliptic velocity components can be rotated through the angle ε (obliquity of the ecliptic) to produce rectangular equatorial velocity components X_G', Y_G', and Z_G' using the formulas

$$X_G' = x_G'$$

$$Y_G' = y_G'\cos\varepsilon - z_G'\sin\varepsilon$$

$$Z_G' = z_G'\sin\varepsilon + z_G'\cos\varepsilon$$

In these formulas the subscript G may be replaced by the subscript H or the subscript S.

Whether in the heliocentric, geocentric, ecliptic or equatorial system, denote the rectangular velocity components of the body by x', y', and z' and denote the position components of the body by x, y, and z. Let λ denote either the longitude or right ascension of the body. Since

$$\lambda = \tan^{-1}(y/x)$$

then the daily motion in longitude or right ascension is

$$\lambda' = (xy' - yx')/(x^2 + y^2) \text{ radians per day}$$

Also, let β denote either the latitude or declination of the body. Since

$$\beta = \tan^{-1} z/(x^2 + y^2)^{1/2}$$

the daily motion in latitude or declination is

$$\beta' = \frac{x(xz' - zx') + y(yz' - zy')}{(x^2 + y^2 + z^2)(x^2 + y^2)^{1/2}} \text{ radians per day.}$$

If $\lambda' > 0$, the motion is direct in longitude or right ascension, and if $\lambda' < 0$, the motion is retrograde in longitude or right ascension. It should be noted that the motion of a body can, for example, turn direct in right ascension before or after it turns direct in longitude. Also, if $\beta' > 0$, then the latitude or declination is increasing (becoming more northernly), and if $\beta' < 0$, then the latitude or declination is decreasing (becoming more Southernly).

As a means of checking the accuracy of your computer program, you may use x_ω, y_ω, x_ω" and y_ω' in the λ' formula to compute the Daily Motion of the body. The Daily Motion is tabulated on pages 198 through 214 of the recent editions of The American Ephemeris and Nautical Almanac (AENA). The angles ω, i, and Ω that are used in the rotation matrices denote the argument of perigee, the orbital inclination, and the longitude of the ascending node, respectively.

Example solution for April 2, 1978, 0h GMT

	x_ω	y_ω	x_ω'	y_ω'
Sun	0.0115231	0.9994617	-0.0172013	0.0004859
Mercury	0.0231799	0.3652291	-0.0281920	0.0075981

	X	Y	Z	X'	Y'	Z'
Earth-H	-0.9780	-0.2062	0.0000	0.003268	-0.016895	0.
Sun-Geo	0.9780	0.2062	0.	-0.003268	0.016895	0.
Merc-H	-0.3490	0.1024	0.0403	-0.013732	-0.025753	-0.000859
Merc-G	0.6290	0.3086	0.0403	-0.017000	-0.008858	-0.000859

Using the 'ω' values for Mercury, I get 0.0781953 rad/day= 4.4803°/day (cf. AENA, pg 200) for the daily motion. Also, (using only the accuracy typed on the previous page), I get

λ' (Helio-merc) = 0.0785714 rad/day= 4°.5018/day, and

λ' (Geo-mercu) = -0.000663 rad/day= -0.0380°/day

I dont have anything to compare these last figures to except that Mercury has just turned retrograde and so the motion is quite slow.

BASIC implementation of Neely Planetary Velocities Formulae
This routine can be used with BASIC listing (replaces lines 270-490)

```
260 REM PLANETARY ROUTINE WITH NEELY VELOCITY COORDINATES
265 REM ENTER WITH 'T' FROM 1900.0
266 REM
270 FOR I=1 TO 9
275 GOSUB 900:M=FNR(FNU(S))      :GOSUB 900:E=S
280 REM ITERATIVE LOOP FOR ECCENTRIC ANOMALY
285 EA=M:FOR A=1 TO 5:EA=M+E*SIN(EA):NEXTA
290 REM BEGIN VELOCITY COMPUTATIONS
295 READ AU:E1=.0172020989/(AU^1.5*(1-E*COS(EA)))
300 REM COMPUTE PERIFOCAL COORDINATE VELOCITIES (TWO)
305 XW1=-(AU*E1)*SIN(EA):YW1=(AU*E1)*(1-E*E)^.5*COS(EA)
310 REM ROTATE THRU ARGUMENT OF PERIHELION,NODE & INCLINATION
320 GOSUB 900:AP=S:GOSUB 900:AN=S:GOSUB 900:IN=S:X=XW1:Y=YW1:GOSUB 3550
330 REM HELIO ECLIPTIC RECTANGULAR VELOCITY COORDINATES
335 XH=X:YH=Y:ZH=G
340 REM GEO COMPONENTS OF SOLAR VELOCITY
345 IF I=1 THEN XA=-XH:YA=-YH:ZA=-ZH:GOTO 365
350 XW=XH+XA:YW=YH+YA:ZW=ZH+ZA
355 REM PERIFOCAL COORDINATES FOR RECTANGULAR POSITION COORDINATES
360 REM ROTATION, ETC. TO GET RECT. POSITION COORD.S (XX,YY,ZZ)
365 X=AU*(COS(EA)-E):Y=AU*SIN(EA)*(1-E*E)^.5
366 PRINTX;Y
370 GOSUB 3550:XX=X:YY=Y:ZZ=G
375 REM COMPUTE HELIO MOTION
380 XK=(XX*YH-YY*XH)/(XX*XX+YY*YY)
385 PRINT "HELIO DAILY MOTION= ";FND(XK)
390 REM CONVERT RECT TO SPHERICAL COORDINATES
395 GOSUB950:AA=A:X=R:Y=G:GOSUB 950:D=FND(A)
400 X=R:Y=G:GOSUB 950:D=FND(A):IF D>20 THEN D=D-360
405 REM PRINT HELIO LONG & LAT
410 PRINT "HELIO LONG & LAT ";FNU(FND(AA));D
415 REM IF EARTH/SUN, STORE X1,Y1,Z1
420 IF I=1 THEN X1=XX:Y1=YY:Z1=ZZ:GOTO 435
425 REM GEO RECTANGULAR POSITION COORDINATES
430 XX=XX-X1:YY=YY-Y1:ZZ=ZZ-Z1
435 XW=(XX*YW-YY*XW)/(XX*XX+YY*YY)
440 PRINT "GEO DAILY MOTION= ";FND(XW)
445 Z$="  ":IF XW<0 THEN Z$=" R":REM DIRECT OR RETROGRADE?
450 IF I=1 THEN C=FNU(C+180):D=0:GOTO 475
455 REM RECT TO SPHERICAL POSITION COORDINATES FOLLOW
460 Y=YY:X=XX:GOSUB 950:G=A:Y=ZZ:X=R:GOSUB 950
470 AA=G:D=FND(A):IF D>20 THEN D=D-360
475 PRINT "GEO LONG & LAT ";FNU(FND(AA));D
480 NEXTI

3500 REM SUBROUTINE USED FOR POSITION & VELOCITY COORDINATES (ROTATE)
3550 GOSUB950:A=A+AP:GOSUB930:D=X:X=Y:Y=0:GOSUB950
3552 A=A+IN:GOSUB930:G=Y:Y=X:X=D:GOSUB950:A=A+AN:IFA<0THENA=A+2*PI
3555 GOSUB930:RETURN
```

NOTE: Some additional OUTPUT formating will be needed [C$(I) PRINT, STORE X(I), Y(I)]

AN INTRODUCTION TO SOME OF THE TERMS USED IN ORBIT DETERMINATION

A BRIEF INTRODUCTION TO ORBITAL TERMS

Orbital Elements. The orbital characteristics of a secondary (planet) about a primary (star) are defined by a number of quantities called the ELEMENTS or parameters of the orbit. Theoretically six independent elements should describe the position of a planet in orbit about the Sun, but seven are often used. An understanding of these elements will help to clarify the structure of our Solar System.

The Orbital Elements:

1. Semi-major axis denoted by the symbol a. This term is usually expressed in terms of the semi-major axis of the Earth (one astronomical unit = AU). One AU is the mean of the maximum and minimum distances from the Earth to the Sun— that is, the semi-major axis of the Earth's orbit.

2. Eccentricity denoted by the symbol 'e'. Orbital eccentricity is an expression of the elliptical shape of the orbit and may be any value from zero to 1.00 (a perfect circle has zero eccentricity...a parabola has an eccentricity of 1.00 ...and a hyperbola has an eccentricity greater than 1.00). Almost all of the planets in our solar system have very nearly circular orbits and the notable exceptions are mercury and pluto with eccentricites greater than 0.20. A list of the planets ranging from the least eccentric to the most eccentric: Venus, Neptune, Earth, Uranus, Jupiter, Saturn, Mars, Mercury and Pluto. The values for the orbital eccentricities are given in radians.

3. Inclination of the plane of the planet's orbit to the plane of the ecliptic denoted by the symbol 'i'. A list of the various important planes in relation to the plane of the earth's orbit (the ecliptic) and ranging from the most nearly inclined to the least inclined are: Uranus, Jupiter, Invariable Plane of the Solar System, Neptune, Mars, Saturn, Venus, Mercury, Equator of the Sun, Pluto.

4. Longitude of the Ascending Node (the angle from the equinoctial point (0° Aries) '♈' to the ascending node that marks the point on the ecliptic where the plane of the given planet intersects the plane of the ecliptic) is denoted by the symbol 'Ω'.

5. Argument or displacent of perihelion from the node is the angle between the ascending node and the perihelion or 'ω' (the perihelion is that point in a planet's orbit that marks it's closest approach to the Sun). The sum of the angles $\Omega + \omega$ ...of which the first is measured in the ecliptic and the second in the plane of the planet's orbit is called the LONGITUDE OF THE PERIHELION and is denoted by the symbol '$\tilde{\omega}$'.

6. Period 'T' (sidereal period measured in tropical years or the mean daily motion 'n'.

7. Epoch 'E' or the instant in time of perihelion passage 'τ' by the planet.

The elements 'a' and 'e' determine the SIZE and SHAPE of the orbit, 'i' and 'Ω' the ORBITAL PLANE, 'ω' the ORIENTATION of the orbit in the plane. The course of the motion is determined by 'T' and 'τ', where in accordance with Kepler's third law, the period 'T' is determined by 'a', apart from small adjustments.

Each planet revolves around the Sun in an ellipse with the Sun at one focus. This ellipse defines a plane passing thru the center of the Sun and the plane of the Earth's orbit we call the Ecliptic. The planes of the orbits of the various planets in our solar system do not coincide, but are inclined to one another, slightly. In Figure 1 the Ecliptic is represented by the ellipse '♈XUE', while the orbit of a second planet is shown inclined to the ecliptic by the angle '♈ΩE' which is termed it's inclination or 'i'. The line defined by the intersection of any two planetary orbits is called the LINE OF NODES and consists of two points on the Ecliptic that

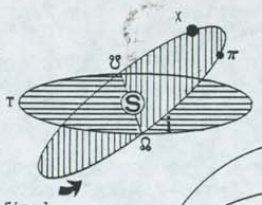


Fig. 1
X= Planet
T= 0° Aries
i= Inclination
π= Perihelion
Ω= North Node

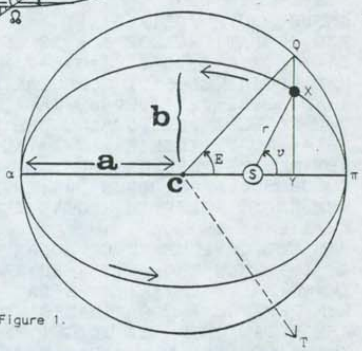


Figure 1.

Fig. 2 (+)
α= Aphelion π= Perihelion
a= Semimajor b= Semiminor axis
υ= True Anom. E= Eccentric Anom.
X= Planet S= Sun

are 180° apart denoted by the symbol 'Ω' for the ascending or northern node (where the planet crosses from under to above the ecliptic) and '☋' for the descending or southern node (where the planet passes from above to below...or from north to south thru the ecliptic).

In Figure 1, let 'T' be the position of the Vernal Equinox (0° Aries) on the plane of the ecliptic '♈ΩE☋'. The arc '♈Ω' is then the LONGITUDE OF THE ASCENDING NODE which is denoted by 'Ω'. The perihelion 'π' of the planet in Figure 1 does not occur in the ecliptic plane, but in this case has a northern latitude (above the ecliptic). The symbol 'ω' denotes the displacement of the perihelion from the ascending node (the arc '$\Omega\pi$') and the LONGITUDE OF THE PERIHELION is the sum of the arcs '♈Ω' and '$\Omega\pi$' denoted by '$\tilde{\omega}$'($\tilde{\omega} = \Omega + \omega$). Note that only the part 'Ω' (angle '♈Ω') of the longitude of the perihelion is measured along the ecliptic. The angle '$\Omega\pi$' or 'ω' is measured along the planet's orbit and not on the ecliptic.

The TRUE and the MEAN ANOMALY

Another very important value used in the determination of the planet's position in orbit is the TRUE ANOMALY denoted by 'υ'. The true anomaly is the arc of the orbit measured in an easterly direction from the perihelion to the planet in it's orbit (arc 'πSX') or the portion of the orbit from 'π' to 'X'). The position of the perihelion and the time at which the planet last was at 'π' is very important in determining the planet's position in space. The reason is simple: The LINE OF APSIDES or line connection the perihelion with the aphelion divides the planetary orbit into two symmetrical portions or halves. The time it takes for a planet to travel from 'π' to 'A' is the same as from 'A' to 'π'. The speed a planet is moving at a given number of degrees of arc (or time) before reaching 'π' is the same speed for an equal number of degrees (or time) after passing 'π' (or 'A'). In orbital astronomy, the time at which a planet last passed thru perihelion, denoted bt 'τ', the semi-major axis 'a', the eccentricity 'e' and the orbital period 'T' are all that are required to calculate the position of a planet in it's orbit at any time. This is done thru the use of Kepler's second law or the formula:

Area 'ΩSX' : Area of Ellipse = $t - \tau : T$

Where t = a given instant and the other symbols are as explained above.

ORBIT DETERMINATION (continued)

In practice the previously given formula is found to be inconvenient by astronomers and use is made of an imaginary MEAN PLANET which, coinciding with the true planet at perihelion, moves with a uniform angular velocity equal to the mean angular velocity of the true planet. The planet's MEAN ANOMALY denoted by 'M' is the anomaly of this fictitious body, and it's MEAN LONGITUDE denoted by 'ℓ', is the "longitude" of this fictitious planet, counted, like the "longitude" of perihelion, in the plane of the ecliptic from the Vernal Equinox to the ascending node, and in the plane of the planet's orbit from the ascending node to the place of the mean planet.

In an orbital period 'T', the radius vector 'r', sweeps out an angle of 360° or 2π. Let 'n' denote the average rate of description of angle by the radius vector. Then $n = 2\pi/T$. 'n' is called the MEAN ANGULAR MOTION of the planet. Some formulas used to determine the value for 'ℓ' and 'M' above are"

$\ell = \Omega + \omega + n(t - \tau)$ or $\ell = \tilde{\omega} + n(t - \tau)$

$M \equiv n(t - \tau) = \ell - \tilde{\omega}$

Again: 't' equals an instant of time for which we wish to determine a planet's position.

Our goal in this section is to introduce you to some of the terms and symbols used in orbital computation... and not to provide you with the rigorous formulae used to calculate very precise ephemerides.

ANOMALY, ANOMALIES ... HOW MANY?

Astronomers make use of yet another ANOMALY in the determination of a planet's position in orbit and this is the ECCENTRIC ANOMALY denoted by the symbol 'E'. Let use review the definitions of the two anomalies introduced thus far: the True Anomaly 'υ' and the Mean Anomaly 'M'. The mean anomaly 'M' represents the angle described in an interval of time ($t - \tau$) by a radius vector 'r' rotating about the Sun with CONSTANT ANGULAR VELOCITY 'n'. $M = n(t - \tau)$ where 't' is the time for which we desire a planet's position, 'τ' is the time the planet was last at perihelion, and 'n' is the mean angular motion ($n = 360° \div T$). The True Anomaly 'υ', is the angle '♈SX' or the arc of the orbit measured in an Easterly direction from the '♈' of the planet to the present position of the planet in that orbit.

THE ECCENTRIC ANOMALY

Let a circle be described on the major axis with '♈A' as the diameter. The angle 'QC♈' is called the ECCENTRIC ANOMALY 'E' and represents an intermediary angle obtained from the mean motion 'n' and eccentricity 'e' and from which values for the radius vector 'r' and the true anomaly 'υ' may be derived. The eccentric anomaly (see Figure 2) is the angle at the center of the ellipse between the semi-major axis and a line drawn from the center 'C' to the point where the prolongation of the ordinate perpendicular to this axis, and drawn thru the place of the planet, (line 'QY') meets the circuference of the circumscribed circle ('Q')...if that is not too confusing. When a planet is at it's perihelion, the true anomaly, mean anomaly and eccentric anomaly are each equal to zero. All three increase from perihelion to aphelion, where they each are equal to 180°, and decrease from aphelion to perihelion accordingly (provided they are considered as negative). From perihelion to aphelion 'υ' is greater than 'E', and 'E' is greater than 'M', and the same relation holds true from the aphelion to the perihelion. One last term one may encounter is the EQUATION OF THE CENTER which is simply the difference between the true and the mean anomaly and is denoted by the symbol 'f'. $f = \upsilon - M$ 'f' is positive from peri to aphelion and negative from aphelion back to perihelion. When the planet is in either apsis, the equation of the center will be equal to zero.

SOLVE KEPLER'S EQUATION

Every astrocomputer is faced with the famous equation of Kepler. Kepler's equation is a relation between the eccentric anomaly 'E' and the mean anomaly 'M'. It is often written as follows:

$M = E - e \sin E$ or $n(t - T) = E - e \sin E$

If 'E' and 'e' are known, there is no difficulty in obtaining 'M'. But if 'M' and 'e' are known (as is the usual case), there is no direct way of determining 'E', and some method of approximation must be used. In the programs listed in this issue, the eccentric anomaly is solved by iteration thru what is known as the Newton-Raphson Method. The radius vector may be obtained then by

$r = a(1 - e\cos E)$, and the true anomaly by:

$$\tan\left(\frac{\upsilon}{2}\right) = \left(\frac{1+e}{1-e}\right)^{\frac{1}{2}} \cdot \tan \frac{E}{2}$$

The longitude in orbit obeys the following equation:

$L = \upsilon + \tilde{\omega}$ ($= \ell + f$)

The true Longitude in orbit having been found, all that remains is the process termed reduction to the Ecliptic which simply reduces the position of the planet in it's own orbit to it's position in the plane of the Zodiac or Ecliptic in heliocentric longitude & latitude.

REDUCTION TO THE ECLIPTIC

The programs in this issue involve rotation matrices(that are better left until the next issue for documentation)to reduce the planet's position to the plane of the ecliptic. We will present here an alternate method. The helio longitude in orbit 'L' and radius vector 'r' in the plane of the orbit having an ascending node 'Ω' and inclination 'i' is converted to spherical coordinates (referred to the mean ecliptic and equinox) ...heliocentric longitude 'ℓ' and latitude 'b' (sometimes expressed 'λ' and 'β') plus 'r' (which remains the same). The relations can be written:

$\tan(\ell - \Omega) = \tan(L - \Omega) \cdot \cos i$

$\tan b = \sin(\ell - \Omega) \cdot \tan i$

The first equation is solved for '$\lambda - \Omega$', and then for 'λ'; the second is then solved for 'β'.

HELIOCENTRIC TO GEOCENTRIC TRANSFORMATION

Heliocentric longitude & latitude ('ℓ' & 'b') are transformed to Rectangular Ecliptic Coordinates thru use of the following formulas:

$X = r \cdot \cos b \cdot \cos \ell$
$Y = r \cdot \cos b \cdot \sin \ell$
$Z = r \cdot \sin b$

These Heliocentric Rectangular Ecliptic Coordinates are then transformed to Geocentric Rectangular Ecliptic Coordinates by subtracting the Earth's (or adding the Sun's) Helio Rectangular Coordinates (X,Y,Z) as follows:

$XG = X - X1$, $YG = Y - Y1$, $ZG = Z - Z1$

Where XG,YG,ZG are the desired geocentric rectangular ecliptic coordinates, X,Y,Z are the heliocentric rectangular ecliptic coordinates and X1,Y1,Z1 are the heliocentric rectangular ecliptic coordinates of the Earth.

RECTANGULAR TO SPHERICAL CONVERSION

The last step in the process of obtaining geocentric planet's positions is that of converting the Geocentric Rectangular Ecliptic Coordinates to Ecliptic Spherical Coordinates...the familiar longitude 'λ' and latitude 'β' used by astrologers. Here are the formulas:

$\lambda = \tan^{-1}(YG/XG)$, $\beta = \sin^{-1}(ZG/R)$

where $R = XG^2 + YG^2 + ZG^2$ (R is distance of body)

There you have it. More another issue.—Editor

ASTROLOGICAL ROUTINES FOR THE TI-59/PC-100A PROGRAMMABLE

Authored by James Neely

These astrological programs for the TI-59/PC-100A are submitted to MATRIX for publication with some reluctance, for they are not a finished product by comparison to the author's HP-67 programs.

On the one hand, they are somewhat more elaborate than the HP-67 programs for they contain the printing of prompts, headings, and astrological signs. They also contain the computation of planetary astrological distance values and the automatic storage of all planetary longitudes so that aspects and midpoints can be computed and printed without the necessity of re-entering these values.

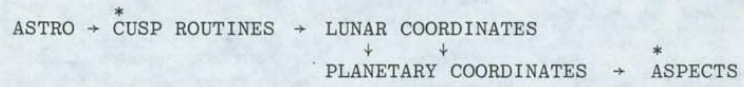
On the other hand, they are not a finished product in that all of the options which are available in the HP-67 programs are not available in the TI-59 programs without minor modification. For example, the synetic vernal point transformation to the sidereal zodiac, and the display of planetary rectangular coordinates cannot be accomplished without a minor bit of reprogramming. The routines for all of these computations are included, but their execution has been defeated (by-passed) so that the entire set of programs will perform all tropical zodiac computations with a minimum of operator intervention.

NOTES:

1. ASTRO runs in the 719.29 partition, and the keystrokes must be programmed with that partition set. However, the partition must be changed to the "power-up" partition of 479.59 BEFORE RECORDING THE 4 BANKS OF REGISTERS. The ASTRO program cards are read into the TI-59 with the partition in the "power-up" mode. When execution commences (pressing "A"), the program automatically changes the partition to 719.29 for execution and then returns the partition to 479.59 so that subsequent program cards can be read without manual re-partitioning.

2. Marginal notes, such as "(*) DELETE", are inserted as comments on the listings so that the user may return a program to a more flexible (less automatic) mode of operation and hence reinstate some of the options that have been defeated. It is easier to provide this information than to illustrate ways of over-riding these features.

3. The recommended sequencing of the programs is:



[Editors note: The Neely TI-59/PC-100A material is presented here with PERMISSION TO USE, BUT NOT TO SELL and is Copyright © 1977 by James Neely]

* Cusp & Aspect Routines to be published in the next issue.

ASTROLOGICAL PROGRAM INSTRUCTIONS

ASTRO

Inputs:
1. Date: MM.DDYYYY
2. Greenwich Mean Time: HH.MMSS
3. Longitude: DDD.MMSS (- for West)
4 Latitude: DD.MMSS (- for South)

Computations:
1. T: Julian Centuries from 0.5 January 1900.
2. ε: Obliquity of the Ecliptic corrected for nutation
3. αG: Greenwich mean sidereal time.
4. Ω: Mean longitude of the Moon's ascending node.
5. SVP: Synetic Vernal Point
6. α_{MC}: RAMC in degrees.

Output:
1. Local Sidereal Time: HH.MMSS
2. Moon's ascending node: Degree-in-sign DD.MMSS & Sign

NOTE: See program listing for modifications to obtain additional output.

ASTRO
(Input & Output)

DATE	MM.DDYYYY
	4.201976
TIME	HH.MMSS
	1.48
LONG	DDD.MMSS +E,-W
	-121.55
LAT	DD.MMSS +N,-S
	37.2
LST	HH.MMSS
	7.3327
NODE	13.2603 SC

Instructions:
1. Read ASTRO Cards 1 & 2 (Banks 1,2,3 and 4)
2. Press *ST FLG 3 if geographic latitude is to be converted to geocentric latitude.
3. Press key A
4. At prompt, key in DATE, press R/S
5. At prompt, key in TIME, press R/S
6. At prompt, key in Longitude (- for West), press R/S
7. At prompt, key in Geographic Latitude (- for South), press R/S
8. Zero is displayed when computations are complete.

MOON

Inputs: None.

Output:
1. Longitude: Degree-in-sign (DD.MM), and Sign.
2. Latitude: DD.MM (- for South)
3. Distance Value (100.00 for closest approach, 0.00 for furthest distance).
4. Right Ascension: HH.MM
5. Declination: DD.MM (- for South)

Instructions:
1. Execute ASTRO.
2. Read program card 1 (banks 1 & 2)

Instructions:MOON (continued)

3. Press A
4. When execution stops with zero in display, read program card 2 (banks 1 and 2)
5. Press A.
6. Zero is displayed when execution is complete.

PLANETARY COORDINATES

Input: One planetary data card for each body.

Output: (Geocentric Coordinates)

1. Longitude: Degree-in-sign DD.MM & Sign.
2. Latitude: DD.MM (- for South)
3. Distance Value: (100.00 for closest approach, 0.00 for furthest distance).
4. Right Ascension: HH.MM
5. Declination: DD.MM (- for South)
6. Distance Value (see 3).

NOTE: The ecliptic longitude of each body is automatically stored for use by the ASPECT & MID-POINT program.

Instructions:

1. Execute ASTRO.
2. Read program card (banks 1 & 2)
3. Read SUN/EARTH data card (bank 3)
4. Press A.
5. When 3. displays, read data card (bank 3) for the next body. Repeat from step 4.

Optional Output:
See the program listing for necessary changes. The key sequence for the various options are:

1. C': Start new computation.
2. E A: Geocentric sidereal ecliptic coordinates
3. E B: Geocentric tropical ecliptic coordinates
4. E C: Geocentric equatorial coordinates
5. D A: Heliocentric sidereal ecliptic coordinates
6. D B: Heliocentric tropical ecliptic coordinates
7. D C: Heliocentric equatorial coordinates

MOON & PLANETS
SAMPLE PRINT-OUT

MOON		
Longitude	15.17	CP
Latitude	4.42	
Distance Value	49.49	
Right Ascension	19.04	
Declination	-17.53	
SUN	0.07	TA
	0.00	
	35.83	
	1.52	
	11.30	
	35.83	
MERC	17.58	TA
	2.04	
	45.10	
	2.59	
	19.10	
	45.10	
VENUS	14.25	AR
	-1.30	
	6.99	
	0.55	
	4.18	
	6.99	
MARS	15.44	CN
	1.55	
	46.92	
	7.09	
	24.25	
	46.92	
JUPTR	5.44	TA
	-0.58	
	19.88	
	2.15	
	12.31	
	19.88	
SATRN	26.36	CN
	0.24	
	64.42	
	7.54	
	21.14	
	64.42	

30	M & x→θ	40	Body Name	50	i_2
31	e & y→φ	41	Body Number	51	ω_0
32	E & z→r	42	DV_1	52	ω_1
33		43	DV_2	53	ω_2
34	X_G	44	a	54	e_0
35	Y_G	45	Ω_0	55	e_1
36	Z_G	46	Ω_1	56	e_2
37	X_H	47	Ω_2	57	m_0
38	Y_H	48	i_0	58	m_1
39	Z_H	49	i_1	59	m_2

PLANETARY DATA STORAGE ALLOCATION

PLANETARY DATA CARDS

SUN		MERCURY	
3641310000.	40	3017351500.	40
20.	41	22.	41
1.0168	42	1.4835	42
0.033502	43	0.966901	43
1.00000023	44	0.3870984	44
0.	45	47.14594444	45
0.	46	1.185208333	46
0.	47	0.000173889	47
0.	48	7.002880556	48
0.	49	0.001860833	49
0.	50	-0.000018333	50
101.2208333	51	28.75375287	51
1.719175	52	0.370280556	52
0.000452778	53	0.000120833	53
0.01675104	54	0.20561421	54
-0.0000418	55	0.00002046	55
-0.000000126	56	-0.00000003	56
358.4758445	57	102.2793806	57
35999.04975	58	149472.5153	58
-0.000150278	59	0.000006389	59

VENUS		VENUS	
4217314136.	40	-.000000972	50
23.	41	54.38418611	51
1.745	42	0.508186111	52
1.49003	43	-0.001386389	53
0.7233316	44	0.00682069	54
75.78364722	45	-0.00004774	55
0.89985	46	0.000000091	56
0.00041	47	212.6032194	57
3.393630556	48	58517.80386	58
0.001005833	49	0.001286056	59

MOON & PLANETS
SAMPLE PRINT-OUT

URANS	5.17	SC
	0.30	
	93.81	
	14.12	
	-12.48	
	93.81	
NEPT	13.35	SG
	1.33	
	70.46	
	16.49	
	-20.52	
	70.46	
PLUTO	9.49	LI
	17.27	
	95.18	
	13.03	
	12.08	
	95.18	

MARS	
3013353600.	40
24.	41
2.6828	42
2.31814	43
1.5236915	44
48.78644167	45
0.770991667	46
-0.000001389	47
1.850333333	48
-0.000675	49
0.000012611	50
285.4317611	51
1.069766667	52
0.00013125	53
0.0933129	54
0.000092064	55
-0.000000077	56
319.529425	57
19139.8585	58
0.000180806	59

PLANETARY DATA CARDS (continued)

JUPITER	
2541333735.	40
25.	41
6.4716	42
2.53814	43
5.20290493	44
99.41984827	45
1.05829152	46
0.	47
1.3096585	48
-0.00515613	49
0.	50
273.3930152	51
1.33834464	52
0.	53
0.04838144	54
-0.0000155	55
0.	56
225.4928125	57
3033.687936	58
0.	59

SATURN	
3613373531.	40
26.	41
11.106	42
3.10158	43
9.55251745	44
112.8261394	45
0.82587569	46
0.	47
2.49080547	48
-0.00466035	49
0.	50
338.911673	51
-0.31667941	52
0.	53
0.05422831	54
-0.00020495	55
0.	56
174.215296	57
1223.507963	58
0.	59

PLUTO	
3327413732.	40
29.	41
50.36	42
21.6852	43
39.53903455	44
108.94405	45
1.37395444	46
0.	47
17.15140319	48
-0.01611824	49
0.	50
113.5365761	51
0.20863761	52
0.	53
0.24797376	54
0.00289875	55
0.	56
229.7810007	57
145.1781092	58
0.	59

URANUS	
4135133136.	40
27.	41
21.126	42
3.81481	43
19.22150505	44
73.52220082	45
0.52415598	46
0.	47
0.77256652	48
0.00012824	49
0.	50
95.68630387	51
2.05082548	52
0.	53
0.04681664	54
0.00041875	55
0.	56
74.17574887	57
427.2742717	58
0.	59

NEPTUNE	
3117333700.	40
28	41
31.397	42
2.57568	43
30.1137593	44
130.6841531	45
1.10046492	46
0.	47
1.77939281	48
-0.00975088	49
0.	50
284.168255	51
-21.6328615	52
0.	53
0.00912805	54
-0.00127185	55
0.	56
30.1329437	57
240.4551595	58
0.	59

ASTRO DATA CARD		
3713.1335	00	TA.AR
1531.2217	01	CN.GE
4224.2717	02	VI.LE
3615.2724	03	SC.LI
1533.3622	04	CP.SG
3324.1334	05	PI.AQ
0.	06	Ind. Cont.
1613371700.	07	DATE
3030401616.	08	MM.DD
4545454500.	09	YYYY
0.	10	T
0.	11	ε
0.	12	ϕ
0.	13	α-MC
0.	14	SVP
0.	15	α-G
0.	16	t-G
0.	17	Ω-Moon
0.	18	Temp
0.	19	Temp
27133700.	20	LAT
16164030.	21	DD.M
4731572036.	22	+N,-S
2732312200.	23	LONG
1616164030.	24	DDD.M
3036360000.	25	MSS
4717572043.	26	+E,-W
3724301700.	27	TIME
23234030.	28	HH.M
31321617.	29	NODE

Pre-recorded BANK 4

ASTRO: PROGRAM STEPS FOR THE TI-59/PC-100A

000	76	LBL	SUBROUTINE TO ADD THE SYNETIC VERNAL POINT (SVP)
001	85	+	
002	85	+	
003	43	RCL	
004	14	14	
005	54	)	
006	92	RTN	
007	76	LBL	SUBROUTINE FOR 360° MODULAR ARITHMETIC
008	95	=	
009	55	÷	
010	03	3	
011	06	6	
012	00	0	
013	54	)	
014	22	INV	
015	59	INT	
016	85	+	
017	01	1	
018	54	)	
019	22	INV	
020	59	INT	
021	65	x	
022	03	3	
023	06	6	
024	00	0	
025	54	)	
026	92	RTN	
027	76	LBL	SUBROUTINE
028	75	-	
029	58	FIX	
030	04	04	
031	22	INV	FIND SIGN AND D-IN-SIGN
032	88	DMS	
033	42	STO	
034	19	19	PRT& R/S
035	55	÷	COMPUTE INDIRECT ADDRESS & STORE
036	03	3	
037	00	0	
038	54	)	
039	59	INT	
040	42	STO	
041	18	18	
042	85	+	
043	01	1	
044	54	)	
045	43	RCL	
046	18	18	
047	55	÷	
048	02	2	
049	54	)	
050	42	STO	UNPACK SIGN FOR PRINTING
051	06	06	
052	22	INV	
053	59	INT	
054	32	X-T	
055	00	0	
056	67	EQ	
057	35	1/X	UNPACK LEFT-HAND PORTION
058	73	RC*	
059	06	06	
060	59	INT	
061	61	GTO	
062	45	Yˣ	
063	76	LBL	UNPACK RIGHT-HAND PORTION
064	35	1/X	
065	73	RC*	
066	06	06	
067	22	INV	
068	59	INT	
069	65	x	
070	01	1	
071	52	EE	
072	04	4	
073	22	INV	
074	52	EE	
075	76	LBL	PRINT DEGREE-IN-SIGN AND SIGN
076	45	Yˣ	
077	54	)	
078	69	OP	
079	04	04	
080	43	RCL	
081	19	19	
082	75	-	
083	03	3	
084	00	0	
085	65	x	
086	43	RCL	
087	18	18	
088	54	)	
089	69	OP	
090	06	06	
091	22	INV	
092	58	FIX	
093	06	6	REPARTITION MEMORY
094	69	OP	
095	17	17	
096	00	0	
097	91	R/S	*DELETE
098	92	RTN	
099	76	LBL	
100	11	A	
101	03	3	SET NEW PARTITION
102	69	OP	
103	17	17	
104	98	ADV	
105	69	OP	PRINT DATE PROMPT
106	00	00	
107	43	RCL	
108	07	07	
109	69	OP	
110	01	01	
111	43	RCL	
112	08	08	
113	69	OP	
114	02	02	
115	43	RCL	
116	09	09	
117	69	OP	
118	03	03	
119	22	INV	
120	58	FIX	
121	69	OP	
122	05	05	INPUT DATE AND PRINT
123	91	R/S	
124	99	PRT	
125	42	STO	
126	19	19	
127	43	RCL	
128	27	27	PRINT TIME PROMPT
129	69	OP	
130	01	01	
131	43	RCL	
132	28	28	
133	69	OP	
134	02	02	
135	43	RCL	
136	25	25	
137	69	OP	
138	03	03	
139	69	OP	INPUT TIME AND PRINT
140	05	05	
141	91	R/S	
142	99	PRT	
143	88	DMS	PRINT LONGITUDE PROMPT
144	42	STO	
145	16	16	
146	43	RCL	
147	23	23	
148	69	OP	
149	01	01	

```
150  43 RCL
151  24  24
152  69 OP
153  02  02
154  43 RCL
155  25  25
156  69 OP
157  03  03
158  43 RCL
159  26  26
160  69 OP
161  04  04
162  22 INV          INPUT &
163  58 FIX          PRINT
164  69 OP           LONGITUDE
165  05  05
166  91 R/S
167  99 PRT ————————————————
168  88 DMS          PRINT
169  42 STO          LATITUDE
170  13  13         PROMPT
171  43 RCL
172  20  20
173  69 OP
174  01  01
175  43 RCL
176  21  21
177  69 OP
178  02  02
179  43 RCL
180  22  22
181  69 OP           INPUT
182  04  04         LATITUDE
183  69 OP           & PRINT
184  05  05
185  91 R/S
186  99 PRT ————————————————
187  88 DMS
188  42 STO
189  12  12         IF FLAG 03
190  22 INV }        IS CLEAR,
191  87 IFF }        LATITUDE IS
192  03  03 }       GEOGRAPHIC
193  87 IFF
194  30 TAN          OTHERWISE
195  65  x          CONVERT TO
196  93  .          GEOCENTRIC
197  09  9
198  09  9
199  03  3

200  03  3          LATITUDE
201  00  0          TO
202  05  5          GEOCENTRIC
203  95  =          LATITUDE
204  22 INV
205  30 TAN
206  42 STO
207  12  12
208  22 INV
209  88 DMS          PRINT
210  58 FIX          GEOCENTRIC
211  04  04         LATITUDE
212  99 PRT ————————————————
213  76 LBL          UNPACK
214  87 IFF          DATE
215  43 RCL
216  19  19
217  59 INT
218  22 INV
219  44 SUM
220  19  19
221  75  -
222  03  3
223  85  +
224  01  1
225  02  2
226  65  x
227  53  (
228  53  (
229  43 RCL
230  19  19
231  65  x
232  01  1
233  00  0
234  00  0
235  54  )
236  42 STO
237  19  19
238  59 INT
239  22 INV
240  44 SUM
241  19  19
242  42 STO
243  10  10
244  43 RCL
245  19  19
246  65  x
247  01  1
248  00  0
249  00  0

250  00  0
251  00  0
252  85  +
253  04  4
254  08  8
255  00  0
256  00  0
257  42 STO
258  17  17
259  54  )
260  95  =
261  42 STO
262  19  19
263  55  ÷
264  04  4
265  08  8
266  54  )
267  59 INT
268  44 SUM
269  10  10
270  43 RCL
271  19  19
272  75  -
273  53  (
274  24 CE
275  55  ÷
276  01  1
277  02  2
278  54  )
279  59 INT
280  65  x ←281 01  1
282  02  2
283  54  )
284  65  x
285  02  2
286  54  )
287  85  +
288  07  7
289  85  +
290  03  3
291  06  6
292  05  5
293  65  x
294  43 RCL
295  19  19
296  54  )
297  55  ÷
298  01  1
299  02  2
```



```
300  54  )
301  59 INT
302  44 SUM
303  10  10
304  03  3
305  02  2
306  00  0
307  08  8
308  03  3
309  22 INV
310  44 SUM
311  10  10
312  02  2          TEST FOR
313  02  2          JULIAN OR
314  09  9          GREGORIAN
315  09  9          CALENDAR
316  01  1
317  07  7
318  01  1
319  32 X-Y
320  43 RCL
321  10  10
322  22 INV }        TRANSFER IF
323  77  GE }       JULIAN
324  65  x
325  43 RCL
326  19  19
327  55  ÷
328  43 RCL
329  17  17
330  54  )
331  59 INT          MODIFY FOR
332  75  -          GREGORIAN
333  53  (          CALENDAR
334  43 RCL
335  19  19
336  55  ÷
337  01  1
338  02  2
339  00  0
340  00  0
341  54  )
342  59 INT
343  85  +
344  03  3
345  08  8
346  54  )
347  44 SUM
348  10  10 ————————————————
349  76 LBL

350  65  x
351  02  2
352  04  4
353  01  1
354  05  5
355  00  0
356  02  2
357  00  0
358  22 INV          STORE JD1900
359  44 SUM          IN REG-10
360  10  10
361  43 RCL
362  16  16
363  55  ÷
364  02  2
365  04  4
366  54  )
367  44 SUM
368  10  10         CORRECT
369  93  .          JD1900
370  05  5          FOR TIME
371  22 INV          OF DAY
372  44 SUM
373  10  10
374  03  3
375  06  6          CONVERT TO T,
376  05  5          JULIAN
377  02  2          CENTURIES
378  05  5          FROM 0.5
379  22 INV          JAN 1900
380  49 PRD
381  10  10 ————————————————
382  02  2          COMPUTE
383  03  3          MEAN
384  93  .          OBLIQUITY
385  04  4          OF THE
386  05  5          ECLIPTIC
387  02  2            ε0
388  02  2
389  09  9
390  04  4
391  75  -
392  93  .
393  00  0
394  01  1
395  03  3
396  00  0
397  01  1
398  03  3
399  65  x

400  43 RCL
401  10  10
402  95  =
403  42 STO          STORE ε0
404  11  11 ————————————————
405  02  2
406  06  6
407  52  EE         COMPUTE
408  06  6          GREENWICH
409  94 +/-         MEAN
410  65  x          SIDEREAL
411  43 RCL         TIME
412  10  10
413  85  +
414  02  2
415  04  4
416  00  0
417  00  0
418  93  .
419  00  0
420  05  5
421  01  1
422  02  2
423  06  6
424  02  2
425  54  )
426  65  x
427  43 RCL
428  10  10
429  85  +
430  06  6
431  93  .
432  06  6
433  04  4
434  06  6
435  00  0
436  06  6
437  85  +
438  43 RCL
439  16  16
440  95  =
441  65  x          CONVERT TO
442  01  1          RIGHT
443  05  5          ASCENSION
444  95  =          (DEGREES)
445  71 SBR         OF GREENWICH
446  95  =          MERIDIAN
447  22 INV         AND
448  52  EE         STORE αG
449  42 STO
```

```
450  15  15
451  07   7   COMPUTE
452  93   .   THE MEAN
453  04   4   LONGITUDE
454  08   8   OF THE
455  65   x   MOON'S
456  43 RCL   ASCENDING
457  10  10   NODE
458  75   -
459  06   6
460  09   9
461  06   6
462  02   2
463  09   9
464  01   1
465  01   1
466  93   .
467  02   2
468  03   3
469  95   =
470  65   x
471  43 RCL
472  10  10
473  85   +
474  09   9
475  03   3
476  03   3
477  00   0
478  05   5
479  09   9
480  93   .
481  07   7
482  09   9
483  95   =
484  55   ÷
485  03   3
486  06   6
487  00   0
488  00   0
489  42 STO
490  06  06
491  95   =
492  71 SBR
493  95   =
494  42 STO   STORE
495  17  17   NODE
496  02   2
497  05   5
498  09   9
499  02   2

500  00   0
501  05   5
502  05   5
503  03   3
504  06   6
505  65   x   COMPUTE
506  43 RCL   AND STORE
507  10  10     THE
508  85   +   AUXILLARY
509  02   2   ANGLE
510  00   0   2L
511  01   1
512  03   3
513  08   8
514  01   1
515  06   6
516  95   =
517  55   ÷
518  03   3
519  06   6
520  00   0
521  00   0
522  95   =
523  42 STO
524  19  19
525  39 COS
526  65   x   COMPUTE THE
527  93   .   DIFFERENTIAL
528  05   5   NUTATION
529  05   5   OF THE
530  85   +   OBLIQUITY
531  43 RCL   δε
532  17  17
533  39 COS
534  65   x
535  09   9
536  93   .
537  02   2
538  01   1
539  95   =
540  55   ÷
541  03   3
542  06   6   CORRECT
543  00   0   OBLIQUITY
544  00   0   FOR
545  95   =   NUTATION
546  44 SUM
547  11  11   ε =ε₀+δε
548  53   (
549  05   5

550  00   0
551  02   2
552  05   5   COMPUTE THE
553  93   .   PRECESSION
554  06   6   AND NUTATION
555  04   4   OF THE
556  85   +   ECLIPTIC
557  01   1   LONGITUDE
558  93   .
559  01   1
560  01   1
561  65   x
562  43 RCL
563  10  10
564  54   )
565  65   x
566  43 RCL
567  10  10
568  75   -
569  01   1
570  07   7
571  93   .
572  02   2
573  03   3
574  65   x
575  43 RCL
576  17  17
577  38 SIN
578  75   -
579  43 RCL
580  19  19
581  38 SIN
582  65   x
583  01   1
584  93   .
585  02   2
586  07   7
587  85   +
588  08   8   COMPUTE AND
589  04   4   STORE THE
590  00   0   SYNETIC
591  03   3   VERNAL
592  08   8   POINT
593  93   .   (SVP)
594  02   2
595  07   7
596  95   =
597  55   ÷
598  03   3
599  06   6
```



```
600  00   0
601  00   0
602  95   =
603  94 +/-
604  42 STO
605  14  14
606  43 RCL
607  13  13   COMPUTE
608  85   +   AND STORE
609  43 RCL   RAMC IN
610  15  15   DEGREES
611  95   =
612  71 SBR   αMC
613  95   =
614  42 STO
615  13  13
616  69 OP
617  00  00
618  02   2
619  07   7
620  03   3
621  06   6
622  03   3
623  07   7
624  00   0   PRINT
625  00   0   "LST"
626  22 INV   HEADING
627  58 FIX
628  98 ADV
629  69 OP
630  01   1
631  43 RCL
632  28  28
633  69 OP
634  02   2
635  43 RCL
636  25  25
637  69 OP
638  03   3
639  69 OP
640  05   5
641  43 RCL
642  13  13
643  55   ÷   COMPUTE AND
644  01   1   PRINT THE
645  05   5   LOCAL
646  95   =   SIDEREAL
647  22 INV   TIME
648  88 DMS
649  58 FIX

650  04   4
651  99 PRT
652  69 OP
653  00  00
654  43 RCL   PRINT NODE
655  29  29   HEADING
656  69 OP
657  01  01
658  69 OP
659  05  05
660  43 RCL
661  17  17
662  22 INV   IF FLAG 0
663  87 IFF   IS CLEAR,
664  00  00   PRINT
665  28 LOG   TROPICAL
666  71 SBR   NODE. IF
667  85   +   SET, PRINT
668  76 LBL   SIDEREAL
669  28 LOG   NODE.
670  71 SBR   CONVERT
671  95   =   TO 360°,
672  71 SBR   PRINT NODE
673  75   -   AND
674  91 R/S   TERMINATE
675  91 R/S
676  91 R/S
END
```

LUNAR COORDINATES

```
000  76 LBL
001  11   A
002  69 OP   PRINT
003  00  00   "MOON"
004  03   3   HEADING
005  00   0
006  03   3
007  02   2
008  03   3
009  02   2
010  03   3
011  01   1
012  00   0
013  00   0
014  69 OP   Principal
015  01   1   ARGUMENTS
016  98 ADV   ONLY ARE
017  69  OP   LISTED IN
018  05  05   THE
019  04   4   COMMENTS
020  94 +/-
021  65   x
022  43 RCL
023  10  10
024  85   +
025  01   1
026  07   7
027  03   3
028  02   2
029  05   5
030  06   6
031  04   4
032  03   3
033  07   7
034  09   9
035  95   =
036  65   x
037  43 RCL
038  10  10
039  85   +
040  09   9
041  07   7
042  03   3
043  05   5
044  06   6
045  03   3
046  95   =
047  42 STO
048  40  40
049  42 STO
```

```
050  57  57  ACCUMULATE
051  42 STO  λ
052  44  44
053  42 STO
054  45  45
055  42 STO
056  47  47
057  06   6
058  01   1
059  08   8
060  09   9
061  65   x
062  43 RCL
063  10  10
064  85   +
065  01   1
066  00   0
067  01   1
068  02   2
069  03   3
070  09   9
071  05   5
072  95   =
073  42  STO  Γ
074  41  41
075  94 +/-
076  42 STO
077  46  46
078  03   3
079  07   7
080  94 +/-
081  65   x
082  43 RCL
083  10  10
084  85   +
085  01   1
086  04   4
087  06   6
088  04   4
089  08   8
090  05   5
091  02   2
092  03   3
093  95   =
094  65   x
095  43 RCL
096  10  10
097  85   +
098  01   1
099  02   2

100  00   0
101  03
102  05   5
103  08   8
104  06   6
105  95   =
106  42 STO  Γ'
107  42  42
108  22 INV
109  44 SUM  ℓ
110  44  44
111  01   1
112  06   6
113  00   0
114  02   2
115  09   9
116  06   6
117  01   1
118  06   6
119  01   1
120  01   1
121  65   x
122  43 RCL
123  10  10
124  85   +
125  01   1
126  02   2
127  06   6
128  02   2
129  06   6
130  05   5
131  05   5
132  95   =
133  42 STO  D
134  43  43
135  22 INV
136  44 SUM
137  45  45  L
138  43 RCL
139  45  45
140  44 SUM  ℓ'
141  46  46
142  03   3
143  06   6
144  00   0
145  00   0
146  35 1/X
147  49 PRD
148  40  40
149  49 PRD

150  41  41  CONVERT
151  49 PRD  SECONDS
152  42  42  TO
153  49 PRD  DEGREES
154  43  43
155  49 PRD
156  44  44
157  49 PRD
158  45  45
159  49 PRD
160  46  46
161  49 PRD
162  47  47
163  43 RCL  ρ
164  17  17
165  22 INV
166  44 SUM  F
167  47  47
168  01   1
169  32 X-T
170  43 RCL
171  44  44
172  37 P/R
173  65   x
174  02   2
175  02   2
176  06   6
177  04   4
178  00   0
179  95   =
180  44 SUM  22640 SIN ℓ
181  57  57
182  32 X-T
183  65   x
184  01   1
185  08   8  1865 COS  ℓ
186  06   6
187  05   5
188  95   =
189  42 STO  ACCUMULATE
190  59  59  PARALLAX
191  01   1    π
192  32 X-T
193  43 RCL
194  43  43
195  37 P/R
196  65   x
197  01   1
198  02   2
199  05   5
```



```
200  95   =
201  22 INV
202  44 SUM  125 SIN D
203  57  57
204  32 X-T
205  65   x
206  01   0
207  00   0
208  95   =
209  22 INV
210  44 SUM  -10 COS D
211  59  59
212  01   1
213  32 X-T
214  43 RCL
215  43  43
216  65   x
217  02   2
218  95   =
219  42 STO   2D
220  43  43
221  37 P/R
222  65   x
223  02   2
224  03   3
225  07   7
226  00   0
227  95   =
228  44 SUM  2370 SIN 2D
229  57  57
230  32 X-T
231  65   x
232  02   2
233  08   8
234  02   2
235  95   =
236  44 SUM
237  59  59  282 COS 2D
238  01   1
239  32 X-T
240  43 RCL
241  44  44
242  75   -
243  43 RCL
244  43  43
245  95   =
246  42 STO
247  40  40  ℓ-2D
248  37 P/R
249  65   x

250  04   4
251  05   5
252  08   8
253  06   6
254  95   =
255  22 INV
256  44 SUM  4586 SIN(
257  57  57  ℓ-2D)
258  32 X-T
259  65   x
260  03   3
261  04   4
262  03   3
263  95   =
264  44 SUM  343 COS(
265  59  59  ℓ-2D)
266  01   1
267  32 X-T
268  43 RCL
269  44  44
270  65   x
271  02   2
272  95   =
273  42 STO
274  49  49  2ℓ
275  37 P/R
276  65   x
277  07   7
278  06   6
279  09   9
280  95   =
281  44 SUM  769 SIN2ℓ
282  57  57
283  32 X-T
284  65   x
285  01   1
286  00   0
287  02   2
288  95   =
289  44 SUM
290  59  59  102 COS 2ℓ
291  01  01
292  32 X-T
293  43 RCL
294  44  44
295  85   +
296  43 RCL
297  43  43
298  95   =
299  37 P/R

300  65   x
301  01   1
302  09   9
303  02   2
304  95   =
305  44 SUM  192 SIN(ℓ+2D)
306  57  57
307  32 X-T
308  65   x
309  03   3
310  01   1
311  95   =
312  44 SUM  31 COS(ℓ+2D)
313  59  59
314  01   1
315  32 X-T
316  43 RCL
317  46  46
318  75   -
319  43 RCL
320  43  43
321  95   =
322  42 STO  ℓ'-2D
323  41  41
324  37 P/R
325  65   x
326  01   1
327  06   6
328  05   5
329  95   =
330  22 INV
331  44 SUM  -165 SIN(ℓ'-2D)
332  57  57
333  32 X-T
334  65   x
335  01   1
336  09   9
337  95   =
338  44 SUM  19 COS(ℓ'-2D)
339  59  59
340  01   1
341  32 X-T
342  43 RCL
343  44  44
344  75   -
345  43 RCL
346  46  46
347  95   =
348  42 STO
349  50  50  ℓ-ℓ'
```

```
350  37 P/R
351  65  x
352  01  1
353  04  4
354  08  8
355  95  =
356  44 SUM  148 SIN(
357  57  57  ℓ-ℓ')
358  32 X-T
359  65  x
360  01  1
361  02  2
362  95  =
363  44 SUM  12 COS(ℓ-ℓ')
364  59  59
365  01  1
366  32 X-T
367  43 RCL
368  44  44
369  85  +
370  43 RCL
371  46  46
372  95  =
373  43 STO  ℓ+ℓ'
374  42  42
375  37 P/R
376  65  x
377  01  1
378  01  1
379  00  0
380  95  =
381  22 INV
382  44 SUM -110 SIN(
383  57  57  ℓ+ℓ')
384  32 X-T
385  65  x
386  01  1
387  00  0
388  95  =
389  22 INV
390  44 SUM  -10 COS(
391  59  59  ℓ+ℓ')
392  43 RCL
393  47  47
394  85  +
395  24 CE
396  95  =
397  42 STO
398  48  48  2F
399  38 SIN
```

```
400  65  x
401  04  4
402  01  1
403  02  2
404  95  =
405  22 INV
406  44 SUM  -412 SIN 2F
407  57  57
408  01  1
409  32 X-T
410  43 RCL
411  44  44
412  75  -
413  43 RCL
414  48  48
415  95  =
416  37 P/R
417  65  x
418  04  4
419  00  0
420  95  =
421  44 SUM  40 SIN(
422  57  57  ℓ-2F)
423  32 X-T
424  65  x
425  07  7
426  95  =
427  22 INV -7 COS(ℓ-2F)
428  44 SUM
429  59  59
430  01  1
431  32 X-T
432  43 RCL
433  43  43
434  85  +
435  24 CE
436  95  =
437  42 STO  4D
438  51  51
439  94 +/-
440  85  +
441  43 RCL
442  44  44
443  95  =
444  37 P/R
445  65  x
446  03  3
447  08  8
448  95  =
449  22 INV
```

```
450  44 SUM  -38 sin(ℓ-4D)
451  57  57
452  32 X-T
453  65  x
454  06  6
455  95  =
456  44 SUM  6 COS(ℓ-4D)
457  59  59
458  01  1
459  32 X-T
460  43 RCL
461  44  44
462  65  x
463  03  3
464  95  =
465  37 P/R
466  65  x
467  03  3
468  06  6
469  95  =
470  44 SUM  36 SIN 3ℓ
471  57  57
472  32 X-T
473  65  x
474  06  6
475  95  =
476  44 SUM  6 COS 3ℓ
477  59  59
478  00  0
479  91 R/S  SET FOR CARD 2
```



```
000  76 LBL  SUBROUTINE
001  85  +   TO ADD THE
002  85  +   SYNETIC
003  43 RCL  VERNAL
004  14  14  POINT
005  54  )   (SVP)
006  92 RTN
007  76 LBL  SUBROUTINE
008  95  =   FOR 360°
009  55  ÷   MODULAR
010  03  3   ARITHMETIC
011  06  6
012  00  0
013  54  )
014  22 INV
015  59 INT
016  85  +
017  01  1
018  54  )
019  22 INV
020  59 INT
021  65  x
022  03  3
023  06  6
024  00  0
025  54  )
026  92 RTN
027  76 LBL  START CARD
028  11  A      2
029  01  1   CALCULATION
030  32 X-T
031  43 RCL
032  42  42
033  75  -
034  43 RCL
035  43  43
036  95  =
037  37 P/R
038  65  x
039  02  2
040  00  0
041  06  6
042  95  =
043  22 INV
044  44 SUM  -206 SIN(
045  57  57  ℓ+ℓ'-2D)
046  32 X-T
047  65  x
048  01  1
049  04  4
```

```
050  95  =
051  44 SUM  14 COS(
052  59  59  ℓ+ℓ'-2D)
053  43 RCL
054  46  46
055  38 SIN
056  65  x
057  06  6
058  06  6
059  09  9
060  94 +/-  -669 SIN ℓ'
061  75  -
062  53  (
063  43 RCL
064  49  49
065  75  -
066  43 RCL
067  43  43
068  54  )
069  38 SIN
070  65  x
071  02  2
072  01  1
073  02  2  -212 SIN(
074  75  -   2ℓ-2D)
075  53  (
076  43 RCL
077  50  50
078  75  -
079  43 RCL
080  43  43
081  54  )
082  38 SIN
083  65  x
084  02  2
085  09  9  -29 SIN(
086  75  -   ℓ-ℓ'-2D)
087  53  (
088  43 RCL
089  48  48
090  75  -
091  43 RCL
092  43  43
093  54  )
094  38 SIN
095  65  x
096  05  5
097  05  5  -55 SIN(
098  75  -   2F-2D)
099  53  (
```

```
100  43 RCL
101  44  44
102  85  +
103  43 RCL
104  48  48
105  54  )
106  38 SIN
107  65  x
108  04  4
109  05  5  -45 SIN(
110  75  -   ℓ+2F)
111  53  (
112  43 RCL
113  49  49
114  75  -
115  43 RCL
116  51  51
117  54  )
118  38  SIN
119  65  x
120  03  3
121  01  1  -31 SIN(
122  75  -   2ℓ-4D)
123  53  (
124  43 RCL
125  46  46
126  85  +
127  43 RCL
128  43  43
129  54  )
130  38 SIN
131  65  x
132  02  2
133  04  4  -24 SIN(
134  95  =   ℓ'+2D)
135  44 SUM
136  57  57  λ
137  01  1
138  08  8
139  04  4
140  06  6
141  01  1
142  65  x
143  43 RCL
144  47  47
145  38 SIN  18461 SIN F
146  85  +
147  01  1
148  00  0
149  01  1
```

```
150  00  0
151  65  x
152  53  (
153  43 RCL
154  44  44
155  85  +
156  43 RCL
157  47  47
158  54  )
159  38  SIN   1010 SIN(
160  75  -      ℓ+F)
161  01  1
162  00  0
163  00  0
164  00  0
165  65  x
166  53  (
167  43 RCL
168  47  47
169  75  -
170  43 RCL
171  44  44
172  54  )
173  42 STO  F-ℓ
174  52  52
175  38  SIN  -1000 SIN(
176  75  -      F-ℓ)
177  06  6
178  02  2
179  04  4
180  65  x
181  53  (
182  43 RCL
183  47  47
184  75  -
185  43 RCL
186  43  43
187  54  )
188  42 STO  F-2D
189  53  53
190  38  SIN  -162 SIN(
191  85  +      F-2D)
192  01  1
193  09  9
194  09  9
195  65  x
196  53  (
197  43 RCL
198  52  52
199  85  +
200  43 RCL
201  43  43
202  54  )
203  38  SIN  199 SIN(
204  75  -      F-ℓ+2D)
205  01  1
206  06  6
207  07  7
208  65  x
209  53  (
210  43 RCL
211  53  53
212  85  +
213  43 RCL
214  44  44
215  54  )
216  38  SIN  -167 SIN(
217  85  +      F-2D+ℓ)
218  01  1
219  01  1
220  07  7
221  65  x
222  53  (
223  43 RCL
224  47  47
225  85  +
226  43 RCL
227  43  43
228  54  )
229  38  SIN  117 SIN(
230  85  +      F+2D)
231  06  6
232  02  2
233  65  x
234  53  (
235  43 RCL
236  49  49
237  85  +
238  43 RCL
239  47  47
240  54  )
241  38  SIN  62 SIN(
242  75  -      2ℓ+F)
243  03  3
244  03  3
245  65  x
246  53  (
247  43 RCL
248  53  53
249  75  -
250  43 RCL
251  44  44
252  54  )
253  38  SIN -33 SIN(F-2D-ℓ)
254  75  -
255  03  3
256  02  2
257  65  x
258  53  (
259  43 RCL
260  47  47
261  75  -
262  43 RCL
263  49  49
264  54  )
265  38  SIN  -32 SIN(F-2ℓ)
266  75  -
267  03  3
268  00  0
269  65  x
270  53  (
271  43 RCL
272  53  53
273  85  +
274  43 RCL
275  46  46
276  54  )
277  38  SIN  -30 SIN(
278  95  =      F-2D+ℓ')
279  55  ÷
280  03  3
281  06  6
282  00  0
283  00  0
284  42 STO
285  54  54
286  95  =
287  42 STO  LATITUDE β
288  58  58
289  43 RCL
290  54  54
291  22 INV  CONVERT
292  49 PRD  SECONDS TO
293  57  57  DEGREES
294  43 RCL
295  59  59
296  55  ÷
297  01  1
298  00 00
299  85  +
```



```
300  03  3
301  04  4
302  02  2
303  02  2
304  93  .
305  05  5
306  95  =
307  55  ÷
308  43 RCL
309  54  54
310  95  =
311  38 SIN
312  35 1/X
313  65  x
314  06  6
315  03  3
316  07  7
317  08  8
318  93  .
319  03  3
320  08  8
321  08  8
322  95  =
323  42 STO  STORE
324  39  39
325  58 FIX
326  02  2
327  43 RCL
328  57  57
329  71 SBR
330  95  =
331  42 STO  STORE
332  21  21  LUNAR
333  22 INV  LONGITUDE
334  88 DMS  FOR ASPECT
335  42 STO  PROGRAM
336  19  19
337  55  ÷
338  03  3
339  00  0
340  95  =
341  59 INT  CONVERT
342  42 STO  LONGITUDE
343  18  18  TO SIGN &
344  85  +   DEG-IN-SIGN
345  01  1
346  95  =
347  43 RCL
348  18  18
349  55  ÷
350  02  2
351  95  =
352  42 STO  INDIRECT
353  06  06 ADDRESS
354  22 INV
355  59 INT
356  32 X-T
357  00  0  } UNPACK LEFT
358  67  EQ } OR RIGHT-
359  35 1/X } HAND SIGN?
360  73 RC*
361  06  6
362  59 INT
363  61 GTO  LEFT-HAND
364  45 Yˣ   SIGN
365  76 LBL
366  35 1/X
367  73 RC*
368  06  6
369  22 INV
370  59 INT  RIGHT-HAND
371  65  x   SIGN
372  01  1
373  52 EE
374  04  4
375  22 INV
376  52 EE
377  76 LBL
378  45 Yˣ
379  95  =
380  69 OP
381  04  4
382  43 RCL
383  19  19
384  75  -
385  03  3
386  00  0
387  65  x
388  43 RCL
389  18  18
390  95  =   PRINT
391  69  OP  DEG-IN-SIGN
392  06  06 AND SIGN
393  43 RCL
394  58  58
395  22 INV
396  88 DMS
397  99 PRT  PRINT
398  04  4   LATITUDE
399  00  0
400 06  6
401  06  6
402  09  9
403  08  8
404  75  -
405  43 RCL
406  39  39  COMPUTE
407  95  =   AND PRINT
408  55  ÷   DISTANCE
409  05  5   VALUE
410  00  0
411  02  2
412  93  .
413  08  8
414  07  7
415  95  =
416  99 PRT  [RTN]
417  98 ADV
418  01  1   CONVERT
419  32 X-T  LATITUDE
420  43 RCL  AND
421  58  58  LONGITUDE
422  37 P/R  TO
423  42 STO  RIGHT
424  38  38  ASCENSION
425  43 RCL  AND
426  57  57  DECLINATION
427  37 P/R
428  32 X-T
429  42 STO
430  37  37
431  43 RCL
432  38  38
433  22 INV
434  37 P/R
435  85  +
436  43 RCL
437  11  11
438  95  =
439  37 P/R
440  22 INV
441  38 SIN
442  42 STO
443  56  56
444  43 RCL
445  37  37
446  32 X-T
447  22 INV
448  37 P/R
449  71 SBR
```

```
450  95  =
451  55  ÷
452  01  1
453  05  5
454  95  =
455  22  INV
456  88  DMS   PRINT
457  99  PRT   RIGHT
458  43  RCL   ASCENSION
459  56  56
460  22  INV
461  88  DMS
462  99  PRT   PRINT
463  22  INV   DECLINATION
464  58  FIX
465  00  0
466  91  R/S
467  91  R/S
468  91  R/S
469  91  R/S
```

NOTE: The SVP transformation to the sidereal zodiac has not been implemented.


```
000  76  LBL   SUBROUTINE
001  85  +     TO ADD THE
002  85  +     SYNETIC
003  43  RCL   VERNAL
004  14  14    POINT (SVP)
005  54  )
006  92  RTN
007  76  LBL
008  95  =     SUBROUTINE
009  55  ÷     FOR 360°
010  03  3     MODULAR
011  06  6     ARITHMETIC
012  00  0
013  54  )
014  22  INV
015  59  INT
016  85  +
017  01  1
018  54  )
019  22  INV
020  59  INT
021  65  x
022  03  3
023  06  6
024  00  0
025  54  )
026  92  RTN
027  76  LBL   SUBROUTINE
028  75  -
029  22  INV
030  88  DMS
031  42  STO
032  19  19
033  55  ÷     FIND SIGN
034  03  3     AND
035  00  0     DEGREE-IN-
036  54  )     SIGN
037  59  INT
038  42  STO
039  18  18
040  85  +
041  01  1
042  54  )
043  43  RCL   COMPUTE
044  18  18    INDIRECT
045  55  ÷     ADDRESS &
046  02  2     STORE
047  54  )
048  42  STO
049  06  06

050  22  INV
051  59  INT   UNPACK
052  32  X-Y   SIGN FOR
053  00  0     PRINTING
054  67  EQ
055  35  1/X
056  73  RC*   } UNPACK
057  06  06    } LEFT-HAND
058  59  INT   } PORTION
059  61  GTO
060  45  Yˣ
061  76  LBL
062  35  1/X
063  73  RC*   UNPACK
064  06  06    RIGHT-HAND
065  22  INV   PORTION
066  59  INT
067  65  x
068  01  1
069  52  EE
070  04  4
071  22  INV
072  52  EE
073  76  LBL
074  45  Yˣ
075  54  )
076  69  OP
077  04  04
078  43  RCL   PRINT
079  19  19    DEGREE-IN-SIGN
080  75  -     AND SIGN
081  03  3
082  00  0
083  65  x
084  43  RCL
085  18  18
086  54  )
087  69  OP
088  06  06
089  92  RTN
090  76  LBL   SUBROUTINE TO
091  44  SUM   EVALUATE
092  53  (     A₀ + A₁T + A₂T²
093  53  (
094  73  RC*
095  06  06
096  65  x
097  43  RCL
098  10  10
099  69  OP
```



```
100  36  36
101  85  +
102  73  RC*
103  06  06
104  54  )
105  65  x
106  43  RCL
107  10  10
108  69  OP
109  36  36
110  85  +
111  73  RC*
112  06  06
113  54  )
114  69  OP
115  36  36
116  92  RTN
117  76  LBL   SUBROUTINE
118  37  P/R   TO CONVERT
119  43  RCL   RECTANGULAR
120  30  30    COORDINATES
121  32  X-T   TO
122  43  RCL   SPHERICAL
123  31  31    COORDINATES
124  22  INV
125  37  P/R
126  42  STO
127  30  30
128  43  RCL
129  32  32
130  22  INV
131  37  P/R
132  42  STO
133  31  31
134  32  X-T
135  42  STO
136  32  32
137  92  RTN
138  76  LBL
139  39  COS   SUBROUTINE
140  53  (     TO CONVERT
141  43  RCL   ECLIPTIC
142  31  31    RECTANGULAR
143  32  X-T   COORDINATES
144  43  RCL   TO
145  32  32    EQUATORIAL
146  22  INV   RECTANGULAR
147  37  P/R   COORDINATES
148  85  +
149  43  RCL

150  11  11    EQUATORIAL
151  54  )     RECTANGULAR
152  37  P/R   COORDINATES
153  42  STO
154  32  32
155  32  X-T
156  42  STO
157  31  31
158  92  RTN   START
159  76  LBL   COMPUTATIONS
160  18  C'
161  76  LBL   ALTERNATIVE
162  11  A     ENTRY POINT
163  98  ADV   AUTOMATIC
164  69  OP    MODE (*)
165  00  00
166  43  RCL   PRINT
167  40  40    PLANET
168  69  OP    NAME
169  01  01
170  69  OP
171  05  05
172  05  5     } SET FOR
173  09  9     } INDIRECT
174  42  STO   } CONTROL
175  06  06
176  60  DEG
177  01  1
178  32  X-T   } COMPUTE
179  71  SBR   } AND STORE
180  44  SUM   } M IN
181  37  P/R   } RADIANS
182  70  RAD   }
183  22  INV
184  37  P/R
185  42  STO
186  30  30
187  42  STO   E   M
188  32  32
189  71  SBR   } COMPUTE AND
190  44  SUM   } STORE e
191  42  STO
192  31  31
193  58  FIX
194  08  08
195  76  LBL
196  34  √X    NEWTON-
197  43  RCL   RAPHSON
198  31  31    LOOP TO
199  32  X-T   COMPUTE E

200  43  RCL
201  32  32
202  37  P/R
203  75  -
204  43  RCL
205  32  32
206  85  +
207  43  RCL
208  30  30
209  95  =
210  55  ÷
211  53  (
212  32  X-T
213  75  -
214  01  1
215  54  )
216  95  =
217  22  INV
218  44  SUM
219  32  32
220  52  EE
221  22  INV
222  52  EE
223  32  X-T
224  00  0     LOOP IF NOT
225  22  INV   CONVERGED
226  67  EQ
227  34  √X
228  43  RCL
229  44  44    } a SIN E
230  32  X-T   }   &
231  43  RCL   } a COS E
232  32  32    }
233  37  P/R
234  60  DEG
235  65  x
236  53  (
237  01  1     } Yω =
238  75  -     } a sinE√1-e²
239  43  RCL   }
240  31  31    }
241  65  x     }
242  24  CE
243  54  )
244  34  √X
245  95  =
246  32  X-T
247  75  -
248  43  RCL
249  44  44
```

```
250  65  x      X_ω =acosE-ae
251  43 RCL
252  31  31
253  95  =
254  32 X-T
255  22 INV
256  37 P/R
257  85  +
258  71 SBR      COMPUTE &
259  44 SUM      ROTATE THRU
260  95  =        ω
261  37 P/R
262  32 X-T
263  42 STO
264  37  37      COMPUTE &
265  71 SBR      ROTATE THRU
266  44 SUM        i
267  37 P/R
268  42 STO
269  39  39     Z_H
270  43 RCL
271  37  37
272  32 X-T
273  22 INV
274  37 P/R
275  85  +      COMPUTE &
276  71 SBR      ROTATE THRU
277  44 SUM       ⌐¬
278  95  =
279  37 P/R
280  42 STO
281  38  38     Y_H
282  32 X-T
283  42 STO     X_H
284  37  37     ------------
285  87 IFF      FIRST PLANET?
286  05  05     SUN?
287  28 LOG      - - - - - - -
288  86 STF
289  05  05     FIRST DATA
290  43 RCL      CARD
291  37  37     ASSUME
292  42 STO      EARTH?SUN
293  07  07
294  94 +/-     STORE
295  42 STO      HELIOCENTRIC
296  34  34     COORDINATES
297  43 RCL      OF EARTH
298  38  38
299  42 STO

300  08  08     AND STORE
301  94 +/-      GEOCENTRIC
302  42 STO      COORDINATES
303  35  35     OF SUN
304  43 RCL
305  39  39
306  42 STO
307  09  09
308  94 +/-
309  42 STO      recall
310  36  36     GEOCENTRIC
311  61 GTO      RECTANGULAR
312  23 LNX      COORDINATES
313  76 LBL      FOR CONVERSION
314  28 LOG
315  43 RCL
316  37  37     COMPUTE AND
317  75  -       STORE
318  43 RCL      GEOCENTRIC
319  07  07     RECTANGULAR
320  95  =       COORDINATES
321  42 STO      OF THE
322  34  34     PLANET
323  43 RCL
324  38  38
325  75  -
326  43 RCL
327  08  08
328  95  =
329  42 STO
330  35  35
331  43 RCL
332  39  39
333  75  -
334  43 RCL
335  09  09     CONVERT TO
336  95  =       0°-360°
337  42 STO      FIND SIGN
338  36  36     - - - - - - -
339  76 LBL
340  23 LNX
341  43 RCL      RECALL
342  41  41     BODY
343  42 STO      NUMBER.
344  06  06
345  43 RCL
346  34  34
347  32 X-T      COMPUTE
348  43 RCL      AND STORE
349  35  35     LONGITUDE

350  22 INV      FOR ASPECTS
351  37 P/R      AND MIDPOINT
352  71 SBR      ROUTINE
353  95  =
354  72 ST*
355  06  06
356  61 GTO      (*) REPLACE WITH
357  12  B       R/S
358  76 LBL
359  15  E       recall
360  43 RCL      GEOCENTRIC
361  36  36     RECTANGULAR
362  42 STO      COORDINATES
363  32  32     FOR CONVERSION
364  43 RCL
365  35  35
366  42 STO
367  31  31
368  43 RCL
369  34  34
370  42 STO
371  30  30
372  00  0
373  58 FIX
374  02  02
375  92 RTN
376  76 LBL      CONVERT TO
377  12  B
378  71 SBR      (*) DELETE
379  15  E       TROPICAL
380  71 SBR      ECLIPTIC
381  37 P/R      - - - - - - -
382  43 RCL
383  30  30
384  76 LBL
385  47 CMS      CONVERT TO
386  71 SBR      0°-360°
387  95  =       FIND SIGN
388  71 SBR
389  75  -
390  71 SBR
391  57 ENG      (*) DELETE
392  61 GTO
393  13  C
394  76 LBL
395  57 ENG
396  43 RCL      PRINT OR
397  31  31     DISPLAY
398  22 INV      β or δ
399  88 DMS
```



```
400  99 PRT      R/S FOR
401  53  (       DISPLAT ONLY
402  43 RCL
403  42  42
404  75  -
405  43 RCL
406  32  32
407  54  )       COMPUTE AND
408  55  ÷       DISPLAY
409  43 RCL      DISTANCE
410  43  43     VALUE
411  65  x
412  01  1
413  00  0
414  00  0
415  95  =
416  99 PRT      R/S FOR
417  43 RCL      DISPLAY
418  32  32     RECALL DIST-
419  58 FIX      ANCE IN A.U.
420  04  04     PRT AND/OR
421  92 RTN      R/S
422  61 GTO
423  97 DSZ      ------------
424  76 LBL
425  16  A'      CONVERT TO
426  71 SBR      SIDEREAL
427  37 P/R      ECLIPTIC
428  43 RCL
429  30  30
430  71 SBR
431  85  +
432  61 GTO
433  47 CMS      ------------
434  76 LBL
435  13  C
436  98 ADV
437  71 SBR      (*) DELETE
438  15  E
439  71 SBR      CONVERT
440  39 COS       TO
441  71 SBR      EQUATORIAL
442  37 P/R      COORDINATES
443  71 SBR
444  95  =
445  43 RCL
446  30  30
447  55  ÷
448  01  1
449  05  5

450  95  =
451  22 INV
452  88 DMS
453  99 PRT      R/S
454  71 SBR
455  57 ENG      R/S - - - - - -
456  76 LBL
457  10  E'
458  22 INV
459  58 FIX
460  00  0
461  91 R/S
462  76 LBL      ------------
463  14  D       RECALL
464  43 RCL      HELIOCENTRIC
465  37  37     RECTANGULAR
466  42 STO      COORDINATES
467  30  30     FOR
468  43 RCL      CONVERSION
469  38  38
470  42 STO
471  31  31
472  43 RCL
473  39  39
474  42 STO
475  32  32
476  58 FIX
477  02  02
478  91 R/S
479  91 R/S      ------------
```

NOTE: A LAST MINUTE ARRIVAL..AS WE ARE GOING TO PRESS FROM DAVID & GINA COHRANE

Astrological Counseling &
Research
Route 2, Box 44B
Alachua, FL 32615
1-904-377-8527

The Cohranes have obtained a full-scale and very accurate computer program for planet and lunar positions for larger computers (in FORTRAN). They will sell a limited number of copies of this program on magnetic tape or on cards. This is the first large computer program that I am aware of that has been offered for sale. Call for details. Asking price:in the vicinity of $150. (a reasonable price for the whole works)

— Editor

MEAN ORBITAL ELEMENTS: A DISCUSSION

Small computing machines (hand-held calculators, micros with limited memory) are capable of generating planetary positions with accuracies to within about one minute of arc. Most of the planetary programs written for small machines make use of a set of equations for the mean orbital elements. Greater accuracy is possible if the astrologer is willing to enter a great number of program cards or chain load several programs from cassettes. The programs listed in this issue all fit in a very limited amount of memory. We will be publishing more accurate programs in future issues that require much more program memory. As many of our readers will know from hard-won experience, the numerical values used in the equations for these mean orbital elements are scattered thru a fair amount of literature— not all of which is readily available. With this in mind, I am sure you will appreciate these remarks from James Neely on this issue and the various tables he sends for us that are listed at the end of this discussion.

(These excerpts from letter from James Neely)

" Here are the primary references that I use, and I've pretty much listed them in the order of frequency of use. There are any number of special purpose references, such as the Astronomical Papers prepared for the use of The American Ephemeris and Nautical Almanac (A.P.A.E.)of Simon Newcomb, the "Improved Lunar Ephemeris 1952-1959" which contains all of the lunar terms, miscellaneous JPL and NASA publications seem to round out the lot. References:

1. Explanatory Supplement to the American Ephemeris and Nautical Almanac, Her Majesty's Stationary Office, London 1961
2. Escobal, P.R., "Methods of Astrodynamics", Wiley 1968
   Escobal, P.R., "Methods of Orbit Determination", Wiley 1965
   (I use the Orbit one more than the Astrodynamic one.)
3. W.M. Smart, "Text-Book of Spherical Astronomy", Cambridge University Press. (still in print)
4. Woolard & Clemence, "Spherical Astronomy", Academic Press 1966
5. Ivan I. Mueller, "Spherical and Practical Astronomy as Appliend to Geodesy", Frederick Ungar Publ. Co., 1969
6. F.R. Moulton, "An Introduction to Celestial Mechanics", Dover Publ. 1970

" Hope that helps. The original Neely planetary programs for the HP-65 used all of the terms in all of the formulas listed in Escobal's "Astrodynamics". These formulas were also used for the elements of the HP-67/97 programs [listed this issue] except that small terms of T^3 and greater were omitted. These terms are of no consequence when T is between — 1 and +1 [one century]. The Escobal reference was convenient since all of the formulas were in one place. The inner body formulas are from the Explanatory Supplement, and the outer body formulas are from the 1965 Connaissance des Temps. The Explanatory Supplement does not list the outer body formulas because they are considerably more inaccurate More precise simple formulas have not been developed simply because the outer bodies suffer considerably from mutual perturbations. About the time that such formulas might have been devised, the Nautical Almanac Office published Volume XII of the A.P.N.A.

Orbital Values (continued)

"... in which the results of a numerical integration which was performed were presented. These results are the Heliocentric rectangular coordinates of the outer bodies for 1653-2060. This gave accurate information to people with big computers, and so formulas for smaller devices were never developed.

" In JPL TR 32-1508 (Jet Propulsion Laboratory, Pasadena CA), "Polynomial Expressions for Planetary Equators and Orbital Elements with Respect to the Mean 1950.0 Coordinate System", the orbital elements are taken from the Explanatory Supplement for the inner bodies and are simply linear fits of the outer body elements that are given on page 115 of the Explanatory Suppl. The equations in Table 13 of JPL TR-1306, " Constants and Related Information for Astrodynamic Calculations, 1968" are also from the Expl. Suppl., as they acknowledge. Some further, very accurate elements, are also quoted in TR 32-1306, but they are osculating elements and hence are valid for only one given instant of time although very good computations can be made from these elements at times which are not too far removed from the epoch. [see listing]

"The Neely outerbody elements are derived from data that very closely reproduces the heliocentric coordinates in the A.P.N.A. Vol. XII (Carpenter's NASA TN D-3168), but only the years 1900-2000 have been developed. My HP and TI linear elements are from a least squares fit of the derived orbital elements of date at 40 day intervals for the entire century. They represent the most accurate linear fit possible for the years 1900-2000 ONLY. For extrapolations outside of the 20th century, the user is advised to use the elements quoted in Escobal. Even after the linear terms have been removed from the 1900-2000 elements, the residuals have a large harmonic content. The effect is that computations are periodically "good" and "bad". Harmonic analysis has not been too much help in separating the frequencies involved, but they do indicate that a reduction using theoretical "beat" frequencies of the body's orbital periods may be as good as an empirical reduction. This work has not yet been done, and you can rest assured that I am as anxious to see the results as anyone!

" I really think it is a shame that the Almanac people haven't done this sort of analysis. They have all of the data on cards for any time period that we would ever be interested in, and they have also computed the "Elements of the Outer Planets for One Million Years", which is the title of A.P.N.A. Vol. XXII, part I. With a data set like that, I would think that a harmonic analysis would be most interesting. I guess that the experts can see all that interests them by looking at the theory and that the numerical quantities have no fascination. If I were an expert I'd probably feel that way too.

" Gad zooks, but I've rambled on and on. Somehow I think that this may be the sort of thing that you wanted regarding the various values of orbital elements that are extant. Please keep in mind that this is how I see things out of my window. I'm not an expert at all in this field, I just can walk around in the literature a little more easily than most. Anyhow, the way I see it may or not be the way that it is (sometime I think that in a past life I knew more of these things than I do now, but that's another story)."

Orbital Elements (continued)

The standard elements and their symbols:

- $\Omega \equiv$ ecliptic longitude of the ascending node
- $\varpi \equiv$ ecliptic argument of perihelion
- M $\equiv$ mean anomaly
- L $\equiv$ the mean longitude = $\Omega + \omega +$ M
- $\tilde{\omega} \equiv$ the longitude of perihelion = $\Omega + \omega$
- $e \equiv$ the orbital eccentricity
- $i \equiv$ the orbital inclination to the ecliptic plane
- a $\equiv$ the semimajor axis in astronomical units
- T $\equiv$ the time of perifocal passage
- $n \equiv$ the mean sidereal motion

The following terms are those not found in the Escobal tables quoted on the following page and are from the Explanatory Supplement to the American Ephemeris.

Mercury

$n = 538106".3093 - 0".000495T$
$M = 102°16'45".77 + (415^r + 261055".04)T + 0".024\ T^2$

Venus

$n = 2106641".3832 + 0".000096T$
$M = 212°36'11".59 + (162^r + 712093".95)T + 4".6298T^2$

Earth

$M = 358°23'33".04 + 129596579".10T - 0".54T^2 - 0".012T^3$
$e = 23°27'08".26 - 46".845T - 0".0059T^2 + 0".00181T^3$

Mars

$n = 689050".9262 + 0".000169T$
$M = 319°31'45".93 + (53^r + 215490".60)T + 0".6509T^2 + 0".0043T^3$

Jupiter

$n = 109256".6481$
$M = 136°37'44".88 + 299".123557d$

Saturn

$n = 43996".18875$
$M = 174°19'45".64 + 120".39926d$

Uranus

$n = 15426".33375$
$M = 73°35'18".25 + 42".2131d$

Neptune

$n = 7864".563$
$M = 41°16'50".73 + 21".3092d$

PLEASE NOTE: The EPOCH is 1900 January 0.5 ET or equivalently, Julian Ephemeris Day (JED) 2415020.0. The time interval from the epoch is denoted by 'T' when measured in Julian Centuries of 36525 days, by 'D' when measured in units of 10000 ephemeris days (D= 3.6525 T), and by 'd' when measured in ephemeris days (d= 1000D, d= 36525 T). Values here as of early 1960s.

On the following pages are the orbital values (mean) from the Escobal book, the Neely Outer Body values and the JPL osculating elements. Elements follow for the four major asteroids and for the new planet Chiron.

MEAN PLANETARY ORBITAL ELEMENTS AS A FUNCTION OF TIME: P.R Escobal, "METHODS OF ASTRODYNAMICS", Wiley 1968

MERCURY

$L = 178°10'44".68 + 538106654".80T + 1".084T^2$
$\tilde{\omega} = 75°53'58".91 + 5599".76T + 1".061T^2$
$\Omega = 47°08'45".40 + 4266".75T + 0".626T^2$
$e = 0.20561421 + 0.00002046T - 0.000000030T^2$
$i = 7°00'10".37 + 6".699T - 0".066T^2$
$a = 0.3870984$

VENUS

$L = 342°46'01".39 + 210669162".88T + 1".1148T^2$
$\tilde{\omega} = 130°09'49".8 + 5068".93T - 3".515T^2$
$\Omega = 75°46'46".73 + 3239".46T + 1.476T^2$
$e = 0.00682069 - 0.00004774T + 0.000000091T^2$
$i = 3°23'37".07 + 3".621T - 0".0035T^2$
$a = 0.72333015$

EARTH

$L = 99°41'48".04 + 129602768".13T + 1".089T^2$
$\tilde{\omega} = 101°13'15".0 + 6189".03T + 1".63T^2 + 0".012T^3$
$\Omega = 0°$
$e = 0.01675104 - 0.00004180T - 0.000000126T^2$
$i = 0°$
$a = 1.00000013$

MARS

$L = 293°44'51".46 + 68910117".33T + 1".1184T^2$
$\tilde{\omega} = 334°13'05".53 + 6626".73T + 0".4675T^2 - 0".0043T^3$
$\Omega = 48°47'11".19 + 2775".57T - 0".005T^2 - 0".0192T^3$
$e = 0.09331290 + 0.000092064T - 0.000000077T^2$
$i = 1°51'01".20 - 2".430T + 0".0454T^2$
$a = 1.52368839$

JUPITER

$L = 238°02'57".32 + 10930687".148T + 1".2048 6T^2 - 0".005936T^3$
$\tilde{\omega} = 12°43'15".34 + 5795".862T + 3".80258T^2 - 0".01236T^3$
$\Omega = 99°26'36".19 + 3637".908T + 1".2680T^2 - 0".03064T^3$
$e = 0.04833475 + 0.000164180T - 0.0000004676T^2 - 0.0000000017T^3$
$i = 1°18'31".45 - 20".506T + 0".014T^2$
$a = 5.202561$

SATURN

$L = 266°33'51".76 + 4404635".5810T + 1".16835T^2 - 0".021T^3$
$\tilde{\omega} = 91°05'53".38 + 7050".297T + 2".9749T^2 + 0".0166T^3$
$\Omega = 112°47'25".40 + 3143".5025T - 0".5478 5T^2 - 0".0191T^3$
$e = 0.05589232 - 0.00034550T - 0.0000000728T^2 + 0.0000000074T^3$
$i = 2°29'33".07 - 14".108T - 0".05576T^2 + 0".00016T^3$
$a = 9.554747$

URANUS

$L = 244°11'50".89 + 1547508".765T + 1".13774T^2 - 0".002176T^3$
$\tilde{\omega} = 171°32'55".14 + 5343".958T + 0".8539T^2 - 0".00218T^3$
$\Omega = 73°28'37".55 + 1795".204T 4".722T^2$
$e = 0.0463444 - 0.0000265 8T + 0.0000000077T^2$
$i = 0°46'20".87 + 2".251T + 0".1422T^2$
$a = 19.21814$

NEPTUNE

$L = 84°27'28".78 + 791589".291T + 1".15374T^2 - 0".002176T^3$
$\tilde{\omega} = 46°43'38".37 + 5128".468T + 1".40694T^2 - 0".002176T^3$
$\Omega = 130°40'52".89 + 3956".166T + 0".89952T^2 - 0".016984T^3$
$e = 0.00899704 + 0.000000633 0T - 0.000000002T^2$
$i = 1°46'45".27 - 34".357T - 0".0328T^2$
$a = 30.10957$

PLUTO

$T = 1989\ October\ 0.0344\ day$
$\tilde{\omega} = 113°31'17".72$
$\Omega = 108°57'16".18$
$e = 0.2486438$
$i = 17°08'48".40$
$a = 39.517738$

Planet	Sidereal Revolution	Tropical Revolution	Anomalistic Revolution
Mercury	87.9692925577 + .000000011T	87.96843447 - .00000036T	87.96934991 - .000000011T
Venus	224.70079804 - .000000011T	224.69543882 - .00000238T	224.70084537 - .000009 88T
Earth	365.25636042 + .000000011T	365.24219879 - .00000614T	365.25964134 + .000003 04T
Mars	686.9797021	686.9296068 - .0000233T	686.9956487 - .0000130T
Moon	27.321661	27.321582	27.554551

NOTE: All above periods of revolution in TROPICAL DAYS (from A.P.N.A. Vol. VI)

The NEELY VALUES for the Outer Planets for the years 1900 thru 2000 ONLY

ORBITAL ELEMENTS FOR JUPITER THRU PLUTO

JUPITER

M = 225.4928125 + 3033°.687936T
e = 0.048381440 − 0.000015500T
a = 5.202904930
ω = 273.3930152 + 1.338344640 T
i = 1.309658500 − 0.005156130 T
Ω = 99.41984827 + 1.058291520 T

SATURN

M = 174.2152960 + 1223.507963T
e = 0.054228310 − 0.000204950T
a = 9.552517450
ω = 338.9116730 − 0.316679410T
i = 2.490805470 − 0.004660350T
Ω = 112.8261394 + 0.825875690T

URANUS

M = 74.17574887 + 427.2742717 T
e = 0.046816640 + 0.00041875T
a = 19.22150505
ω = 95.68630387 + 2.050825480 T
i = 0.772566520 + 0.000128240 T
Ω = 73.52220082 + 0.524155980 T

NEPTUNE

M = 30.13294370 + 240.4551595 T
e = 0.009128050 − 0.001271850T
a = 30.11375930
ω = 284.1682550 -21.63286150 T
i = 1.779392810 − 0.009750880 T
Ω = 130.6841531 + 1.100464920 T

PLUTO

M = 229.7810007 + 145.1781092 T
e = 0.247973760 + 0.002898750T
a = 39.53903455
ω = 113.5365761 + 0.208637610 T
i = 17.15140319 − 0.016118240 T
Ω = 108.9440500 + 1.373954440 T

Note from J. Neely.." Enclosed is a new list of Neptune elements that I've arrived at in a somewhat different manner than the earlier ones. The numbers look different, but theoretically they should be no better..or a tad better."

JUPITER	#	SATURN	#	URANUS	#	NEPTUNE	#	PLUTO	#		NEPTUNE (alternate)
0.000000000	0	0.000000000	0	0.000000000	0	0.000000000	0	0.000000000	0		0.000000000
99.41984827	1	112.8261394	1	73.52220082	1	130.6841531	1	108.9440500	1		130.6841531
1.058291520	2	0.825875690	2	0.524155980	2	1.100464920	2	1.373954440	2		1.100464920
0.000000000	3	0.000000000	3	0.000000000	3	0.000000000	3	0.000000000	3		0.000000000
1.309658500	4	2.490805470	4	0.772566520	4	1.779392810	4	17.15140319	4		1.779392810
-0.005156130	5	-0.004660350	5	0.000128240	5	-0.009750880	5	-0.016118240	5	Primary Registers	-0.009750880
0.000000000	6	0.000000000	6	0.000000000	6	0.000000000	6	0.000000000	6		0.000000000
273.3930152	7	338.9116730	7	95.68630387	7	284.1682550	7	113.5365761	7		284.1683081
1.338344640	8	-0.316679410	8	2.050825480	8	-21.63286150	8	0.208637610	8		-21.63320343
0.000000000	9	0.000000000	9	0.000000000	9	0.000000000	9	0.000000000	9		0.000000000
5.202904930	0	9.552517450	0	19.22150505	0	30.11375930	0	39.53903455	0		30.11375930
0.048381440	1	0.054228310	1	0.046816640	1	0.009128050	1	0.247973760	1		0.009128050
-0.000015500	2	-0.000204950	2	0.000418750	2	-0.001271850	2	0.002898750	2		-0.001271850
0.000000000	3	0.000000000	3	0.000000000	3	0.000000000	3	0.000000000	3		0.000000000
225.4928125	4	174.2152960	4	74.17574887	4	30.13294370	4	229.7810007	4		30.13255180
3033.687936	5	1223.507963	5	427.2742717	5	240.4551595	5	145.1781092	5	Secondary Registers	240.4557382
0.000000000	6	0.000000000	6	0.000000000	6	0.000000000	6	0.000000000	6		0.000000000
0.000000000	7	0.000000000	7	0.000000000	7	0.000000000	7	0.000000000	7		0.000000000
0.000000000	8	0.000000000	8	0.000000000	8	0.000000000	8	0.000000000	8		0.000000000
0.000000000	9	0.000000000	9	0.000000000	9	0.000000000	9	0.000000000	9		0.000000000

JPL EQUATORIAL RECTANGULAR COORDINATES, VELOCITIES AND OSCULATING ECLIPTIC ELEMENTS

The following values provided thru the courtesy of the Jet Propulsion Laboratory, California Institute of Technology. The data is for the epoch JED 2433280.5 (December 31, 1950, 0h) and are referred to the mean equinox, equator and ecliptic of 1950.0 (JED 2433282.423). The Equatorial Rectangular Coordinates (x,y,z) and velocities ($\dot{x}$,$\dot{y}$,$\dot{z}$) are on the left...ecliptic elements on the right.

Note: Listed values often in **scientific notation**. i.e. 0.6810 9366 0405 9934 -02 = 0.0068 1093 6604 0599 34

Equatorial Rectangular Coordinates	Ecliptic Elements
Mercury	**Mercury**
x = 0.3439 2628 2595 0512 00 AU	a = 0.3870 9767 6143 4659 00 AU
y = 0.4561 2086 7296 2349 -01 AU	n = 0.7142 5062 8941 1173 -01 rad/day
z =-0.1092 5237 7672 6325 -01 AU	e = 0.2056 2139 2696 1776 00
$\dot{x}$ =-0.8466 3252 4718 1976 -02 AU/day	i = 0.1222 3790 4101 3027 00 rad
$\dot{y}$ = 0.2561 4777 7129 3402 -01 AU/day	Ω = 0.8331 9221 2035 1764 00 rad
$\dot{z}$ = 0.1458 6762 7826 5551 -01 AU/day	ω = 0.5051 7122 8386 4736 00 rad
	M_0 = 0.5416 5385 1667 6136 01 rad
Venus	**Venus**
x = 0.1429 7052 9471 8901 00 AU	a = 0.7233 3519 4140 1882 00 AU
y = 0.6470 0406 9944 5343 00 AU	n = 0.2796 2279 9327 9817 -01 rad/day
z = 0.2824 8152 5073 4543 00 AU	e = 0.6810 9366 0405 9934 -02
$\dot{x}$ =-0.1989 3793 1396 6423 -01 AU/day	i = 0.5923 9147 6374 4428 -01 rad
$\dot{y}$ = 0.3113 2345 4293 3853 -02 AU/day	Ω = 0.1330 5193 1376 6087 +01 rad
$\dot{z}$ = 0.2659 4964 8941 4391 -02 AU/day	ω = 0.9562 7719 8582 3581 00 rad
	M_0 = 0.5378 2134 9887 7672 +01 rad
Earth-Moon Barycenter	**Earth-Moon Barycenter**
x =-0.1363 6133 0110 0867 00 AU	a = 0.1000 0078 7236 0544 +01 AU
y = 0.8933 9775 6948 9210 00 AU	n = 0.1720 1921 9320 3717 -01 rad/day
z = 0.3874 5843 1572 1408 00 AU	e = 0.1675 0114 1626 6023 -01
$\dot{x}$ =-0.1732 0015 4902 0189 -01 AU/day	i = 0.3019 5435 1067 9661 -05 rad
$\dot{y}$ =-0.2244 2676 7908 6503 -02 AU/day	Ω = 0.5866 9905 6919 3158 +01 rad
$\dot{z}$ =-0.9733 4185 6786 7504 -03 AU/day	ω = 0.2198 0752 5929 5807 +01 rad
	M_0 = 0.6213 6054 9876 8146 +01 rad
Mars	**Mars**
x =-0.1369 8312 5671 4650 +01 AU	a = 0.1523 7494 5726 3805 +01 AU
y = 0.8431 3716 1771 0496 00 AU	n = 0.9145 5781 6237 8094 -02 rad/day
z = 0.4238 3609 4908 1033 00 AU	e = 0.9326 0810 2118 8317 -01
$\dot{x}$ =-0.7384 5892 9362 9874 -02 AU/day	i = 0.3228 8222 5779 1756 -01 rad
$\dot{y}$ =-0.9477 3446 0757 8137 -02 AU/day	Ω = 0.8581 8453 5514 8757 00 rad
$\dot{z}$ =-0.4151 6538 4773 5353 -02 AU/day	ω = 0.4991 5092 0674 7051 +01 rad
	M_0 = 0.2938 8519 6401 7474 +01 rad

Jupiter

x = 0.3349 3566 4461 7624	+01	AU
y =-0.3473 7659 9386 1919	+01	AU
z =-0.1572 1612 0308 8752	+01	AU
$\dot{x}$ = 0.5585 6549 6410 6917	-02	AU/day
$\dot{y}$ = 0.4962 2486 5918 9390	-02	AU/day
$\dot{z}$ = 0.1992 2660 7644 6181	-02	AU/day

Saturn

x =-0.8972 4944 5632 1996	+01	AU
y = 0.2279 7122 9499 0131	+01	AU
z = 0.1330 3683 2124 4373	+01	AU
$\dot{x}$ =-0.1858 2735 1290 4143	-02	AU/day
$\dot{y}$ =-0.4983 8513 7862 8318	-02	AU/day
$\dot{z}$ =-0.1980 2491 2780 6463	-02	AU/day

Uranus

x =-0.1002 9132 6963 7378	+01	AU
y = 0.1732 2491 9404 7683	+02	AU
z = 0.7604 8360 5654 0355	+01	AU
$\dot{x}$ =-0.3955 2571 5130 4471	-03	AU/day
$\dot{y}$ =-0.3759 0074 7195 8835	-03	AU/day
$\dot{z}$ =-0.1088 4370 6981 7871	-03	AU/day

Neptune

x = -0.2919 4267 7427 1409	+02	AU
y = -0.7719 1336 0132 2025	+01	AU
z = -0.2427 2492 8084 7945	+01	AU
$\dot{x}$ = 0.8207 8983 1005 6175	-03	AU/day
$\dot{y}$ = -0.2772 0922 4647 0526	-02	AU/day
$\dot{z}$ = -0.1156 1171 1628 3100	-02	AU/day

Pluto

x = -0.2623 2756 1603 1849	+02	AU
y = 0.2056 1529 7731 2375	+02	AU
z = 0.1444 3690 2947 7839	+02	AU
$\dot{x}$ = -0.1315 7218 4319 3501	-02	AU/day
$\dot{y}$ = -0.2619 8366 1853 7051	-02	AU/day
$\dot{z}$ = -0.4270 5125 4357 5085	-03	AU/day

Jupiter

a = 0.5202 6553 8209 9465	+01	AU
n = 0.1450 2774 0969 2968	-02	rad/day
e = 0.4891 0755 7695 3512	-01	
i = 0.2281 0075 4232 1975	-01	rad
Ω = 0.1744 6738 0279 8027	+01	rad
ω = 0.4777 3851 4538 7904	+01	rad
M_0= 0.5279 6468 2494 4107	+01	rad

Saturn

a = 0.9522 6887 3876 7056	+01	AU
n = 0.5854 6921 3211 8279	-03	rad/day
e = 0.5349 2699 3422 3929	-01	
i = 0.4345 2611 3823 3223	-01	rad
Ω = 0.1976 5298 1653 3096	+01	rad
ω = 0.5883 0963 5241 1480	+01	rad
M_0= 0.1183 0954 0981 9556	+01	rad

Uranus

a = 0.1916 3718 8923 4575	+02	AU
n = 0.2050 5541 8127 4017	-03	rad/day
e = 0.4620 9970 2713 5565	-01	
i = 0.1347 3849 5921 9508	-01	rad
Ω = 0.1287 3633 3315 9055	+01	rad
ω = 0.1703 6263 2661 5070	+01	rad
M_0= 0.5005 8317 3611 7874	+01	rad

Neptune

a = 0.3006 8940 4016 5808	+02	AU
n = 0.1043 3151 1142 8949	-03	rad/day
e = 0.7942 6832 7095 8694	-02	
i = 0.3098 3362 6924 2442	-01	rad
Ω = 0.2291 3580 3446 3485	+01	rad
ω = 0.4587 6871 3081 3981	+01	rad
M_0= 0.2809 7734 6432 2865	+01	rad

Pluto

a = 0.3937 3641 3530 0176	+02	AU
n = 0.6962 6357 0829 8997	-04	rad/day
e = 0.2488 0330 5362 3924	00	
i = 0.2996 7069 7085 9694	00	rad
Ω = 0.1914 3375 5010 2258	+01	rad
ω = 0.1995 5817 5268 9690	+01	rad
M_0= 0.5265 3021 0022 1278	+01	rad

Orbital Elements for the Four Asteroids: Ceres, Juno, Pallas & Vesta

[Editor's note: I wrote to James Neely this Spring asking for help in locating a set of orbital elements that could be used with the hand-helds and the larger machines. The only source I had been able to find was the APNA Vol. XX (Papers of the American Ephemeris and Nautical Almanac). Here is his reply.]

"Enclosed are the elements for the four big asteroids. The asteroid elements are derived from the elements on page 141 of APNA Vol. XX, Pt. II, and as such are osculating elements valid for only one instant in time, I've computed terms from the data that allow for some extrapolation on either side of the osculation epoch and have included the precession effect in the ascending node. I've not tried to check the accuracy for times removed from the epoch, so I can't comment on how good they are except that they almost have to deteriorate rapidly. I have never seen a source of more accurate elements".

HP-67/97 REGISTER STORAGE

CERES		PALLAS		JUNO		VESTA	
80.23555556	R1	172.4972222	R1	170.1377778	R1	103.2197222	Ω Ascending Node
1.396011111	R2	1.396011111	R2	1.396011111	R2	1.396011111	
0.000308333	R3	0.000308333	R3	0.000308333	R3	0.000308333	
10.59694444	R4	34.81416667	R4	13.01694444	R4	7.139444444	i Inclination
0.000000000	R5	0.000000000	R5	0.000000000	R5	0.000000000	
0.000000000	R6	0.000000000	R6	0.000000000	R6	0.000000000	
71.07944444	R7	310.1661111	R7	245.3752778	R7	149.6386111	ω Argument of Perihelion
0.000000000	R8	0.000000000	R8	0.000000000	R8	0.000000000	
0.000000000	R9	0.000000000	R9	0.000000000	R9	0.000000000	
2.767227300	S0	2.770495500	S0	2.668989700	S0	2.360723000	a Semi-Major Axis
0.079431700	S1	0.234709600	S1	0.256231800	S1	0.090280700	e Eccentricity
0.000000000	S2	0.000000000	S2	0.000000000	S2	0.000000000	
0.000000000	S3	0.000000000	S3	0.000000000	S3	0.000000000	
108.2925000	S4	106.6641667	S4	267.6850000	S4	138.7733333	M Mean Anomaly
7820.365556	S5	7806.531667	S5	8256.081111	S5	9924.931111	
0.000000000	S6	0.000000000	S6	0.000000000	S6	0.000000000	

The following Listing are the Orbital Elements for the Four Major Asteroids that will run with the BASIC program listed elsewhere in this issue .

```
2995 REM ASTEROID ORBITAL ELEMENTS FOR USE WITH
2996 REM       MATRIX NATAL PROGRAM
2997 REM
2999 REM CERES
3000 DATA108.2925,7820.365556,0,.0794314,0,0,2.7672273,71.07944444
3010 DATA0,0,80.23555556,1.396011111,0,10.59694444,0,0
3019 REM PALLAS
3020 DATA106.6641667,7806.531667,0,.2347096
3030 DATA0,0,2.7704955,310.1661111,0,0
3040 DATA172.4972222,1.396011111,0,34.81416667,0,0
3049 REM JUNO
3050 DATA267.685,8256.081111,0,.2562318,0,0,2.6689897
3060 DATA245.3752778,0,0,170.1377778,1.396011111,.000308333
3070 DATA13.01694444,0,0
3079 REM VESTA
3080 DATA138.7733333,9924.931111,0,.0902807,0,0
3090 DATA2.360723,149.6386111,0,0,103.2197222,1.396011111,.000308333
3100 DATA7.139444444,0,0
```

ORBITAL ELEMENTS FOR THE PLANET (PLANETOID?) CHIRON

Editors note: Many of us will want to experiment with the positions of Chiron. Letters to Malcolm Dean of PHENOMENA (who is in the process of publishing a very accurate ephemeris of Chiron) and to James Neely brought this response:

From Malcolm Dean: " I enclose below the elements for Chiron... from the Minor Planet Circular 4346...and they do not include the 1894 April 24 observation. The circular indicates that Chiron approached Saturn to within 0.1 AU in — 1664, and its orbit appears 'rather stable for at least 5500 years.' Perihelion is given as 8.5 AU and aphelion is given as 18.9 AU.

Epoch 1977 September 14.0 ET = JDE 2443400.5
(1950.0)

M = 229.07217 ω = 339.10361 -0.98945538 +0.13275719
N = 0.0.944642 Ω = 208.71456 -0.10978528 -0.94823260
Semi-Major Axis = 13.6954465 =
Eccentricity = 0.3786034 i = 6.92293 -0.09447352 -0.28849691
G = 6.0

I'm still waiting with baited breath for our senior astronomer to debug his program. Meanwhile, our junior astronomer is preparing the subroutines which will churn out the geo and helio positions to equinox of date, and Eric Tarkington is working with a computor advisor who will handle interfacing with a Diablo printer."

From James Neely: " The Chiron elements are the result of trying to help Malcolm Dean get his ephemeris on the road. They seem to agree with published observations moderately well, but the Marsden data that Malcolm sent me is not completely explained, so I haven't been able to do any better. In any case it was not to the 0'.1 that Malcolm wanted, and such methods can never be that precise. In the data that I'm enclosing, a linear term in the semimajor axis is omitted since my HP-67/97 program [in this issue] and the 1900-2000 year program make no provisio for a linear correction to that element. With the correction, I got aggreement to within 1^m of Right Ascension over the period of 1937 to 1976, but was off by 5^m of R.A. for the 1895 datum. I dont know what happens without that term though. If you want to try to fine tune the semimajor axis, pick a value of T and use a = 13.66975144 + 0.032745259T."

Here are the elements ready to run on the BASIC program in this issue: (Below) and the HP-67/97 Storage Registers (on the right).

BASIC PROGRAM DATA

```
4000 DATA 34,6127752,713.5756219,0
4010 DATA .382270369,-.004694073,0
4020 DATA 13.66975144,337.407213
4030 DATA 2.163306646,0,208.1482658
4040 DATA 1.247724355,0,6.911179715
4050 DATA .011236955,0
```

HP-67/97 STORAGE

```
R1= 208.1482658 Ω
R2= 1.247724355
R4= 6.911179715 i
R5= 0.011236955
R7= 337.4072130 ω
R8= 2.163306646
S0= 13.66975144 a
S1= 0.382270369 e
S2=-0.004694073
S4= 34.61277520 M
S5= 713.5756219
```


Planetary Coordinates on the Hewlett-Packard HP-67/97 Programmables

by James Neely
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[Editor's note: The following program will calculate the heliocentric rectangular, heliocentric ecliptic and heliocentric equatorial coordinates and the geocentric rectangular, geocentric ecliptic and geocentric equatorial coordinates for the nine planets. The data cards contain constants (planetary orbital elements) that are appropriate for constructing charts within a span of many centuries. The reader will find a discussion of planetary elements elsewhere in this issue. In that article is the set of "Neely Values" for very accurate outer body calculation for the 20th century only and these may be substituted for those elements listed here.]

Program Description, Equations, Variables: Compute:

Mean Anomaly, $M = m_0 + m_1T + m_2T^2$, and

Eccentricity, $e = e_0 + e_1T + e_2T^2$. Solve Kepler's Equation $M = E - e \sin E$ for the eccentric anomaly E by the Newton-Raphson Method. The $X_\omega = a(\cos E - e)$ and $Y_\omega = a \sin E\sqrt{1-e}$ are the perifocal coordinates, where a is the Semimajor Axis. The Classical Orientation Angles are the Argument of Perigee $\omega = \omega_0 + \omega_1T + \omega_2T^2$, the orbital Inclination $i = i_0 + i_1T + i_2T^2$, & the Longitude of the Ascending Node $\Omega = \Omega_0 + \Omega_1T + \Omega_2T^2$. The Heliocentric Rectangular Coordinates are:

$$\begin{pmatrix} X_H \\ Y_H \\ Z_H \end{pmatrix} = \begin{pmatrix} \cos\Omega & -\sin\Omega & 0 \\ \sin\Omega & \cos\Omega & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 1 & 0 \\ 0 & \cos i & -\sin i \\ 0 & \sin & \cos i \end{pmatrix} \begin{pmatrix} \cos\omega & -\sin\omega & 0 \\ \sin\omega & \cos\omega & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} X_\omega \\ Y_\omega \\ 0 \end{pmatrix}$$

The Geocentric Rectangular Coordinates are $X_G = X_H + X_{SUN}$; $Y_G = Y_H + Y_{SUN}$ & $Z_G = Z_H + Z_{SUN}$. m_i, e_i, ω_i, i_i, Ω_i, i=0,1,2 and a are input from data cards. 'T' is described in the introductory article on Planet's Positions elsewhere in this issue. $R = \sqrt{X^2+Y^2+Z^2}$ is the distance of the body, $\lambda = \tan^{-1}(Y/X)$ is the Ecliptic Longitude, and $\beta = \sin^{-1}(Z/R)$ is the Ecliptic Latitude. The Equatorial coordinates are: $X_E = X$, $Y_E = Y \cos\varepsilon - Z \sin\varepsilon$, $Z_E = Y \sin\varepsilon + Z \cos\varepsilon$, then Right Ascension $\alpha = \tan(Y_E/X_E)$ & Declination $\delta = \sin^{-1}(Z_E/R)$.

OPERATING LIMITS AND WARNINGS: Two-Body theory is only an approximation since the effects of all other bodies are neglected. The user should spot ckeck the accuracy of this program against an ephemeris for the general period of interest.

PLANETARY COORDINATES on the HP-67/97

Sample Problem: For 0148 hours GMT on April 20, 1976, the following data is calculated for Mars. (Notes: (1) ε_0= 23°26' 33" from Astro I (MATRIX issue ONE), (2) DSP4 to observe more figures, (3) Execute the Earth/Sun Card, then the Mars card)

HELIOCENTRIC COORDINATES:

Rectangular: X_H = -1.3017 AU; Y_H= 1.0303 AU; Z_H = 0.0536 AU

Ecliptic: R = 1.6609 AU; λ = 141°38'19", β = 1°50'54"

Equatorial: R = 1.6609 AU; α = 9h38m32s; δ = 16°02'36"

Ecliptic (with [H] [CF] [0]): R = 1.6609 AU; λ = 141°38'19", 5th Sign, 21°LEO 38'19"; β = 1°50'54"

GEOCENTRIC COORDINATES:

Rectangular: X_G = -0.4325 AU; Y_G = 1.5344 AU; Z_G = 0.0536 AU

Ecliptic: R = 1.5951 AU; λ = 105°44'30"; β = 1°55'29"

Equatorial: R = 1.5951 AU; α = 7h09m18s; δ = 24°25'30"

Ecliptic (with [H] [CF] [0]): R= 115951 AU; λ = 105°44'30", 4th Sign, 15°CANCER 44'30"; β = 1°55'29"

In case of trouble, check the following data obtained from Astro I: RCLA — T = 0.763000000; RCLB — ε = 23.4424 . Proper Data Card preparation for each planet can be verified by computing the heliocentric rectangular coordinates given here below. FLAG 2 MUST be ON prior to Earth/Sun execution (Set FLAG 2 before writing the data card for the Earth/Sun).

To VERIFY the planetary program cards produced from the DATA PAGE proceed as follows:

Execute ASTRO I for April 30, 1976, at 0148 GMT. The check the contents of registers A & B; they should contain T = 0.763000000 & 23.44236508°= ε_0 respectively. Next enter the planetary coordinate program (Program Listing I & II). Then, to check each card, the sequence is: [f] [C] 16.0000 (enter data card). When the computation stops with 0.00 (or 0.0000) in the display, proceed to exhibit the Heliocentric Rectangular Coordinates: [D] X_H [HR↓] Y_H [HR↓] Z_H.

The following results should be observed:

Planet	X_H	Y_H	Z_H
Earth/Sun	-0.8692	-0.5042	0.0000
Mercury	-0.1685	0.2735	0.0379
Venus	0.7194	-0.0957	-0.0428
Mars	-1.3017	1.0303	0.0536
Jupiter	3.9754	2.9786	-0.1011
Saturn	-4.9812	7.6035	0.0671
Uranus	-15.0593	-10.8284	0.1545
Neptune	-9.4675	-28.8313	0.8105
Pluto	-28.8504	-5.2996	8.9232

REPEATED NOTE: FLAG 2 must be SET when Earth/Sun Card is recorded.

USER INSTRUCTIONS:	KEYS	OUTPUT
1A Execute Astro I (for those who do not have a copy of Astro I, the value of "T" should be stored in register A and the obliquity of the ecliptic (in degrees and decimal fraction) should be stored in register B)		
B (OPTIONAL- To correct the obliquity for nutation, execute Astro II) Astro I & II were listed in MATRIX issue One.		
2 ENTER Planetary Coordinate Program (both sides)		
3A Prepare to merge (enter) a Data Card	[F] [C]	
B While 16.00 shows in the display, insert a planetary data card (the Earth/Sun card must be first for Geocentric Coordinates). The 16.00 will display for one-second intervals until the data card is read. (WARNING: In case of a card-reader error, use the following key-stroke sequence to RESTART: [CLX] [GTO4] [R/S]. DO NOT REPEAT STEP 3A since this will exchange the P&S registers).		
4 In ANY sequence, perform the following:		
5 Display Heliocentric Coordinates:		
A Rectangular:	[D]	X_H (AU)
	[H] [R↓]	Y_H (AU)
	[H] [R↓]	Z_H (AU)
B Ecliptic:	[D] [B]	R (AU)
NOTE: The Tropical Zodiac Sign (1= Aries, 2=Taurus, etc.) and Degree-in-Sign will display only after H CF 0 KEYSTROKES.	[R/S]	λ (DDD.MM)
	[R/S]	SIGN
	[R/S]	DEG-IN-SIGN
	[R/S]	β (DD.MM)
C Equatorial:	[D] [C]	R (AU)
	[R/S]	α (HH.MM)
	[R/S]	δ (DD.MM)
6 Display Geocentric Coordinates		
A Rectangular	[E]	X_G (AU)
	[H] [R↓]	Y_G (AU)
	[H] [R↓]	Z_G (AU)
B Ecliptic	[E] [B]	R (AU)
NOTE: Zodiac Sign & Deg-in-Sign will display if FLAG 0 is cleared (OFF).	[R/S]	λ (DDD.MM)
	[R/S]	SIGN
	[R/S]	DEG-IN-SIGN

USER INSTRUCTIONS (continued)

	KEYS	OUTPUT
6 Display Geocentric Coordinates		
B Ecliptic	R/S	β (DD.MM)
C Equatorial	E C	R (AU)
	R/S	α (HH.MM)
	R/S	δ (DD.MM)

7 REPEAT from STEP 3A for a NEW PLANET

REVISION for SIDEREAL LONGITUDES

This first revision of 00211D incorporates a rewriting of much of the program logic so that ecliptic longitudes may be displayed in the Sidereal system in addition to the more familiar Tropical system. The sidereal longitude is computed by adding the Synetic Vernal Point (SVP) to the Tropical longitude. The SVP is computed and stored by Astro 2 (MATRIX ONE, HP-USER SOLUTIONS:ASTROLOGY)

Sample Problem: Continue problem given above by computing the sidereal coordinates of Mars in both the heliocentric and geocentric coordinate systems. Use the Sign and Deg-In-Sign display. (NOTE: Both Astro I and Astro II must first be executed. For this example do NOT use the obliquity correction for nutation that can be accomplished with Astro 2.)

Solutions:

Heliocentric Sidereal Ecliptic Coordinates:

R= 1.6609 AU; λ_s = 117°14'35", 4th Sign, 27° CANCER 13'35";

β = 1°50'54"

Geocentric Sidereal Ecliptic Coordinates: R = 1.5951 AU;

λ_s = 81°19'45"; 3rd Sign, 21°GEMINI19'45"; β = 1°55'29"

REFERENCES: Stahl-Allen, "Synetic Vernal Point Ephemeris", Solunar Research Publications, Bay City, Michigan, 1969

User Instructions:

If the Ecliptic Sidereal option is not desired, use the instructions given on previous page. To use this option, proceed as follows (numeric steps refer to previous page):

Execute steps 1A and 1B to generate the SVP of Astro 2. The nutation correction of Astro 2 is optional.
Perform steps 2,3, and 4 as desired.
To display Heliocentric Ecliptic Sidereal Coordinates:

	D A	R (AU)
NOTE: The Zodiac Sign (1=Aries, 2=Taurus, etc.) and DEGREE-IN-SIGN will display only after CF 0 Keystrokes.	R/S	λ (DDD.MM)
	R/S	SIGN
	R/S	DEG-IN-SIGN
	R/S	β (DD.MM)

To display Geocentric Ecliptic Sidereal Coordinates:

	E B	R (AU)
NOTE: Zodiac Sign and Degree-in-Sign will display if FLAG 0 is clear (OFF).	R/S	λ (DDD.MM)
	R/S	SIGN
	R/S	DEG-IN-SIGN
	R/S	β (DD.MM)

Return to STEP 4 or to STEP 7 as desired

PLANETARY COORDINATES: DATA (One Data Card for each Planet)

REG	EARTH/ SUN	MERCURY	VENUS	MARS	JUPITER	
01	0.0	47.14594444	75.77964722	48.78644167	99.44338611	
02	0.0	1.185208333	0.899850000	0.770991667	1.010530000	Ω
03	0.0	0.000173889	0.000410000	-0.000001389	0.000352222	
04	0.0	7.002880556	3.393630556	1.850333333	1.308736111	
05	0.0	0.001860833	0.001005833	-0.000675000	-0.005696111	i
06	0.0	-0.000018333	-0.000000972	0.000012611	0.000003889	
07	101.2208333	28.75375278	54.38418611	285.4317611	273.2775417	
08	1.719175000	0.370280556	0.508186111	1.069766667	0.599431667	ω
09	0.000452778	0.000120833	-0.001386389	0.000131250	0.000704050	
10	1.000000230	0.387098400	0.723331600	1.523691500	5.202561000	a
11	0.016751040	0.205614210	0.006820690	0.093312900	0.048334750	
12	-0.000041800	0.000020460	-0.000047740	0.000092064	0.000164180	e
13	-0.000000126	-0.000000030	0.000000091	-0.000000077	-0.000004676	
14	358.4758445	102.2793806	212.6032194	319.5294250	225.3283278	
15	35999.04975	149472.5153	58517.80386	19139.85850	3034.692022	M
16	-0.000150278	0.000006389	0.001286056	0.000180806	-0.000721589	

REG	SATURN	URANUS	NEPTUNE	PLUTO	Elements
01	112.7903889	73.47709722	130.6813583	108.9544444	
02	0.873195139	0.498667778	1.098935000	1.396011111	Ω Ascending Node
03	-0.000152181	0.001311667	0.000249867	0.000308333	
04	2.492519444	0.772463889	1.779241667	17.14677778	
05	-0.003918889	0.000625278	-0.009543611	0.0	i Inclination
06	-0.000015489	0.000039500	-0.000009111	0.0	
07	338.3077722	98.07155278	276.0459667	113.5213889	
08	1.085220694	0.985765000	0.325639444	0.0	ω Argument Perihelion
09	0.000978542	-0.001074472	0.000140950	0.0	
10	9.554747000	19.21814000	30.10957000	39.51773800	a Semimajor Axis
11	0.055892320	0.046344400	0.008997040	0.248643800	
12	-0.000345500	-0.000026580	0.000006330	0.0	e Eccentricity
13	-0.000000728	0.000000077	-0.000000002	0.0	
14	175.4662167	72.64881944	37.73066944	229.9472222	
15	1221.551468	428.3791131	218.4613397	144.9130556	M Mean Anomaly
16	-0.000501819	0.000078844	-0.000070333	0.0	

Prepare one Data Card (HP-67/97 Owner's Handbook) for each planet of interest from the data given above. These data cards contain the planetary orbital elements in addresses 1 thru 16 and may be permanently used since they are valid for all dates. If Geocentric Coordinates are desired, then the Earth/Sun data card must be used (once and first) in addition to the other eight cards.

LUNAR COORDINATES for the HP-67/97 Programmable Calculator

by James Neely

[Editor's Note: This program calculates the ecliptic longitude and latitude and/or the right ascension and declination of the Moon in either the Tropical or the Sidereal Zodiac. This program has been adapted to the computer language BASIC and is listed elsewhere in this issue.]

Program Equations, Variables. Computations:

☽ = 973563" + 1732564379"T - 4"T^2; Γ = 1012395" + 6189"T;

Γ' = 1203586" + 14648523T - 37T^2; ☊ = 933060"- 6962911T;

D = 1262655" + 1602961611T ; ℓ=☽-Γ'; L=☽-D; ℓ'=L-Γ; F=☽-☊

Longitude: λ = 22640"sinℓ- 4586"sin(ℓ-2D)+2370"sin2D +769"sin2ℓ
-669"sinℓ'- 412"sin2F -212"sin(2ℓ-2D) -206"sin(ℓ+ℓ'-2D)
+192"sin(ℓ+2D) -165"sin(ℓ'-2D) +148"sin(ℓ-ℓ') -125"sinD
-110"sin(ℓ+ℓ') -55"sin(2F-2D) -45"sin(ℓ+2F)
+40"sin(ℓ-2F) -38"sin(ℓ-4D) +36"sin3ℓ-31"sin(2ℓ-4D)
-29"sin(ℓ-ℓ'-2D) -24"sin(ℓ'+2D) + ☽

Latitude: β = 18461"sinF +1010"sin(ℓ+F) -1000"sin(F-ℓ)
-624"sin(F-2D) +199"sin(F+2D-ℓ) -167"sin(ℓ+F-2D)
+117"sin(F+2D) +62"sin(2ℓ+F) -33"sin(F-2D-ℓ) -32"sin(F-2ℓ)
-30"sin(ℓ'+F-2D)

Parallax: π = 3422".5 +186".5cosℓ +34".3cos(ℓ-2D) +28".2cos(2D)
+10".2cos(2ℓ) +3".1cos(ℓ+2D) +1".9cos(ℓ'-2D) +1".4cos(ℓ+ℓ'-2D)
+1".2cos(ℓ-ℓ') -1".0cosD -1".0cos(ℓ+ℓ') -0".7cos(ℓ-2F)
+0".6cos(3ℓ) +0".6cos(ℓ-4D)

Distance Γ = 6378.388/sinπ km.

NOTE: Both T and ε are computer by Astro I (See MATRIX One)

Equatorial Coordinates

$$\begin{pmatrix} \cos\delta\cos\alpha \\ \cos\delta\sin\alpha \\ \sin\delta \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\varepsilon & -\sin\varepsilon \\ 0 & \sin\varepsilon & \cos\varepsilon \end{pmatrix} \begin{pmatrix} \cos\beta\cos\lambda \\ \cos\beta\sin\lambda \\ \sin\beta \end{pmatrix}$$

Operating Limits: All terms smaller than 20" in Lunar Longitude & Latitude have been neglected, as have all terms smaller than 0".5 of Lunar Parallax.

Sample Problem: For 0148 hours GMT on April 20, 1976 compute the Geocentric Ecliptic and Equatorial Coordinates of the Moon.
NOTE: ε_0 = 23 26'33" is obtained from ASTRO I. If the SVP correction to sidereal longitude is required, then ASTRO 2 must also be executed. Here, ε_0 is used to transform to Equatorial Coordinates. ASTRO 1 & ASTRO 2 are listed in MATRIX One & HP's ASTROLOGY.

LUNAR COORDINATES on the HP-67/97 Programmable Calculator

Sample Solution:

Ecliptic: λ = 285°17'09"; β = 4°42'46"; r = 381812.47 Km

Equatorial: α = 19h04m06s ; δ = -17°52'59"; r = 381812.47 Km

with [H] [CF] [1]

Ecliptic: λ = 285°17'09"; 10th Sign; 15°CAP 17'09"
β = 4°42'46"; r= 381812.47

with [H] [CF] [1] & F E (with ASTRO 2) Sidereal

Ecliptic λ = 260°52'25"; 9th Sign; 20°SAG 52'52";
β = 4°42'46"; r = 381812.47

Reference: P.R. Escobal, "Methods of Astrodynamics", John Wiley & Sons, 1968

	USER INSTRUCTIONS	KEYS	OUTPUT
1A	Execute ASTRO 1 (to get T and ε)		
B	To correct for nutation and/or to convert to sidereal longitudes, execute ASTRO 2. (ASTRO 2 is optional)		
2	Execute Moon Card 1 (ENTER card 1)	[A]	2.
3	ENTER Moon Card 2	[A]	3.
4	ENTER Moon Card 3 (CAUTION: Execute KEY A once only)	[A]	0.00
5	Compute & display Ecliptic Cooridnates	[B]	λ(DDD.MM)
		[R/S]	Sign
	Note: The Zodiac Sign (1=Aries, 2=Taurus, etc) and Degree-in-Sign will display only after [F] [B] *Keystrokes.	[R/S]	DEG-IN-SIGN
		[R/S]	β(±DD.MM)
		[R/S]	r(k.m.)
6	Compute & display Equatorial Coordinates	[C]	α(DDD.MM)
		[R/S]	δ(±DD.MM)
		[R/S]	r(k.m.)
7	For sidereal coordinates, execute this step (ONLY if ASTRO 2 was executed), then execute step 5	[F] [E]	
8	To reset to tropical system if Step 7 has been executed	[F] [A]	

* No Sign & Deg-in-Sign (default) for Sign & Deg-in-Sign.

PLEASE NOTE: Both the Lunar & Planetary Coordinate routines require that ASTRO 1 be executed. For those of you who may not have either a copy of MATRIX issue ONE or the Hewlett-Packard USER-SOLUTIONS book ASTROLOGY (in which both of these programs are listed), you may put the obliquity of the ecliptic for the event time in STOB (1950.0 = 23.44578889) in DEGREES & DECIMAL FRACTION and "T" is STOA. "T" may be computed as follows:

T= (GMT/24)+(JD#— 2415020)— 0.5

Where JD# = Julian Day Number for NOON of event
GMT = Greenwich Mean Time for event

There is no easy substitute to ASTRO 2 for Sidereal Longitude
-editor

PLANETARY COORDINATES

STEP	KEY	CODE	
1	LBL3	21 03	SUBROUTINE TO
2	RCLi	36 45	EVALUATE
3	RCLA	36 11	$A_0+A_1T+A_2T^2$
4	x	-35	
5	DSZI	16 25 46	
6	RCLi	36 45	
7	+	-55	
8	RCLA	36 11	
9	x	-35	
10	DSZI	16 25 46	
11	RCLi	36 45	
12	+	-55	
13	DSZI	16 25 46	
14	RTN	24	
15	LBLc	21 16 13	SET UP TO MERGE
16	P<>S	16-51	A DATA CARD
17	1	01	
18	6	06	
19	STOI	35 46	
20	LBL4	21 04	LOOP UNTIL DATA CARD
21	CF3	16 22 03	HAS BEEN MERGED
22	MRG	16-62	
23	PSE	16 51	
24	F3?	16 23 03	
25	GTO8	22 08	
26	GTO4	22 04	EVALUATE M
27	LBL8	21 08	EVALUATE e
28	GSB3	23 03	
29	GSB3	23 03	
30	P<>S	16-51	
31	STO3	35 02	
32	RLDN	-31	
33	GSB9	23 09	
34	RAD	16-22	
35	D>R	16 45	
36	STO1	35 01	} M IN RADIANS
37	STO2	35 02	
38	DSP7	-63 07	
39	LBL1	21 01	NEWTON-RAPHSON LOOP
40	RCL1	36 01	
41	RCL2	36 02	
42	-	-45	
43	LSTX	16-63	
44	RCL3	36 03	
45	P>R	44	
46	1	01	
47	-	-45	
48	RLDN	-31	
49	+	-55	
50	RLUP	16-31	
51	/	-24	
52	ST-2	35-45 02	
53	RND	16 24	LOOP IF
54	X#0?	16-42	NOT CONVERGED
55	GTO1	22 01	
56	1	01	

STEP	KEY	CODE	
57	9	09	
58	STOI	35 46	a sin E
59	RCL2	36 02	&
60	RCL0	36 00	a cos E
61	P>R	44	
62	RCL3	36 03	}ae
63	RCL0	36 00	
64	x	-35	
65	-	-45	X_ω=a(cosE-e)
66	X><Y	-41	
67	1	01	
68	RCL3	36 03	
69	X2	53	
70	-	-45	
71	SQRX	54	Y_ω=a sinE$\sqrt{1-e^2}$
72	x	-35	
73	X><Y	-41	
74	DEG	16-21	
75	R>P	34	
76	X><Y	-41	
77	GSB3	23 03	COMPUTE & ROTATE
78	+	-55	THRU ω
79	X><Y	-41	
80	P>R	44	
81	STO4	35 04	
82	CLX	-51	
83	X><Y	-41	
84	R>P	34	
85	X><Y	-41	
86	GSB3	23 03	}ROTATE THRU i
87	+	-55	
88	X><Y	-41	
89	P>R	44	
90	X><Y	-41	
91	STO3	35 02	
92	CLX	-51	
93	RCL4	36 04	
94	R>P	34	
95	X><Y	-41	
96	GSB3	23 03	}ROTATE THRU Ω
97	+	-55	
98	X><Y	-41	
99	P>R	44	
100	STO1	35 01	X_H
101	X><Y	-41	Y_H
102	STO2	35 02	
103	F2?	16 23 02	1st PLANET? SUN?
104	GTO5	22 05	
105	RCL1	36 01	
106	RCL7	36 07	COMPUTER GEOCENTRIC
107	-	-45	COORDINATES
108	STO4	35 04	OF PLANET
109	RCL2	36 02	
110	RCL8	36 08	
111	-	-45	
112	STO5	35 05	

HP-97 PLANETARY COODINATES (PAGE 2)

STEP	KEY	CODE	
112	STO5	35 05	
113	RCL3	36 03	
114	RCL9	36 09	
115	-	-45	
116	STO6	35 06	DISPLAY 0
117	0	00	
118	R/S	51	
119	GTO0	22 00	ERROR
120	LBL5	21 05	
121	RCL1	36 01	FIRST DATA CARD
122	STO7	35 07	ASSUME EARTH/SUN
123	CHS	-22	STORE HELIOCENTRIC
124	STO4	35 04	COORDINATES OF
125	RCL2	36 02	EARTH AND
126	STO8	35 08	GEOCENTRIC
127	CHS	-22	COORDINATES OF SUN
128	STO5	35 05	
129	RCL3	36 03	
130	STO9	35 09	
131	CHS	-22	
132	STO6	35 06	
133	0	00	DISPLAY 0
134	R/S	51	
135	LBLE	21 15	
136	DSP4	-63 04	RECALL GEOCENTRIC
137	RCL6	36 06	RECTANGULAR
138	RCL5	36 05	COORDINATES
139	RCL4	36 04	
140	R/S	51	
141	LBLD	21 14	RECALL HELIOCENTRIC
142	DSP4	-63 04	RECTANGULAR
143	RCL3	36 03	COORDINATES
144	RCL2	36 02	
145	RCL1	36 01	
146	R/S	51	
147	LBLC	21 13	
148	SF3	16 21 03	PREPARE TO XFRM
149	STO0	35 00	TO EQUATORIAL
150	RLDN	-31	COORDINATES
151	R>P	34	
152	X><Y	-41	
153	RCLB	36 12	
154	+	-55	ROTATE THRU ε
155	X><Y	-41	
156	P>R	44	
157	RCL0	36 00	
158	GSB2	23 02	CONVERT DEGREES
159	>HMS	16 35	TO HH.MM &
160	R/S	51	DISPLAY α
161	GTO7	22 07	
162	LBLB	21 12	TROPICAL/SIDEREAL?
163	SF3	16 21 03	
164	LBLA	21 11	SIDEREAL ECLIPTIC
165	GSB2	23 02	
166	>HMS	16 35	
167	R/S	51	DISPLAY λ DDD.MM

STEP	KEY	CODE	
168	F0?	16 23 00	
169	GTO7	22 07	
170	ENT	-21	
171	ENT	-21	
172	3	03	
173	0	00	
174	/	-24	
175	INT	16 34	
176	1	01	
177	+	-55	
178	R/S	51	DISPLAY SIGN
179	1	01	
180	-	-45	
181	3	03	
182	0	00	
183	x	-35	DISPLAY
184	-	-45	DEG-IN-SIGN
185	R/S	51	
186	LBL7	21 07	
187	RLDN	-31	
188	>HMS	16 35	DISPLAY
189	R/S	51	δ OR β
190	GTO0	22 00	ERROR
191	LBL2	21 02	
192	R>P	34	
193	X><Y	-41	
194	RLDN	-31	
195	R>P	34	
196	R/S	51	DISPLAY R
197	DSP2	-63 02	
198	X><Y	-41	
199	RLUP	16-31	
200	RCLE	36 15	TROPICAL OR
201	F3?	16 23 03	SIDEREAL?
202	CLX	-51	
203	+	-55	
204	LBL9	21 09	SUBROUTINE TO
205	3	03	ASSURE ANGLE IS
206	6	06	BETWEEN
207	0	00	0° & 360°
208	/	-24	
209	LSTX	16-63	
210	X><Y	-41	
211	FRC	16 44	
212	1	01	
213	+	-55	
214	FRC	16 44	
215	x	-35	
216	RTN	24	
217	LBLa	21 16 11	SETUP FOR SIGN
218	CF0	16 22 00	& DEG-IN-SIGN
219	RTN	24	
220	R/S	51	

LUNAR COORDINATES CARD ONE

STEP	KEY	CODE	
1	LBLA	21 11	PRINCIPAL ARGUMENTS
2	4	04	ONLY ARE KEYED ON
3	CHS	-22	CARDS 1&2
4	RCLA	36 11	in the comments
5	x	-35	
6	1	01	
7	7	07	
8	3	03	
9	2	02	
10	5	05	
11	6	06	
12	4	04	
13	3	03	
14	7	07	
15	9	09	
16	+	-55	
17	RCLA	36 11	
18	x	-35	
19	9	09	
20	7	07	
21	3	03	
22	5	05	
23	6	06	
24	3	03	
25	+	-55	
26	STO7	35 07	
27	6	06	
28	1	01	
29	8	08	
30	9	09	
31	RCLA	36 11	
32	x	-35	
33	1	01	
34	0	00	
35	1	01	
36	2	02	
37	3	03	
38	9	09	
39	5	05	
40	+	-55	
41	CHS	-22	
42	STO1	35 01	
43	3	03	
44	7	07	
45	RCLA	36 11	
46	x	-35	
47	1	01	
48	4	04	
49	6	06	
50	4	04	
51	9	09	
52	5	05	
53	2	02	
54	3	03	
55	-	-45	
56	RCLA	36 11	
57	x	-35	
58	1	01	
59	2	02	
60	0	00	
61	3	03	
62	5	05	
63	8	08	
64	6	06	
65	-	-45	
66	STO0	35 00	
67	6	06	
68	9	09	
69	6	06	
70	2	02	
71	9	09	
72	1	01	
73	1	01	
74	RCLA	36 11	
75	x	-35	
76	9	09	
77	3	03	
78	3	03	
79	0	00	
80	6	06	
81	0	00	
82	-	-45	
83	STO2	35 02	
84	1	01	
85	6	06	
86	0	00	
87	2	02	
88	9	09	
89	6	06	
90	1	01	
91	6	06	
92	1	01	
93	1	01	
94	RCLA	36 11	
95	x	-35	
96	1	01	
97	2	02	
98	6	06	
99	2	02	
100	6	06	
101	5	05	
102	5	05	
103	+	-55	
104	STO3	35 02	D
105	ST-1	35-45 01	-D-
106	RCL7	36 07	
107	ST+0	35-55 00	ℓ
108	ST+1	35-55 01	ℓ'
109	ST+2	35-55 02	F
110	3	03	
111	6	06	
112	0	00	

LUNAR COORDINATES

STEP	KEY	CODE	
113	0	00	
114	STO4	35 04	
115	ST/0	35-24 00	
116	ST/1	35-24 01	
117	ST/2	35-24 02	
118	ST/3	35-24 03	
119	RCL0	36 00	
120	SIN	41	SIN ℓ
121	2	02	
122	2	02	
123	6	06	
124	4	04	
125	0	00	
126	x	-35	
127	ST+7	35-55 07	
128	RCL0	36 00	
129	COS	42	COS ℓ
130	1	01	
131	8	08	
132	6	06	
133	5	05	
134	x	-35	
135	STO9	35 09	
136	RCL3	36 03	
137	SIN	41	SIN D
138	1	01	
139	2	02	
140	5	05	
141	x	-35	
142	ST-7	35-45 07	
143	RCL3	36 03	
144	ST+3	35-55 03	2 D
145	COS	42	COS D
146	1	01	
147	0	00	
148	x	-35	
149	ST-9	35-45 09	
150	RCL0	36 00	
151	RCL3	36 03	
152	-	-45	ℓ-2D
153	ENT	-21	
154	ENT	-21	
155	SIN	41	
156	4	04	
157	5	05	
158	8	08	
159	6	06	
160	x	-35	
161	ST-7	35-45 07	
162	RLDN	-31	
163	COS	42	
164	3	03	
165	4	04	
166	3	03	
167	x	-35	
168	ST+9	35-55 09	
169	RLDN	-31	
170	RCL1	36 01	
171	+	-55	ℓ'+ℓ-2D
172	ENT	-21	
173	SIN	41	
174	2	02	
175	0	00	
176	6	06	
177	x	-35	
178	ST-7	35-45 07	
179	RLDN	-31	
180	COS	42	
181	1	01	
182	4	04	
183	x	-35	
184	ST+9	35-55 09	
185	RCL3	36 03	2D
186	SIN	41	
187	2	02	
188	3	03	
189	7	07	
190	0	00	
191	x	-35	
192	ST+7	35-55 07	
193	RCL3	36 03	
194	COS	42	
195	2	02	
196	8	08	
197	2	02	
198	x	-35	
199	ST+9	35-55 09	
200	RCL0	36 00	
201	RCL3	36 03	
202	+	-55	ℓ+2D
203	ENT	-21	
204	SIN	41	
205	1	01	
206	9	09	
207	2	02	
208	x	-35	
209	ST+7	35-55 07	
210	RLDN	-31	
211	COS	42	
212	3	03	
213	1	01	
214	x	-35	
215	ST+9	35-55 09	
216	RCL1	36 01	ℓ'
217	SIN	41	
218	6	06	
219	6	06	
220	9	09	
221	x	-35	
222	ST-7	35-45 07	
223	2	02	
224	R/S	51	DISPLAY 2. CUE

LUNAR COORDINATES CARD TWO (PAGE 1)

STEP	KEY	CODE	
1	LBLA	21 11	
2	RCL0	36 00	
3	ENT	-21	
4	+	-55	2 ℓ
5	ENT	-21	
6	ENT	-21	
7	SIN	41	
8	7	07	
9	6	06	
10	9	09	
11	x	-35	
12	ST+7	35-55 07	
13	RLDN	-31	
14	COS	42	
15	1	01	
16	0	00	
17	2	02	
18	x	-35	
19	ST+9	35-55 09	
20	RLDN	-31	
21	RCL2	36 02	
22	+	-55	2ℓ+F
23	SIN	41	
24	6	06	
25	2	02	
26	x	-35	
27	STO8	35 08	
28	RCL0	36 00	
29	ENT	-21	
30	+	-55	
31	RCL3	36 03	
32	-	-45	2ℓ-2D
33	ENT	-21	
34	SIN	41	
35	2	02	
36	1	01	
37	2	02	
38	x	-35	
39	ST-7	35-45 07	
40	RLDN	-31	
41	RCL3	36 03	2ℓ-4D
42	-	-45	
43	SIN	41	
44	3	03	
45	1	01	
46	x	-35	
47	ST-7	35-45 07	
48	RCL1	36 01	
49	RCL3	36 03	
50	-	-45	ℓ'-2D
51	ENT	-21	
52	ENT	-21	
53	SIN	41	
54	1	01	
55	6	06	
56	5	05	
57	x	-35	
58	ST-7	35-45 07	
59	RLDN	-31	
60	COS	42	
61	1	01	
62	9	09	
63	x	-35	
64	ST+9	35-55 09	
65	RLDN	-31	
66	RCL2	36 02	
67	+	-55	ℓ'-2D+F
68	SIN	41	
69	3	03	
70	0	00	
71	x	-35	
72	ST-8	35-45 08	
73	RCL0	36 00	
74	RCL1	36 01	
75	-	-45	ℓ-ℓ'
76	ENT	-21	
77	ENT	-21	
78	SIN	41	
79	1	01	
80	4	04	
81	8	08	
82	x	-35	
83	ST+7	35-55 07	
84	RLDN	-31	
85	COS	42	
86	1	01	
87	2	02	
88	x	-35	
89	ST+9	35-55 09	
90	RLDN	-31	
91	RCL3	36 03	
92	-	-45	ℓ-ℓ'-2D
93	SIN	41	
94	2	02	
95	9	09	
96	x	-35	
97	ST-7	35-45 07	
98	RCL0	36 00	
99	RCL1	36 01	ℓ+ℓ'
100	+	-55	
101	ENT	-21	
102	SIN	41	
103	1	01	
104	1	01	
105	0	00	
106	x	-35	
107	ST-7	35-45 07	
108	RLDN	-31	
109	COS	42	
110	1	01	
111	0	00	
112	x	-35	

LUNAR COORDINATES CARD TWO (PAGE 2)

STEP	KEY	CODE	
113	ST-9	35-45 09	
114	RCL0	36 00	
115	3	03	
116	x	-35	3ℓ
117	ENT	-21	
118	SIN	41	
119	3	03	
120	6	06	
121	x	-35	
122	ST+7	35-55 07	
123	RLDN	-31	
124	COS	42	
125	6	06	
126	x	-35	
127	ST+9	35-55 09	
128	RCL0	36 00	
129	RCL3	36 03	
130	ENT	-21	
131	+	-55	
132	-	-45	ℓ-2ℓ'
133	ENT	-21	
134	SIN	41	
135	3	03	
136	8	08	
137	x	-35	
138	ST-7	35-45 07	
139	RLDN	-31	
140	COS	42	
141	6	06	
142	x	-35	
143	ST+9	35-55 09	
144	RCL2	36 02	F
145	SIN	41	
146	1	01	
147	8	08	
148	4	04	
149	6	06	
150	1	01	
151	x	-35	
152	ST+8	35-55 08	
153	RCL0	36 00	
154	RCL2	36 02	
155	+	-55	ℓ+F
156	SIN	41	
157	1	01	
158	0	00	
159	1	01	
160	0	00	
161	x	-35	
162	ST+8	35-55 08	
163	RCL2	36 02	
164	RCL3	36 03	
165	-	-45	F-2D
166	ENT	-21	
167	SIN	41	
168	6	06	
169	2	02	
170	4	04	
171	x	-35	
172	ST-8	35-45 08	
173	RLDN	-31	
174	RCL0	36 00	
175	-	-45	F-2D-ℓ
176	SIN	41	
177	3	03	
178	3	03	
179	x	-35	
180	ST-8	35-45 08	
181	RCL2	36 02	
182	RCL3	36 03	
183	+	-55	F+2D
184	ENT	-21	
185	SIN	41	
186	1	01	
187	1	01	
188	7	07	
189	x	-35	
190	ST+8	35-55 08	
191	RLDN	-31	
192	RCL0	36 00	
193	-	-45	F+2D-ℓ'
194	SIN	41	
195	1	01	
196	9	09	
197	9	09	
198	x	-35	
199	ST+8	35-55 08	
200	RCL8	36 08	
201	RCL0	36 00	
202	-	-45	F-ℓ
203	ENT	-21	
204	SIN	41	
205	EEX	-23	
206	3	03	
207	x	-35	
208	ST-8	35-45 08	
209	RLDN	-31	
210	RCL0	36 00	
211	-	-45	F-2ℓ
212	SIN	41	
213	3	03	
214	2	02	
215	x	-35	
216	ST-8	35-45 08	
217	3	03	
218	R/S	51	

LUNAR COORDINATES CARD THREE (PAGE 3)

STEP	KEY	CODE		STEP	KEY	CODE	
1	LBLA	21 11		57	5	05	
2	RCL1	36 01		58	5	05	
3	RCL3	36 03	ℓ'+2D	59	x	-35	
4	+	-55		60	ST-7	35-45 07	
5	SIN	41		61	RCL8	36 08	
6	2	02		62	RCL4	36 04	
7	4	04		63	/	-24	
8	x	-35		64	6	06	
9	ST-7	35-45 07		65	3	03	
10	RCL0	36 00		66	7	07	EARTH'S
11	RCL2	36 02		67	8	08	EQUATORIAL
12	+	-55		68	.	-62	RADIUS IN
13	RCL3	36 03		69	3	03	KILOMETERS
14	-	-45	ℓ+F-2D	70	8	08	
15	SIN	41		71	8	08	
16	1	01		72	RCL9	36 09	
17	6	06		73	3	03	
18	7	07		74	4	04	
19	x	-35		75	2	02	
20	ST-8	35-45 08		76	2	02	
21	RCL2	36 02		77	5	05	
22	ENT	-21		78	+	-55	CONVERT π TO "
23	+	-55	2F	79	1	01	
24	STO2	35 02		80	0	00	
25	SIN	41		81	/	-24	
26	4	04		82	RCL4	36 04	CONVERT π TO
27	1	01		83	/	-24	DEGREES
28	2	02		84	SIN	41	
29	x	-35		85	/	-24	
30	ST-7	35-45 07		86	P>R	44	
31	RCL0	36 00		87	RCL7	36 07	
32	RCL2	36 02		88	RCL4	36 04	
33	-	-45	ℓ-2F	89	/	-24	
34	ENT	-21		90	X><Y	-41	
35	SIN	41		91	P>R	44	CONVERT TO
36	4	04		92	STO7	35 07	RECTANGULAR
37	0	00		93	RLDN	-31	COORDINATES
38	x	-35		94	STO8	35 08	AND STORE
39	ST+7	35-55 07		95	RLDN	-31	
40	RLDN	-31		96	STO9	35 09	
41	COS	42		97	0	00	
42	7	07		98	R/S	51	
43	x	-35		99	GTO0	22 00	
44	ST-9	35-45 09		100	LBL1	21 01	RECALL
45	RCL0	36 00		101	RCL9	36 09	RECTANGULAR
46	RCL2	36 02	ℓ+2F	102	RCL8	36 08	COORDINATES
47	+	-55		103	RCL7	36 07	
48	SIN	41		104	RTN	24	
49	4	04		105	LBL2	21 02	
50	5	05		106	R>P	34	CONVERSION TO
51	x	-35		107	X><Y	-41	SPHERICAL
52	ST-7	35-45 07		108	RLDN	-31	
53	RCL2	36 02		109	R>P	34	
54	RCL3	36 03		110	STO5	35 05	
55	-	-45	2F-2D	111	X><Y	-41	
56	SIN	41		112	RLUP	16-31	

LUNAR COORDINATES CARD THREE (PAGE 2)

STEP	KEY	CODE		STEP	KEY	CODE	
113	RTN	24		169	3	03	
114	LBL3	21 03	CONVERT ANGLES	170	0	00	
115	3	03	TO 0°-360°	171	x	-35	DISPLAY
116	6	06	RANGE	172	-	-45	DEG-IN-SIGN
117	0	00		173	R/S	51	
118	+	-55		174	LBL5	21 05	DISPLAY β OR δ
119	LSTX	16-63		175	RLDN	-31	
120	/	-24		176	>HMS	16 35	
121	LSTX	16-63		177	R/S	51	
122	X><Y	-41		178	RCL5	36 05	DISPLAY r
123	FRC	16 44		179	R/S	51	
124	x	-35		180	LBL0	21 00	ERROR
125	RTN	24		181	0	00	ROUTINE
126	LBLC	21 13		182	/	-24	
127	GSB1	23 01	EQUATORIAL	183	GTO0	22 00	
128	STO6	35 06	COORDINATE	184	LBLe	21 16 15	SIDEREAL SET
129	RLDN	-31	ROUTINE	185	CF0	16 22 00	
130	R>P	34		186	R/S	51	
131	X><Y	-41		187	LBLa	21 16 11	TROPICAL SET
132	RCLB	36 12		188	SF0	16 21 00	
133	+	-55		189	R/S	51	
134	X><Y	-41		190	LBLb	21 16 12	SET SIGN OFF
135	P>R	44		191	CF1	16 22 01	
136	RCL6	36 06		192	R/S	51	
137	GSB2	23 02		193	LBLc	21 16 13	SET SIGN ON
138	GSB3	23 03		194	SF1	16 21 01	
139	1	01		195	R/S	51	
140	5	05					
141	/	-24					
142	>HMS	16 35					
143	R/S	51	DISPLAY α				
144	GTO5	22 05					
145	LBLB	21 12					
146	GSB1	23 01	ECLIPTIC				
147	GSB2	23 02	COORDINATE				
148	F0?	16 23 00	ROUTINE				
149	GTO4	22 04					
150	RCLE	36 15					
151	+	-55					
152	LBL4	21 04					
153	GSB3	23 03					
154	>HMS	16 35					
155	R/S	51	DISPLAY λ				
156	F1?	16 23 01					
157	GTO5	22 05					
158	ENT	-21					
159	ENT	-21					
160	3	03					
161	0	00					
162	/	-24					
163	INT	16 34					
164	1	01					
165	+	-55					
166	R/S	51	DISPLAY SIGN				
167	1	01					
168	-	-45					

NOTE: As I am going out the door to the printers..here comes the mail with a fascinating letter from Ian Mckinnon who has been digging deep into the Astronomy/Physics literature. Among other things he sends some relevent material on the Mean Element approach to planetary positions...including list for all of the planets (Pluto too!) for Epoch 1950.0

It is too late to make this issue but we will have it in the next.

It is so good to be sharing this information and to get aquainted with the energy and research of other astro-computing individuals!

— Editor

PROGRAM FOR THE PLANETS POSITIONS IN THE BASIC LANGUAGE

Here is a simple planetary program written in Extended BASIC that will run on either the PET or the TRS-80 (any BASIC with trig functions and some string handling...Level II BASIC on the TRS-80). This program will run in well under 8K memory.

In the future we will be publishing more powerful programs that have greater accuracy..but for starters, this is by far better than not having a planetary program. I will spare the readers the kind of interesting story of the many astrologers who possess large computer programs who said "No" to your editor when asked to contribute these listings to MATRIX...and thus putting this material once and for all into the public domain. Let me say that we all owe great thanks first of all to James Neely, Robert Hand and Ian McKinnon for their efforts to make this information available and secondly to all of the many readers who have supported our quest to make these programs available to all astrologers regardless of any attached 'strings'.

ACCURACY OF THIS PROGRAM

The accuracy is identical to the other programs listed in this issue (HP-67/97 and TI-59) or in other words...about 1' of arc for the majority of the planets...and 3-4' of arc for the outer planets with the exception of Uranus..where for some reason the position can be off as much as 18' in some cases. As mentioned in MATRIX ONE, we have every reason to expect that the continued work of James Neely will refine these outer body positions to within the 1' of arc or better. We will keep readers updated with more accurate values...as they come along.

The following program should be a lot of fun for readers just beginning to learn the computer language BASIC to pick thru. There is something pretty special about the moment any astrologer first succeeds in getting a planetary program running on a machine—whether or no he or she has written the program. Entering a program this size is filled with opportunities for errors and the best advice seems to be: enter the program from the listings into your machine and when finished proceed to read thru the listing and check each line against the program line in your display screen. Next step is to attempt to run the program and note where it fouls up. From there on out until the program runs smoothly can be a little or a lot of work for you. We have included a sample run as well as some of the intermediate results that may help if push comes to shove. I have had to (upon occaision) break a program down and print each and every intermediate variable arrived at. The very best of luck to you...and my telephone number in Ann Arbor is 1-313-663-6677 and feel free to give me a buzz if need be.

USER-INSTRUCTIONS

This program accepts the standard event information (detailed below) used by astrologers and outputs:

Local Sidereal Time (RAMC), the Chart Angles: Ascendant, Midheaven and Vertex, Heliocentric Longitude & Latitude, Geocentric Longitude & Latitude, Right Ascension & Declination, Azimuth & Altitude on the horizon and the equivalents of longitude & latitude along the Prime Vertical (Fagan's Mundoscope), Twelve Koch (GOH) House Cusps & a variety of Locality functions.

PLEASE NOTE: This program incorporates the NEELY VALUES for the outer planets and is good ONLY for this century (1900-2000). See section on the MEAN ORBITAL ELEMENTS for other centuries.

STANDARD EVENT INPUT

The information needed for this program as INPUT: Month, Day and Year of event, Time of Day, Time Zone (in hours), and the Geographic Coordinates for the place of the event. The program prompts the user for the required input. Here is a sample input for your editor's birth on July 18, 1941 at 5:03 PM Eastern Daylight Time (4:03 PM EST) at Lancaster, PA (Longitude 76 W 18, Latitude 40 N 02)

After the program is loaded, press RUN and here is the sequence for INPUT:

```
DATE:MM.DDYYYY=?   07.181941

AM*PM?  PM

TIME:HH.MM?  4.03

TIME ZONE: H? 5

LONGITUDE: DD.MM? 76.18

LATITUDE : DD.MM? 40.02
```

...and thats it! Hit RETURN and you should be in business.

ADDITIONAL NOTES FOR PROPER DATA ENTRY

* This program makes use of the calculator-style numeric keypad available on many terminals. A decimal point '.' is often used to separate data input (as will be explained).
* DATE: MM.DDYYYY? Accepts as input the Month, Day and Year of event in the format MM.DDYYYY where MM is the number of the month from 01 to 12 (12 months in a year),DD is the number of the day of the month from 01 to 31, and YYYY is the year of the event from 1900-2000. Note that the DECIMAL POINT (.) is used to separate the month (MM) from the day (DD) of the event. ALSO:months with a single digit (1 thru 9) MUST have a zero (0) before the digit for the month. Example: Jan = 01, Feb = 02, etc.
* AM*PM? Accepts as input either AM or PM. AM indicates that the event took place between MIDNIGHT of the event calendar date up to (but not including) NOON of that date. PM indicates that the event took place between NOON of the calendar date and up to 12 hours after noon (which would be midnight of the following calendar date).
* TIME:HH.MM? Accepts as input the time of the event in HH.MM format where "HH" are the number of hours after noon (or midnight) and MM are the number of minutes after the hour. NOTE that the decimal point (.) is used to separate the HOURS from the MINUTES. ALSO NOTE: Since all hour entries will be either after AM or PM, you will NEVER have to enter the number 12 as input for the HH prompt. Example a birth at 12:03 PM would be entered as 00.03 or simply .03 and NOT as 12.03.

******* MORE NOTES *******

CARE should be taken to determine if DAYLIGHT SAVINGS TIME or WARTIME were in effect. If this was the case, then ONE HOUR should be subtracted from the event-time and the resulting number entered as input. (my birth is an example).

* TIME ZONE.HH? Accepts as input the number of hours for the time zone in which the event took place. Thus Eastern Standard time = 5 hours, CST = 6 hours, MST = 7 hours and PST = 8 hours. For Time Zones East of Greenwich (Eastern Europe, Russia, etc.) the zone in hours MUST be preceded by a MINUS (—) sign. Example: time zone for Australia is 10 hours East of Greenwich and thus a '— 10' would be entered.

GEOGRAPHIC COORDINATES OF EVENT PLACE

LONGITUDE: DD.MM? Accepts as input the Geographic Longitude in the standard DDD.MM format where DD equals degrees and MM equals minutes of longitude as listed in any World Atlas or along the border of most road maps. Example: The Longitude of Lancaster PA is 76W18 (reads: 76 degrees West 45 minutes) and would be entered as 76.18.

* LATITUDE: DD.MM? Accepts as input the Geographic Latitude in DD.MM format where DD equals degrees and MM equals minutes of geographic latitude. Example: Lancaster, PA has a latitude of 40N02 (reads: 40 degrees North 02 minutes) and would be entered as 40.02.

NOTES TO GEOGRAPHIC COORDINATES: For longitudes EAST of Greenwich (Russia, etc.) and/or for South latitudes (Australia, etc.), the input MUST be preceded by a minus (—) sign. Example: Brisbane Australia has a geographic longitude of 153E21 and Latitude of 27S28 and would be entered into the program as — 153.21 and — 27.28.

NOTES ON PROGRAM OUTPUT

This program requires that the user be able to READ planetary positions in Absolute Longitude or 360 degree notation. Thus a planet at 25 degrees and 48 minutes of the sign Capricorn would be listed out in 360/decimal notation as 295.8 and so forth. THEREFORE all OUTPUT this program will be in degrees and decimal fraction notation.

SAMPLE OUTPUT FOR INPUT EXAMPLE (given above)

```
NGLES:
A= 175.725395 (RAMC)   ASC= 248.01 (Ascendant)
MC= 175.34 (Midheaven) VTX= 112.12 (Vertex)
```

	HELIO		GEOCENTRIC	
EAR	295.81	0	SUN 115.81	0
MER	333.94	-6.72	MER 97.35	-3.46
VEN	175.24	3.35	VEN 139.93	1.59
MAR	324.36	-1.84	MAR 9.1	-3.69
JUP	63.81	-.77	JUP 71.86	-.68
SAT	50.51	-2.21	SAT 56.02	-2.1
URA	56.79	-.23	URA 59.28	-.22
NEP	177.09	1.28	NEP 175.43	1.26
PLU	123.85	4.37	PLU 123.65	4.26
			MON 53.49	-4.35
			NOD 174.78	0 *

*NOTE: Lunar Node is True Lunar Node and not Mean Lunar Node.

LOCAL SPACE (Horizon System) OPTIONS

After the program has OUTPUT the Angles of the chart and the Helio and Geocentric planet's positions, the following line will be displayed on the display screen of the computer:

```
1=LS 2=SFT 3=^? 4=EQ 5=RUN 6=VER 7=A*D
```

The numbers represent some powerful options that are open to use...in particular in the Local Space dimension. Local Space is a general term that refers to a variety of techniques that relate to the Horizon Coordinate system—literally the Local Space that surrounds an event. Local Space may be differentiated from the Mundane Space of the Equatorial System of Right Ascension and Declination and the Ecliptic or Zodiac Space. Local Space techniques are often used in locality or relocation astrology—where on this earth might be a good place to live?..and so forth. Here is OUTPUT for some of these techniques for the same chart that has been given above.

*PRESS 1 will calculate and list out the Local Space positions of the geocentric planets on the Horizon in Azimuth and Altitude.

	LOCAL SPACE		PRIME VERTICAL	
SUN	183.23	37.59	217.64	-2.56
MER	171.8	21.62	201.82	7.62
VEN	210.2	52.96	236.89	-17.63
MAR	111.22	-47.75	108.2	38.81
JUP	153.94	2.78	183.1	26.03
SAT	146.07	-11.06	166.75	33.22
URA	146.39	-7.31	171.24	33.3
NEP	270.96	52.93	270.72	-37.06
PLU	186.99	46.05	226.27	-4.85
MON	146.49	-14.42	162.86	32.33
NOD	269.16	52.04	269.34	-37.96

*PRESS 6 will list out the positions of the geo planets along the Prime Vertical (Fagan's Mundoscope.

NOTE: Azimuth is measured from the East thru the North to the West, etc. direction...while longitude along the Prime Vertical is measured from the East thru the Nadir to the West to the Zenith and so forth.

*PRESS 2 will set up for a Locality Shift (after option #1 has been run ONLY). Program will prompt user for INPUT of Geographic Longitude & Latitude of new locality. OUTPUT includes the adjusted Angles for the new locality as well as the Azimuth and Altitude of the planets on the horizon for this new locality. Here is an example move to Ann Arbor from Lancaster PA (radix).

```
INPUT LONG=?  83.45 (83W45 for Ann Arbor)
INPUT LAT =?  42.18 (42N18 for Ann Arbor)
ANGLES:
RA= 168.275395        ASC= 240.74
MC= 167.25            VTX= 104.37

SUN  190.62  42.89
MER  177.5   27.41
VEN  222.34  56.15
MAR  120.27 -43.27
JUP  158.83   8.83
SAT  151.12  -5.09
URA  151.37  -1.34
NEP  282.54  50.02
PLU  195.67  51.11
MON  151.59  -8.44
NOD  280.66  49.3
```

*PRESS 3 will prompt input of a Geographic Longitude & Latitude and will OUTPUT the position of that city in Azimuth and Altitude along the Horizon. Both '3' and '6' may be pressed after either options '1' or '2'

*PRESS 4 will list out the Right Ascension and Declination of geocentric planets (Mundane Space)

*PRESS 5 will RUN the program for a new chart.

*PRESS 7 will accept as input the Right Ascension and Declination of any Celestial object and OUTPUT the position of that object on the Horizon in Azimuth and ALtitude. Example: The position of the Galactic Center for Epoch 1950.0

```
INPUT LONG=? 265.36 (R.A. of 265 36')
INPUT LAT =? -28.55 (Decl. of -28 55')

AZI= 337.0
ALT= -18.03
```

NOTE: This option will work after either 1 or 2 has been used. (option#1 in this case)

— Best wishes to all of you with this program and I hope you find it as useful and interesting as we do in our work.

— Editor

```
 MATRIX NATAL PROGRAM  (Authored by Michael Erlewine

      NOTE: PERMISSION TO USE, BUT NOT TO SELL

10 DIM X(12),Y(12),C$(12)
20 DATA EAR,MER,VEN,MAR,JUP,SAT,URA,NEP,PLU,MON,NOD
29 REM CONVERTS SECONDS TO DEGREES WITHIN 360 CIRCLE
30 DEF FNP(X)=SGN(X)*((ABS(X)/M)/360-INT((ABS(X)/M)/360))*360
35 PI=3.14159265
39 REM CONVERTS DEGREES TO RADIANS
40 DEF FNR(X)=X*PI/180
49 REM CONVERTS RADIANS TO DEGREES
50 DEF FND(X)=X*180/PI
59 REM CASTS OUT CIRCLES (WITHIN 360)
60 DEF FNU(X)=X-(INT(X/360)*360)
69 REM CONVERTS DD.MM FORMAT TO DD.DECIMAL FORMAT
70 DEF FNQ(X)=SGN(X)*(INT(ABS(X))+(ABS(X)-INT(ABS(X)))*100/60)
79 REM SINE FUNCTION WHEN WORKING IN DEGREES
80 DEF FNS(X)=SIN(X*PI/180)
89 REM ARCSINE FUNCTION WHEN WORKING IN DEGREES
90 DEF FNX(X)=ATN(X/(1-X*X)^.5)
99 REM ROUNDS TO TWO PLACES
100 DEF FNW(X)=INT(X*100+.5)/100
130 FOR I=1 TO 11:READ C$(I):NEXTI
149 REM INPUT EVENT INFORMATION FROM A NUMBER KEYPAD
150 INPUT "DATE:MM.DDYYYY=";A$:M=VAL(MID$(A$,1,2))
155 Y=VAL(MID$(A$,6,4)):D=VAL(MID$(A$,4,2))
160 INPUT "AM*PM";F$:INPUT "TIME:HH.MM";F
170 INPUT "TIME ZONE: H";X
180 F=FNQ(F)+X:IF F$="PM" THEN F=F+12
190 INPUT "LONGITUDE: DD.MM";LO:LO=FNQ(LO)
200 INPUT "LATITUDE : DD.MM";LA:LA=FNR(FNQ(LA))
209 REM JULIAN DAY NUMBER ROUTINE (USE FOR 1900-2000 ONLY)
210 JD=367*Y-INT(7*(Y+INT((M+9)/12))/4)+INT(275*M/9)+D+1721013.5
220 JD=JD-.5*SGN(100*Y+M-190002.5)+.5
229 REM T=TIME INTERVAL FROM EPOCH 1900.0
230 T=((JD-2415020)+F/24)/36525
239 REM RAMC (LOCAL SIDEREAL TIME)
240 RA=FNR(FNU((6.646065556+2400.051262*T+2.5805E-5*T*T+F)*15-LO))
249 REM OBLIQUITY OF THE ECLIPTIC FOR EPOCH
250 OE=FNR(23.45229444-.0130125*T)
259 REM ANGLES SUBROUTINE (SET-UP)
260 R2=RA:OB=-OE:B=LA:GOSUB 670
264 REM BEGIN PLANET ROUTINE
265 PRINT:PRINT"    HELIO";TAB(20);"GEOCENTRIC":PRINT
270 FOR I=1 TO 11
280 IF I=10 GOTO 1000:REM MOON ROUTINE
290 IF I=11 THEN G=TN:A=0:GOTO 470:REM TRUE LUNAR NODE
299 REM CALCULATE MEAN ANOMALY & ECCENTRICITY (IN RADIANS)
300 GOSUB 900:M=FNR(FNU(S)):GOSUB 900:E=S
304 REM SOLVE KEPLER'S EQUATION FOR ECCENTRIC ANOMALY BY ITERATION
305 EA=M:FOR A= 1 TO 5:EA=M+E*SIN(EA):NEXTA
309 REM COMPUTE PERIFOCAL COORDINATES
310 READ AU:X=AU*(COS(EA)-E):Y=AU*SIN(EA)*(1-E*E)^.5
319 REM ROTATE THRU CLASSICAL ORIENTATION ANGLE
320 GOSUB 950:GOSUB 900:A=A+FNR(S):GOSUB 930
330 D=X:X=Y:Y=0:GOSUB 950:GOSUB 900:AN=FNR(S):GOSUB 900:A=A+FNR(S)
340 GOSUB 930:G=Y:Y=X:X=D:GOSUB 950
350 A=A+AN:IF A<0 THEN A=A+2*PI
```



```
359 REM CONVERT HELIO RECTANGULAR TO HELIO SPHERICAL COORDINATES
360 GOSUB 930:XX=X:YY=Y:ZZ=G:GOSUB 950
365 C=FNU(FND(A)):X=R:Y=G:GOSUB 950
370 D=FND(A):IF D>20 THEN D=D-360
379 REM DIRECT OR RETROGRADE MOTION? (USING CIRCULAR ORBITS)
380 IF I=1 THEN X1=XX:Y1=YY:Z1=ZZ:M1=R:C1=C:GOTO 410
390 R=((R^.5+M1^.5)*(M1^.5*R^.5))/(R^1.5+M1^1.5)
400RX=R-COS(FNR(C1)-FNR(C))
410 IF I=1THEN X1=XX:Y1=YY:Z1=ZZ:G=FNR(FNU(C+180)):GOTO 460
419 REM TRANSFORM HELIO RECTANGULAR TO GEO RECTANGULAR COORDINATES
420 X=XX-X1:Y=YY-Y1:Z=ZZ-Z1
429 REM CONVERT GEO RECTANGULAR TO GEO SPHERICAL COORDINATES
430 GOSUB 950:G=A:Y=Z:X=R:GOSUB 950
440 IF A>.35 THEN A=A-2*PI
450 IF I=10 OR I=11 THEN GOTO 480
459 REM PRINT HELIO & GEO COORDINATES
460 PRINT C$(I);FNW(C);FNW(D);
470 R$="":IFRX<0 THEN R$=" R"
480 C$(1)="SUN":PRINT TAB(19);C$(I);FNW(FND(G));FNW(FND(A));R$
489 REM STORE GEO COORDINATES (IN RADIANS)
490 X(I)=G:Y(I)=A:NEXTI
499 REM CONVERT GEO PLANETS FROM ECLIPTIC TO R.A. & DECL.
500 FOR I=1 TO 11:L=X(I):B=Y(I):OB=OE:GOSUB 620:X(I)=G:Y(I)=Q
520 NEXTI:GOTO 750
530 REM END MAIN PROGRAM, BEGIN SUB-SECTIONS
549 REM LOCAL SPACE:HORIZON SYSTEM
550 PRINT"LOCAL SPACE":PRINT
560 OB=-(PI/2-LA):R2=RA+PI/2:L3=LO:R3=RA
570 FOR I=1 TO 11:L=X(I)-R2:B=Y(I):GOSUB 620
580 PRINT C$(I);FNW(FND(G));FNW(FND(Q)):NEXTI:IF S=1 THEN OB=S7:S=0
585 GOTO750
589 REM LOCAL SPACE: RELOCATION CHART
590 PRINT "LOCALITY SHIFT  "
600 GOSUB 875:R2=FNR(FNU((LO-L2)+FND(RA))):B2=FNR(B2)
610 R3=R2:L3=L2:B=B2:OB=-OE:GOSUB 670
615 OB=-(PI/2-B2):R2=R2+PI/2:S=1:GOTO 570
619 REM COORDINATE TRANSFORMATION ROUTINE
620 A=B:R=1:GOSUB 930:Q=Y:R=X:A=L:GOSUB 930:G=X:X=Y:Y=Q:GOSUB 950
630 A=A+OB:GOSUB 930:Q=FNX(Y):Y=X:X=G:GOSUB 950:IF A<0 THEN A=A+2*PI
640 G=A:RETURN
669 REM CHART ANGLES ROUTINE
670 A=R2:R=1:GOSUB 930:X=X*COS(OB):GOSUB 950:MC=FND(A)
690 L=R2:GOSUB 620:IF B<0 THEN R2=R2+PI
700 AS=FNU(FND(G+PI/2)):L=R2+PI:B=PI/2-B:GOSUB 620:VT=FNU(FND(G+PI/2))
710 PRINT:PRINT "RA=";FND(R2);TAB(20);"ASC=";FNW(AS)
720 PRINT "MC=";FNW(MC);TAB(20);"VTX=";FNW(VT):RETURN
750 PRINT "1=LS 2=SFT 3=^? 4=EQ 5=RUN 6=VER 7=A*D"
760 GET G$:IF G$="" GOTO 760
770 G=VAL(G$)
780 ON G GOTO 550,590,850,890,830,800,840
790 GOTO 760
799 REM LOCAL SPACE: PRIME VERTICAL CHART (MUNDOSCOPE)
800 PRINT "PRIME VERTICAL":PRINT:S7=OB:S=1:OB=-((PI/2+OB)*-1):GOTO 570
830 RUN 10
```

```
839 REM POSITION OF CELESTIAL OBJECT (RA & DECL) ON HORIZON
840 GOSUB 875:L=FNR(L2)-R2:B=FNR(B2):GOSUB 620:GOTO 860
849 REM LOCAL SPACE: DIRECTION OF A CITY ON HORIZON
850 GOSUB 875:B=FNR(B2):L=(FNR(L3-L2)+R3)-(R3+PI/2):GOSUB 620
860 PRINT "AZI=";FNW(FND(G));:PRINT TAB(19);"ALT=";FNW(FND(Q))
870 GOTO 760
874 REM LOCAL SPACE: INPUT
875 INPUT "LONG=";L2:L2=FNQ(L2)
880 INPUT "LAT=";B2:B2=FNQ(B2):RETURN
889 REM MUNDANE SPACE: EQUATORIAL COORDINATES
890 PRINT "EQUATORIAL SPACE":PRINT:FOR I=1 TO 11
895 PRINT FNW(FND(X(I)));FNW(FND(Y(I))):NEXTI:GOTO 750
899 REM ASSEMBLES ORBITAL ELEMENTS
900 READS,S1,S2:S=S+S1*T+S2*T*T:RETURN
929 REM POLAR TO RECTANGULAR COORDINATES
930 IF A=0 THEN A=1.75453E-09
935 X=R*COS(A):Y=R*SIN(A):RETURN
949 REM RECTANGULAR TO POLAR COORDINATES
950 IF Y=0 THEN Y=1.75453E-09
955 R=(X*X+Y*Y)^.5:A=ATN(Y/X)
960 IF A<0 THEN A=A+PI
965 IF Y<0 THEN A=A+PI
970 RETURN
997 REM MOON & MOON'S NODE ROUTINE
998 REM
999 REM COMPUTE MEAN LUNAR LONGITUDE
1000 LL=973563+1732564379*T-4*T*T
1002 REM COMPUTE SUN'S MEAN LONGITUDE OF PERIGEE
1003 G=1012395+6189*T
1004 REM COMPUTE MEAN LUNAR NODE
1005 N=933060-6962911*T+7.5*T*T
1009 REM COMPUTE MEAN LONGITUDE OF LUNAR PERIGEE
1010 G1=1203586+14648523*T-37*T*T
1014 REM COMPUTE MEAN ELONGATION OF MOON FROM SUN
1015 D=1262655+1602961611*T-5*T*T:M=3600
1019 REM COMPUTE AUXILIARY ANGLES
1020 L=(LL-G1)/M:L1=((LL-D)-G)/M:F=(LL-N)/M:D=D/M:Y=2*D
1029 COMPUTE MOON'S LONGITUDE
1030 ML=22639.6*FNS(L)-4586.4*FNS(L-Y)
1035 ML=ML+2369.9*FNS(Y)+769*FNS(2*L)-669*FNS(L1)
1040 ML=ML-411.6*FNS(2*F)-212*FNS(2*L-Y)
1045 ML=ML-206*FNS(L+L1-Y)+192*FNS(L+Y)
1050 ML=ML-165*FNS(L1-Y)+148*FNS(L-L1)-125*FNS(D)
1055 ML=ML-110*FNS(L+L1)-55*FNS(2*F-Y)
1059 REM COMPUTE LUNAR LATITUDE
1060 MB=18461.5*FNS(F)+1010*FNS(L+F)-999*FNS(F-L)
1065 MB=-624*FNS(F-Y)+199*FNS(F+Y-L)
1070 MB=MB-167*FNS(L+F-Y)+117*FNS(F+Y)
1075 MB=MB+62*FNS(2*L+F)-33*FNS(F-Y-L)
1080 MB=MB-32*FNS(F-2*L)-30*FNS(L1+F-Y)
1085 ML=ML-45*FNS(L+2*F)+40*FNS(L-2*F)
1089 REM COMPUTE TRUE LUNAR NODE
1090 TN=N+5392*FNS(2*F-Y)-541*FNS(L1)-442*FNS(Y)
1095 TN=TN+423*FNS(2*F)-291*FNS(2*L-2*F)
1100 G=FNR(FNP(LL+ML)):TN=FNR(FNU(FNP(TN)))
1105 A=FNR(FNP(MB)):RX=0:GOTO 470
```

should read

1065 MB=MB-624 etc.

ORBITAL DATA USING THE NEELY VALUES (GOOD FOR DATES 1900-2000 ONLY)

```
2000 DATA358.4748445,35999.04975,-.150278E-3,.01675104,-.418E-4,-.126E-6
2010 DATA1.00000023,101.2208333,1.719175,.000452778,0,0,0,0,0,0,102.2793806
2020 DATA149472.5152,.6389E-5,.20561421,.2046E-4,-.3E-7,.3870984,28.75375278
2030 DATA.370280556,.000120833,47.14594444,1.185208333,.000173889,7.002880556
2040 DATA.001860833,-.18333E-4,212.6032194,58517.80386,.001286056,.00682069
2050 DATA-.4774E-4,.91E-7,.7233316,54.38418611,.508186111,-.1386389E-2
2060 DATA75.77964722,.89985,.41E-3,3.393630556,.1005833E-2,-.972E-6,319.529425
2070 DATA19139.8585,.180806E-3,.0933129,.92064E-4,-.77E-7,1.5236915
2080 DATA285.4317611,1.069766667,.13125E-3,48.78644167,.770991667,-1.389E-5
2090 DATA1.850333333,-.675E-3,.12611E-4,225.4928125,3033.687936,0
2100 DATA.04838144,-.155E-4,0
2110 DATA5.20290493,273.3930152,1.33834464,0,99.41984827,1.05829152
2120 DATA0,1.3096585,-.515613E-2,0,174.2152960,1223.507963
2130 DATA0,.05422831,-.20495E-3,0,9.55251745,338.911673
2140 DATA-.31667941,0,112.8261394,.82587569,0,2.49080547
2150 DATA-.00466035,0,74.17574887,427.2742717,0,.04681664
2160 DATA.00041875,0,19.22150505,95.68630387,2.05082548,0
2170 DATA73.52220082,.52415598,0,.77256652,.12824E-3,0
2180 DATA30.1329437,240.4551595,0,.00912805,-.00127185,0
2190 DATA30.1137593,284.168255,-21.6328615,0,130.6841531,1.10046492
2200 DATA0,1.77939281,-.00975088,0,229.7810007,145.1781092,0,.24797376
2210 DATA.00289875,0,39.53903455,113.5365761,.20863761,0,108.94405
2220 DATA1.37395444,0,17.15140319,-.01611824,0
```

ALTERNATE SET OF ORBITAL DATA FOR OTHER CENTURIES

```
1997 REM ORBITAL ELEMENTS LESS ACCURATE FOR 1900-2000
1998 REM BUT GOOD OVER TIME SPAN OF MANY CENTURIES
2000 DATA358.4748445,35999.04975,-.150278E-3,.01675104,-.418E-4,-.126E-6
2010 DATA1.00000023,101.2208333,1.719175,.000452778,0,0,0,0,0,0,102.2793806
2020 DATA149472.5152,.6389E-5,.20561421,.2046E-4,-.3E-7,.3870984,28.75375278
2030 DATA.370280556,.000120833,47.14594444,1.185208333,.000173889,7.002880556
2040 DATA.001860833,-.18333E-4,212.6032194,58517.80386,.001286056,.00682069
2050 DATA-.4774E-4,.91E-7,.7233316,54.38418611,.508186111,-.1386389E-2
2060 DATA75.77964722,.89985,.41E-3,3.393630556,.1005833E-2,-.972E-6,319.529425
2070 DATA19139.8585,.180806E-3,.0933129,.92064E-4,-.77E-7,1.5236915
2080 DATA285.4317611,1.069766667,.13125E-3,48.78644167,.770991667,-1.389E-5
2090 DATA1.850333333,-.675E-3,.12611E-4,225.4928125,3033.687936,-.721589E-3
2100 DATA.04838144,-.155E-4,-.4676E-5
2110 DATA5.20290493,273.3930152,1.33834464,.704050E-3,99.41984827,1.05829152
2120 DATA.352222E-3,1.3096585,-.515613E-2,.3889E-5,174.2152960,1223.507963
2130 DATA-.501819E-3,.05422831,-.20495E-3,-.728E-6,9.55251745,338.911673
2140 DATA-.31667941,.978542E-3,112.8261394,.82587569,-.15218lE-3,2.49080547
2150 DATA-.00466035,-.15489E-4,74.17574887,427.2742717,.78844E-4,.04681664
2160 DATA.0041875,.77E-7,19.22150505,95.68630387,2.05082548,-.001074472
2170 DATA73.52220082,.52415598,.001311667,.77256652,.12824E-3,.395E-4
2180 DATA30.1329437,240.4551595,-.70333E-4,.00912808,-.00127185,-.2E-8
2190 DATA30.11137593,284.168255,-21.6328615,.14095E-3,130.6841531,1.10046492
2200 DATA.249867E-3,1.77939281,-.00975088,-.91111E-5,229.7810007,145.1781092
2210 DATA0,.24797376,0,0,39.53903455,113.5365761,0,0,108.94405,1.37395444
2220 DATA.308333E-3,17.15140319,0,0
```

NOTE: NUMBERS WRITTEN -.20495E-3 ARE READ: -.00020495 and so forth

An Introduction to the Computer Language BASIC for Astrologers:Part I

The BASIC Computer Language

The computer language BASIC is the most readily available of the higher level programming languages. All of the new personal home computer systems to date employ BASIC interpreters. However, since BASIC has never been standardized, there are dozens of different versions available. The latest versions of BASIC found in home computer systems like the Commodore PET and Radio Shack's TRS-80 are Enhanced or Extended versions of BASIC. They include many features not found in the early BASICs. MATRIX will be presenting a great number of astrological programs written in the BASIC language in the coming issues. It is worthwhile to sketch out some of the general rules that apply to all BASIC interpreters as well as indicate the kinds of BASIC commands and statements found in some of the latest Enhanced or Extended BASICs.

THE BASIC RULES

1. All BASIC interpreters evaluate an expression (a line of code) by starting at the LEFT side of the expression and working towards the right...AND BY
2. Performing ALL the power (↑) computations first..∴AND THEN
3. STARTING AGAIN FROM THE LEFT, and working to the right performing all the multiplications (*) and divisions (/)..AND THEN
4. STARTING AGAIN FROM THE LEFT, and working to the right performing all the additions (+) and subtractions (-).
5. HOWEVER, expressions INSIDE of parentheses () are evaluated first, following the same four rules stated above (1-4).
6. IF there are pairs of parentheses WITHIN parentheses, the evaluation or computing is done inside the inner-most set of parentheses first, then computing is done inside the next set of parentheses, and so on.

EXTENDED BASIC: The PET and the TRS-80

It is fortunate that both the PET and the TRS-80 (2nd Level) BASIC interpreters have been authored by the same company (Microsoft) and are very similar. What follows is a list of the BASIC commands and statements in our Commodore PET. When more details on the 2nd-Level Radio Shack BASIC become available we will publish a list of those commands that differ from the PET BASIC. This list may help those of you who are not familiar with BASIC to get at sections of programs written in BASIC that interest you and thus adapt these programs to your own machines.

ARITHMETIC OPERATORS

Symbol	Example	Purpose
=	A=B	Assigns a value to a variable
LET	LET A=B	LET is optional on the PET
↑	PRINT A↑2	Exponentiation; in example, A^2.
/	C=A/8	Division
*	C=A*8	Multiplication
+	C=A+8	Addition
-	C=A-8	Subtraction

BASIC Arithmetic Operators (continued)

Symbol	Example	Purpose
=	IF A=B THEN PRINT C	A 'equals' B
<>	IF A<>B THEN C=4	A 'does not equal' B
<	IF A<B THEN C$="X"	A 'is less than' B
>	IF A>B THEN C$=D$+E$	A 'is greater than' B
<=	IF A<=B THEN C=20	A 'is less than or equal to' B
>=	IF A>=B THEN C=D-1	A 'is greater than or equal to' B
AND	IF A AND B THEN C=0	A and B must both be true for C=0
OR	IF A OR B THEN C=90	Either A OR B must be true for C=90
NOT	IF NOT A THEN PRINT C	Expression is true if A is false

BASIC COMMANDS AND STATEMENTS

Symbol	Example	Purpose
CLR	CLR	Sets variables to zero.
CMD	CMD D	Keeps external device D open to monitor bus
CONT	CONT	Contine program after a STOP command.
GOTO	GOTO 10	Continue program execution at line 10 after a STOP command.
FRE	PRINT FRE(0)	Returns number of bytes of available memory.
LIST	LIST	Lists current program
NEW	NEW	Deletes current program from memory
LOAD	LOAD	Loads next program from audio tape
PEEK	PEEK(A)	Returns byte value from address A
POKE	POKE A,B	Loads byte B into address A
PRINT	PRINT A	Prints value of A on display screen
RUN	RUN	Begins execution of program at lowest line
SAVE	Save "ASPECTS"	Saves program "ASPECTS" on audio tape
STOP	STOP	Stops program execution
SYS	SYS X$	Complete control of PET is transferred to a subsystem at hex address in the string.
USR	USR(X)	Transfers program control to a program whose address is at locations 1 and 2. X is a parameter passed to and from the machince language program
TI$	PRINT TI	Displays number of 'jiffies' (A jiffy = 1/60 second) since system power-up.
WAIT	WAIT A,B,C	Stops execution of BASIC until contents of A, ANDed with B and exclusive ORed with C, is not equal to zero. C defaults to zero.
CLOSE	CLOSE 8	Closes logical file 8
DATA	DATA 1,2,3,4	Specifies data to be read from left to right.
DIM	DIM A(50)	Specifies maximum number of elements in an array or matrix.
END	END	Terminates program execution
GET	GET C	Accepts single character from keyboard.
INPUT	INPUT A	Accepts value of A from keyboard
OPEN	OPEN 7	Opens logical file A
READ	READ A	Obtains value of A from DATA statement
REM	REM**COMMENT**	Inserts non-executable somments in program
RESTORE	RESTORE	Permits re-reading of DATA Statements without re-running program.
TAB	PRINT TAB(A);B	Prints value of B in character positions A+1 on display screen.

BASIC Commands and Statements (continued)

Symbol	Example	Purpose
VERIFY	VERIFY	Verifies program saved on tape with program in PET memory.
SPC	SPC(N)	Prints N spaces or blanks.
FOR NEXT	FOR A=1 to 20 NEXTA	Loop control. Performs all instructions between FOR and NEXT as many times as specified by index (here A).
STEP	FOR A=1 to 20 STEP 2 NEXT A	Same as above but STEP specifies size of increment to increase or decrease.
IF THEN	IF A=10 THEN PRINT A	If condition is 'TRUE,' instructions following THEN would be executed. Otherwise next statement is executed.
IF GOTO	IF A=1 GOTO 10	If 'TRUE', control is transferred to specified line, Otherwise, next statement in sequence is executed.
GOTO	GOTO 10	Transfers control to specified line.
GOSUB	GOSUB 10	Begins execution of a subroutine at specified line.
RETURN	RETURN	Subroutine exit.Transfers control to the statement following most recent GOSUB statement.
ON GOTO	ON A GOTO L,M,N	Transfers control to specified line (in this example, L,M, or N) depending on value of index A.
ON GOSUB	ON A GOSUB L,M,N	Same as above except control is transferred to subroutine.

ARITHMETIC FUNCTIONS (LIBRARY FUNCTIONS)

Symbol	Example	Purpose
ABS	C=ABS(A)	Returns magnitude of argument without regard to sign.
SGN	C=SGN(A)	Returns -1 if argument is negative,returns 0 if argument is zero, and returns +1 if argument is positive.
EXP	C=EXP(A)	Returns contant 'e' raised to power of the argument. Example, e^A
INT	C=INT(A)	Returns largest integer less than or equal to argument.
LOG	C=LOG(A)	Returns natural logarithm of argument.
DEF FN	DEF FNA(B)=C*D	Allows user to define a function. Function label A must be a single letter; argument B is a dummy.
SIN	C=SIN(A)	Returns sine of argument (in radians)
COS	C=COS(A)	Returns cosine of argument (radians)
TAN	C=TAN(A)	Returns tangent of argument (radians)
ATN	C=ATN(A)	Returns arctangent of argument(radians)
RND	C=RND(A)	Generates a random number between zero and one. If A is less than 0, the same random number is produced in each call to RND. If A=0, the same sequence of random numbers is generated each time RND is called. If A is greater than 0, a new sequence is produced for each call to RND.

Extended BASIC: STRING FUNCTIONS

Symbol	Example	Purpose
ASC	A=ASC("XYZ")	Returns integer value corresponding to ASCII code of first character in string.
CHR$	A$=CHR$(N)	Returns character corresponding to ASCII code number.
LEFT$	LEFT$(X$,A)	Returns leftmost A characters from string.
RIGHT$	RIGHT$(X$,A)	Returns rightmost A characters from string.
LEN	LEN(X$)	Returns length of string.
MID$	MID$(X$,A,B)	Returns B characters from string,starting with the Ath character.
STR$	A$=STR$(A)	Returns string representation of number.
VAL	A=VAL(A$)	Returns numberic representation of string.

SPECIAL SYMBOLS, COMMANDS and STATEMENTS

Symbol	Example	Purpose
:	A=1:B=10	Allows multiple statements per line.
;	PRINT A;B	Allows same line printing
;	PRINT A$;B$	Same line printing. Concatenates strings.
,	PRINT A,B	Same line printing (pre-TABed positions)
,	Load"NAME",D	Separates elements in LOAD, SAVE,OPEN & VERIFY.
?	?A	Abbreviation for PRINT.
$	A$="MATRIX"	String identifier.
%	A%=INT(X)	Integer identifier.
"	A$="ASTROLOGY"	String enclosures.
π		Value of Pi (3.1415927)
carriage return		Must follow every command, statement or data entry; causes cursor to return to leftmost position on next lowest line. Signals end of INPUT line.

MORE INFORMATION ON BASIC

There are many good texts on the BASIC computer language. A new and popular one: INSTANT BASIC by Jerald R. Brown deals with the Extended Basics; an old standard by James S. Coan is Basic BASIC. For those of you who may not live in an area that includes a computer store, here is a reputable firm that sells a good selection of BASIC texts. Write for the catalog: Newman Computer Exchange, 1250 N. Main St., Ann Arbor, Michigan 48104.

At this point, it appears that BASIC in one of it's extended forms will be the most dominant higher level language for at least the next couple of years. In fact, the new BASICS are reaching into other high level languages and borrowing useful functions. The new Level-II BASIC by Radio Shack has 16 digit double-precision (borrowed from FORTRAN). It is worthwhile for owners of programmable calculators to begin to pick thru BASIC programs and adapt portions of them to their machines.

Since your editor was "raised up" on HP programmable calculators, BASIC is a relatively new event in my programming experience. I was more than a little fearful that perhaps I might have difficulty getting the hang of it. However, BASIC has been very easy to learn and much easier than programming my HP-97. The programmable calculators are quite strict in what they will tolerate in regard to alternative methods of programming...while BASIC lends itself to a variety of "quick & dirty" patches and programming approaches.

BASIC: TRIGONOMETRIC FUNCTIONS

Most BASIC interpreters contain the following trigonometric functions: sine, cosine and tangent (SIN, COS, TAN). In addition, one inverse function (Arc Tangent or ATN) is included. Some of the next generation of Extended Basics' will no doubt include Arc Sine and Arc Cosine. Until these BASICS are more available, the ArcSin and ArcCos functions may be derived as follows:

```
Arc Sine = ATN(X/(1-X*X)↑.5)     BASIC without SQUARE ROOT
Arc Sine = ATN(X/SQR(1-X*X))     BASIC with SQUARE ROOT

Arc Cosine = ATN(((1-X*X)↑.5)/X) BASIC without SQUARE ROOT
Arc Cosine = ATN(SQR(1-X*X)/X)   BASIC with SQUARE ROOT
```

"X" is the ANGLE measured in RADIANS and NOT in DEGREES

DEGREES AND RADIANS

In BASIC, trigonometric functions operate on ANGLES measured in RADIANS rather than in the DEGREE mode familiar to most astrologers. The RADIAN MODE is more convenient for computers than the DEGREE MODE.

A RADIAN (rad) is defined as the measure of the central angle subtended by an arc of a circle equal to the radius of the circle. The circumference of a circle = 2π(radius) and subtends an angle of 360°. Then 2π radians = 360°, from which we obtain

1 radian = 180°/π= 57.296° = 57°17'45" and

1 degree =π/180 radian = 0.0174533293 where

π = 3.141592654

ASTROLOGERS working with angles (aspects, planet positions) and with trig functions must be able to convert DEGREES TO RADIANS and RADIANS TO DEGREES. While some of the more sophisticated BASICs do have the RAD(X) and DEG(X) functions built in, most do not. Here is the conversion:

from DEGREES to RADIANS = X*π/180 or X*PI/180 (*NOTE)

from RADIANS to DEGREES = X*180/π or X*180/PI

*(NOTE: If your BASIC does not have the "π" function built in, you will have to assign a variable to π. Example: PI= 3.141592654)

The DEGREE/RADIAN conversion (and it's inverse) may be put into a DEFINED FUNCTION statement rather than a subroutine.

```
DEF FNR(X)= X*π/180    DEGREES to RADIANS

DEF FND(X)= X*180/π    RADIANS to DEGREES
```

Example: PRINT FND(X) where X is an angle (in radians) to be converted to an angle expressed in degrees.

There are two general approaches to working with ANGLES and TRIG FUNCTIONS in BASIC. The first involves converting angles at INPUT into radians, performing any number of operations involving trig functions and finally converting the result from radians back to degrees for OUTPUT. The second method involves incorporating the Degree/Radian conversions into a set of DEFINED FUNCTIONS.

DEFINED FUNCTIONS that do TRIG FUNCTIONS on ANGLES in DEGREES

Thanks to Robert Hand for sending these along. Here are a set of DEFINED FUNTIONS that will alow you to work on angles expressed in degrees rather than radians. The Degree/Radian conversion and it's inverse is built into these equations. This method is very handy when using a long chain of trig functions such as that found in the Moon routine in this issue (BASIC). Working in degrees has two benefits in these cases: (1) we are used to reading numbers in degrees and can see what we are operating upon and (2) the Degree mode takes up less computer memory than the Radian mode (try expressing any integer such as 295 in degrees and in radians). Here are the set of Defined Functions you will need (with and without the SQUARE ROOT function):

```
 Sine = DEF FNS(X)=SIN(X*π/180)

Cosine = DEF FNC(X)=COS(X*π/180)

  TAN = DEF FNT(X)=TAN(X*π/180)

Arc Sine = DEF FNX(X)=ATN(X/(1-X*X)↑.5)*180/π[without SQR]

Arc Sine = DEF FNX(X)=ATN(X/SQR(1-X*X))*180/π[with SQR]

Arc Cosine = DEF FNY(X)=ATN(((1-X*X)↑.5)/X)*180/π[without SQR]
Arc Cosine = DEF FNY(X)=ATN(SQR(1-X*X)/X)*180/π  [with SQR]

Arc Tangent = DEF FNZ(X)=ATN(X)*180/π
```

The above set of DEFINED FUNCTIONS operate on the assumption that the variable (X) is in degrees for SIN, COS and TAN Defined Funtions (FNS, FNC, FNT) and in radians for ATN, Arc Sine and Arc Cosine Defined Functions (FNX, FNY, FNZ). In other words, the FNS, FNC and FNT functions perform the trig functions Sine, Cosine and Tangent and at the same time convert the angle operated upon into radians. The FNX, FNY and FNZ functions perform the inverse trig functions Arc Sine, Arc Cosine and Arc Tangent and at the same time convert the angle operated upon from radians into degrees.

We have run out of space for this issue. Next issue we will continue to list out BASIC subroutines and pointers of use to astrologers working with this computer language. Perhaps some of you have some tips, subroutines and so forth to contribute.

ERRATA from MATRIX ONE

The article by Dr. Landscheidt (taken from audio cassette) had the most errors. Here are the major ones: PAGE 23, bottom line, 'energy' should read 'analogy'; PAGE 24, 6th line from bottom should read.. "The insight into cosmic morphology, won by mandala projection and by"; PAGE 25, 16th line from bottom, 'letter' should read 'ladder'; 3rd line from bottom, 'tunnels' should read 'channels'; PAGE 26,16th line from bottom..'Saturn ...' should read "Meridian (MC-IC) is to be found very often"; PAGE 27, first line, 'guding' reads 'guiding'; 9th line from bottom, 'reason' should read 'within'.

PAGE 29, 6th line from bottom should read ' a = 0.002737909;PAGE 38, 11th line from bottom (on left) should read '$\Delta x = X_1 - X_0$; 9th line from bottom (on right) should read "$\Delta^2 Y_0 = \Delta Y_1 - \Delta Y_2$"; PAGE 9, 10th line from bottom $\epsilon_0 = 23°.452294$; 8th line up should read '$R_G = t_G$; and 6th line up from bottom should read '$+7''.48T^2$''. SORRY

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From James S. Williamson of Cambridge Circle (Harmonics researcher): "...I have managed to purchase two HP-97 printing programmable calculators. One is for me and the other I'd like to sell to someone who will put it to good use. Regular price is $750 and I am paying $580 (includes 2 program packages, extra paper)" — 463 Vande Hei Road, Green Bay, WI 54301

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WANG 500 COMPUTER FOR SALE

Charles Jayne wants to sell his WANG 500 computer which cost $13000 seven years ago. The WANG 500 has 320 registers (or steps) — more than the HP-97 but less than the HP-67. The unit includes one of the largest libraries of programs available for the WANG 500. The machine has a built-in cassette to store programs and a four inch printer that is integral to the unit (use adding machine rolls). There is a 10 digit display and the printer is alphanumeric (prints letters & numbers). The machine is some very fine software from previous owner Robert Hand that includes helio positions, Parans, Harmonics, Roundscopes, Composite charts and the like. The software alone would be a most valuable possession (there are 10 cassettes of software by Hand). The machine is beautiful to look at and reasonably priced at $500. For more information contact Charles Jayne, 5 Old Quaker Hill Rd, Monroe New York 10950. Phone (914) 783-1014

ASTROLOGY PROGRAMS FOR THE COMMODORE PET

Your editor has several astrology programs on audio cassette for the PET. The listings for these and other programs that will appear in MATRIX but some of you might rather have the program recorded and ready to run on a machine. These programs are nicely formatted. Each program is $25 POSTPAID (includes audio cassette & instructions)

1) BASIC NATAL CHART & HOUSES- Generates geo and helio (longitudes only). Angles, RAMC, MC, ASC & Vertex. House Cusps (Koch, Campanus, Placidus, choose one). (1900-2000 or other centuries, choose)
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3) COMPLETE NATAL PACKAGE- nice format, 360 degree notation only). Does all of the options in BASIC program this issue. Geo & Helio Longitude & Latitude, R.A. & Decl., Azimuth & Altitude, Prime Vertical Coords plus a variety of LOCAL SPACE locality adjustments. Specify 1900-2000 or other centuries please.

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Fall 1978

Issue Three

MATRIX MAGAZINE

Author	page	Title
Inside Front Cover		THE FIRST ANNUAL JOHNDRO AWARD
	1	EDITORIAL
Ian McKinnon	5	PERTURBED EQUATIONS FOR THE TERRESTRIAL PLANETS: SUN, MERCURY, VENUS & MARS
Ian McKinnon	5	THE TERRESTRIAL PLANETS ON THE HP-67/97
Editor	22	HOME COMPUTERS FOR ASTROLOGICAL WORK
	22	A) WHAT IS A COMPUTER SYSTEM?
	26	B) THE PET AND THE TRS-80 COMPARED
	30	C) OTHER SYSTEMS
John McCormick	34	TRS-80 USER REPORT & COMMENTS
Charles A. Jayne	36	THE "IN THING": A PET USER REPORT
Steve Blake	38	TRS-80 USER REPORT
James Neely	40	ASTROLOGICAL ROUTINES ON THE TI-59/PC-100A
		A) PLACIDUS HOUSE CUSPS
		B) ASPECTS & MIDPOINTS
Digicomp	44	THE DR-70 DESIGN PROCESS
Robert Hand	46	AN EXACT BASIC PROGRAM FOR THE SUN AND MOON
Alexander Borg	48	THE DETERMINATION OF THE "JULIAN DAY NUMBER"
Editor	52	ASTROLOGY IN BASIC: SORTING
	54	HANDSHAKING DEPARTMENT
	39	ERRATA
51, 33,	50	BASIC SUBROUTINES
	39	THE ICN SYMBOL STANDARDS
	45	BOOK REVIEWS

Editors: Michael & Margaret Erlewine

1041 North Main Street ✧ Ann Arbor, Michigan 48104

THE ANNUAL JOHNDRO AWARD

1978

Commencing in 1978 the Annual Johndro Award for excellence in the technical aspects of Cosmecology is being given for those who have distinguished themselves through some major contribution. Dr. Harlan T. Stetson of M.I.T. coined the term COSMECOLOGY many years ago as the study of the Earth's adaptation to its cosmic environment. While this embraces the ancient science of Astrology it also includes a number of other sciences. The award is named after the famous American Radio Engineer-Mathematician-Astrologer, L. Edward Johndro who like James Neely also hailed from California.

For it is to James Neely that this first award is being presented for not only the generous contribution of his great skills in mathematics and with computers, but also for how his competence has aided so many of us. Due largely to his efforts the owner of an inexpensive microcomputer or programmable calculator can calculate the accurate positions of all the planets, asteroids and Chiron in spite of the limited memories of such machines. Furthermore the stereotyped image of the cold calculator is belied by him as he is a warm and friendly man. The award is sponsored by the following editors and will be published in their journals:

COSMECOLOGY BULLETIN— Charles A. Jayne
JOURNAL OF GEOCOSMIC RESEARCH— Robert Hand
MATRIX— Michael and Margaret Erlewine
PHENOMENA— Malcolm Dean
SIRIUS— David Cochrane
CCRS NEWSLETTER— Zip Dobyns

MATRIX MAGAZINE is a periodical with a single copy price (postpaid) of $5 ($6 FIRSTCLASS). Subscribers are notified as each issue becomes available. U.S. dollars only please.
MATRIX is produced and edited by
Michael & Margaret Erlewine
phone (313) 663-6677

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WHAT'S NEW?

It seems as if a lot of water has gone over the dam since MATRIX two went out and that was only a few months ago. There have been a lot of changes here. Here is the news.

MATRIX SOFTWARE DEPARTMENT

Just before we finished the second issue of MATRIX we began to get more letters and phone calls from readers asking for this or that program for this or that particular machine...not in a future issue...but right now. We also began meeting and hearing from another kind of astrologer...one who had no interest in computing or in MATRIX but who wanted software in a pre-recorded form (magnetic cards, cassettes, etc.) for use with their practice.

I believe we kind of ran around in circles for a while wondering what we should do. The upshot was to bring into existence a branch of MATRIX the magazine to be called MATRIX SOFTWARE. All of this happened in a series of fits and starts...on again ...off again...up and down..and so forth. The result is MATRIX SOFTWARE...dedicated to forming both an astrological software depository and to marketing this software to professional astrologers at a fair price.

I contacted astrologers like James Neely, Rob Hand and Charles Jayne to get their opinion on this venture..and others too...as to what prices to charge software users and what to pay the authors of the software in royalty fees. Some of our prices are in the ads in the back of this issue and we are holding now with the idea of trying to pay authors 50% of NET for the non-exclusive right to sell their programs. We hope some of you will write some great software for the rest of us and make some money for your efforts!

We have set up an extensive file and bookeeping system and so forth. We want to keep on file not only popular programs for popular machines but also a very wide selection of material from many authors for all kinds of machines. We will make this material available to the public thru a catalog of software that (due to it's size) will be separate from this magazine (although we are not above advertizing in our own mag-as you can see)

At this point we are still in the beginning stages. We have over 30 programs from James Neely and Rob Hand has promised us some of his material. Some of this material will appear in MATRIX at some point in the future but will be available now for those of you who have a need for a particular program right now. We hope you will support our effort by contributing well-documented programs from time to time. Our catalog will be sent to those who request it when it is finished (sometime early in 1979)

NEW EQUIPMENT AT MATRIX

We took out a loan and bought some new equipment that will make our software venture a little easier. At this time our Commodore PET is sporting 24K of RAM and communicating bi-directionally with our heavy-duty I/O Selectric-based line-printer. Also sharing that line printer is our new Level II TRS-80 from Radio Shack with an Expansion interface and a big 32K of RAM. Perhaps we can list some programs for those of you who have one of the above machines...but no printer.

We are getting some great programs together for the software catalog including a series of statistical/research programs from Charles Hocking for the PET and the TRS...and a large Astrodyne package.

AUTHORS OF SOFTWARE

Those of you interested in participating in sharing software thru MATRIX magazine or MATRIX SOFTWARE can write to us. All programs (not on cassette) must be carefully documented and include the general equations necessary for a user to adapt the program to another kind of computing machine. Complete user instructions must be included and all program code listed by line-printer or by typewriter. Contact us for details.

AWARD FOR JAMES NEELY

If you have not already, take a look at the inside of the front cover to see who is getting some much deserved recognition! The Annual Johndro Award begins this year and will be given to an individual who contributes outstandingly to the advancement of Astrology. Charles Jayne is responsible for the idea and a list of Journals (and editors) who support the idea and share in the selection is given there.

Let me say a few words about the activities of Mr. Neely as of late. For one, he has a very fine article in the current issue of the JOURNAL OF GEOCOSMIC RESEARCH entitled THE ORBITS OF THE TRANSNEPTUNIANS. We have received a large 70page article for publication in MATRIX on Coordinate Transformation and Rotation (MATRIX FOUR). Neely has agreed to do a regular column to start in the next issue that will have to do with his extensive research into the various house systems and related spherical material. Neely will present this material complete with diagrams, algorithms and the like in an extended series of articles.

CHIRON EQUATIONS FROM NEELY

We can go on and on about what James Neely has been up to and will. Malcolm Dean, editor of PHENOMENA is using a very sophisticated program by Neely for generating very precise positions for the new planetoid Chiron in making his forthcoming CHIRON EPHEMERIS. Here is an excerpt from one of Neely's letters to MATRIX:

" What I have been doing is to work on the production of a Chebyshev approximation to the perturbations of Chiron which can be used to produce an accurate ephemeris of Chiron; this effort was primarily to aide Malcolm Dean in the production of the PHENOMENA ephemeris which is soon to be published. The basic methodology in the Chebyshev approximation is that of Lloyd Carpenter which is explained in his NASA Technical Note, " Planetary Perturbations in Chebyshev Series", TN D-3168, January 1966. Fortunately Chiron's orbit lies (mostly) between that of Saturn and Uranus, so it was possible to generate a reasonable approximation of it's motion from about 1895 to 2000. The 1895 date was chosen because an old photographic plate of that vintage was discovered that had an image of Chiron; the coordinates of that image provided a check on the computational procedure. The orbital elements that were used were computed by Brian Marsden of the Smithsonian Astrophysical Observatory. As you can see by the table (which I have sent you), the agreement is

(Neely quote continued)

" is quite good. I'm still not happy with the agreement for the 1895 observation though, so I will try to see if it can be improved, primarily as an exercise in my understanding of Carpenter's methodology. I would be remiss if I did not mention that I have benefitted from many valuable discussions with Alexander Borg regarding Carpenter's work. It happened that he and I had independently programmed Carpenter's computer program but that neither version was working properly. By doing some cross-checking and program exchange we have gotten both of our programs working. And I have certainly benefitted from Alex's understanding of Carpenter's equations."

The sample output that Neely sends shows a variation between the observed Chiron positions and the Neely calculated positions of only a few seconds in many cases.

The NEELY Values for the Outer Bodies

Here is an update on the work Neely has been doing in tuning the Mean Elements for the outer bodies— Jupiter thru Pluto:

For those of you who do not have MATRIX ONE where this project is described a brief synopsis to date: Good positions for the inner planets have been possible using mean orbital elements but this has not been true for the outer planets. Astronomers have not been much concerned with this problem since they have access to large mainframe computers where planet positions can be stored in ephemeris form on magnetic tape— if desired. Using the mean elements and a small computer like say a programmable calculator, positions for the outer bodies can be out as much as 45 minutes of a degree or more (too much for most astrological work). James Neely (and a lot of effort) managed to fine tune these outer body mean elements until positions exact to within 2-3 minutes of arc for most of these bodies are now possible. When we last reported to you, Neely was confident that he could improve these positions until they were well within a minute of accuracy. Here is the latest news in this regard:

Over the last months I have received a number of progress reports from Neely..most of which were kind of discouraging..in regards to a quick solution to this question. Here is a quote from his latest;

" I have not given up on my so-called harmonic analysis of the outer body residuals, but it has taken a back seat to some of my current endeavors. I say "so-called", for it is now evident that a harmonic analysis in the classical sense will not be performed. For harmonic analysis or fast Fourier Transform methods to be effective it is essential that there be many cycles, or periods, represented in the data. It would seem that 100 years of data at 40 days interval would be sufficient to perform a proper analysis, but most of the outer bodies have harmonic residuals that exhibit only 2½ to 3 cycles during that time span. So what I am awkwardly saying is that there are not enough cycles in the data for a harmonic analysis to be effective. What is required is an old fashioned curve fit, but one which has periodic components of unknown frequency, amplitude and phase, and hence is non-linear in form. This sort of curve fitting requires a little insight and a lot of luck, and I haven't had much of a chance to get into it of late."

As an alternative to this project, Neely has been working on another approach to accurate outer body positions for small machines. This is by Chebyshev Analysis. The end result of this approach should be a series of terms that can be truncated at any point to fit the memory restrictions of any given computing machine. Here are some comments from Neely on this:

" I had hoped that it would be possible to develop some sort of "unified" program and set of Chebyshev polynomials for computing planetary positions of all of the bodies over an extended period of time but at the moment it appears that this method is practical only for the outer bodies, for the perturbations of the inner bodies appear to be too extensive for the Chebyshev expansion carried out for more than a few years at a time. Perhaps with our microcomputers we shall have to be content with using a mixture of methods. Carpenter for the outer bodies and (Simon) Newcomb for the inner bodies. With these methods, one minute of arc accuracy is immediately possible and one second of arc is certainly obtainable; the limitations are only in the number of terms that you can use with your particular computer configuration. Ian McKinnon has certainly demonstrated that Newcomb's equations can give very accurate results on a device that is as limited storage-wise as the HP-67/97 programmable calculator. I guess my immediate challanges are to overcome the limitations that I think (at the moment) are inherent in Carpenter's work for an "all body" unification or consolidation of programming, and to do the curve fitting of the outer body harmonics that I thought was only "inches" away last January or February."

The Work of Ian McKinnon

This issue will introduce you to the work of Ian Mckinnon who hails from the Toronto Islands in Canada. McKinnon has taken the quite-difficult-to-decifer 6th volume of the Papers of the American Ephemeris by Newcomb and put the material on the terrestrial planets into a form that the rest of us can use.

He includes not only a translation of this material into HP-67/97 format but more important he gives the general equations so that we micro fans can have really accurate inner body positions (thru mars).

By way of biography, McKinnon is "an electrical engineer by profession, a musician by temperament, and only latterly, and astrologer by hobby." About a couple of years ago, he became interested in the area of how the pocket calculator could best be of use to astrologers. To date, he has written programs for all of the inner planets (this issue) and is currently occupied in trying to construct similar programs for the remainder. These programs are capable of being implemented on any of the popular brands of pocket calculators. We will no doubt carry more of McKinnon's work in MATRIX in the future. We owe our thanks to him for this inner body material. We are lucky to have folks like Neely and McKinnon around!

CALCULATOR VS MICRO VIA MATRIX MAGAZINE

We have gotten some criticism from micro fans to the effect that we devote too much space to calculator programs that are being outdated by the new home micro systems. These folks would like to see more programs, subroutines and the like in BASIC.

My response to this is: so would I! but where are all the contributions from all of you micro fans? Aside from myself and Rob Hand, I have yet to receive <u>any</u> BASIC material at all. What I wish was that Neely and McKinnon had microcomputers along with their programmables. At any rate, if micro users want to see more stuff in BASIC, send it along. We are ready.

MATRIX FORMAT: REDUCED TEXT

Well, as you can see, we did manage to make the reduced format goal...but not in vertical columns. We received quite a few requests from readers for the reduced format..which gives you two pages of copy where before we had one. (twice as much work too!) We like it too and if you will bear with us, we will have (I am hopeful) vertical columns and justified margins by next issue.

INEXPENSIVE MEMORY FOR PET & TRS

They told us that memory was going to go down and they were right. Here is the address of a great shop in the east that has 8K of memory (fits the EXPANDAPET) ready to plug in for $40! and 16K for the TRS-80 for $99.

THE C.P.U. SHOP
39 Pleasant St.
Charlestown, MA 02129
(617) 242-3350

We learned of this place thru Lorelei Woods who works there. Lorelei is also an astrologer and has written a very nice review of MATRIX which appeared in the NEW AGE JOURNAL.

I picked up a great little interface for my TRS-80 to RS-232 line-printer at $40 from

MICROTRONIX
P.O. BOX Q
Philadelphia, PA 19105
1-800-523-4550

The interface connects with or without the expansion interface and requires loading of a short software program. It works great!

I am told that HEWLETT-PACKARD is coming out with a 2000 step programmable calculator for a reasonable price in the near future. The user will be able to purchase a variety of peripherals for it. Will let you know more when there is more to be known.

Another rumor promises that we will see floppy disks for under $200 before the end of 1979!

THE FIRST ANNUAL TECHNICAL CONFERENCE

I don't know if that will be the name of the conference but MATRIX/HEART CENTER along with NCGR will sponsor a major technical conference to be held on an annual basis in Ann Arbor starting next spring-summer. This is all rather tentative at the moment but Charles Jayne, Robert Hand and the editors have agreed to give it a go. Jayne and Hand will come for traveling expenses and we hope to have others.

The conference will provide an opportunity for technically oriented astrologers to meet and share information thru seminars and workshops. Nothing too formal. We will have symposiums on various topics ... attended by all of the speakers. There will also be workshops on a variety of technically interesting subjects. We will have some short courses on programming astrology on micro systems, hand calculators and the like. In addition we hope to agree on a variety of standards that relate to programming, computing and what not.

As pointed out, this is still in the formative stage. Send us your thoughts about what we all could do together..aside from have a good time. We will try to find places for many of you to stay..and otherwise make the conference as economically pleasant as possible.

At this point Hand, Jayne and the Erlewines will be there for sure. Who else would like to speak, lecture, share and what not?

MATRIX issue FOUR and Ramblings.

We are already gathering material for our next issue. At this point, we would appreciate some feedback from our readers as to the direction MATRIX is to take in the future issues. Aside from a lot of support we have received some criticism. The chief criticism is that MATRIX is not immediately accessible to the general astrological public. This kind of thought goes on to point out that <u>if</u> it were, we would not only be a more popular magazine but also better educate the general astrological public in computing matters.

My response to this approach is to suggest that there are signs that a general tutorial approach to astronomy and the mathematics of astrology is near at hand thru the more popular magazines now available to astrologers. I imagine that within a year or two (at the most) we will see a marked increase in the general interest in these matters as reflected thru such magazines as ASTROLOGY NOW and others.

MATRIX was formed as a kind of information co-operative for a group of astrologers who are active in the many technologies of astrology. I envision MATRIX to be a rather technical (and perhaps for that reason, exclusive) publication thru which a group of individuals with a similar mind can hold a dialogue— share an experience that we have in common. At the same time I would not want in any way to deny access ...to this group to individuals who have similar feelings but lack experience.

My entrance into the world of Astronomy, Mathematics and Computers has been difficult with all success very hard won. I dont know exactly what an "easy" approach to these subjects might be. I continue to "plow" into new regions..to bite off new projects and so forth. We could use some really good beginning articles on how to use calculators and computers to do astrology. And yet, my feeling is that MATRIX will remain a little out of touch perhaps for the rank beginner in these subjects. There is so much to learn and the deeper I get..the deeper I get into more things to comprehend and to understand and to learn to use.

I am sure you understand what I am saying here. I would like some feedback from you on this matter of what kind of level should we be aiming at. For myself, I have learned to live with an understanding of how very little I know about math and all of its implications. It seems I am forever "just" making something hang together and work for me in a program. I poured for years (and continue to study) over all kinds of equations that I just could not make head nor tails out of. For an example, I could not translate the Newcomb Vol. 6 of the A.P.N.A. and extract the equations of the inner planets to save my soul. Thank God Ian McKinnon could and did and made them available to me and the rest of us. My message is that those of you who feel like this material in MATRIX is over your head had better know that it (or parts of it) is over most of our heads. You just have to start somewhere...carve out a piece and dig in. My understanding grows and expands as books and equations I could make no sense out of even 6 months ago..now begin to seem possible. I believe that you have to want to put this information to use before the incentive necessary to negotiate this material arises.

GENERAL EQUATIONS FOR EPHEMERIDES

LOCAL SIDEREAL TIME

THE TERRESTRIAL PLANETS

Implemented on the Hewlett-Packard HP-67/97

Programmable Calculator

by

IAN McKINNON

ERRATA in Page 5, line 5 read "+ (30.6 [M+1]) INT for March, April, etc.; for Jan and Feb, use +(30.6[M+13])INT" last paragraph " Nutation in obliquity...", line 5a (a= text on right hand side of pages) reads "+ .27692=..." Page 7, line 15, "+ .0010344 cos(2V - 1A - 160.692)"; line 30, "Values for J,V,Ep are defined on P. 8"; Page 8, line 3, "Mean Sun + (1.9]94603 - 1.31113x10^{-7} Ep)sin 1E"; Page 9, line 1a "relevant"; line 35a, "-(.00296214 - 5.676x10^{-10} Ep) cos 1V"; line 20a "M= 319.5294250+ .524020767 Ep + .0001808(Ep/36525)^2" on page 10, On page 11 line 6 "-(.0002481+2x10^{-11} Ep)cos 3M"; Page 12 opposite step 20 read "Converts longitude and latitude to decimal"; step 56 "X-Y -41"; step 112 read "STO Ø 35 00"; step 168 read "STO D 35 14"; step 224 read "GTO 0 22 00" Page 13, opposite step 50 read "t^2 term in mean Mars and Mean anomaly"; step 195 read " 4 04"; Page 14, step 202 is "TAN 43"; Page 17, step 30 "STO 5 35 05"

(cont page 9)

Ephemeris of Local Sidereal Time

Program Description, Equations, Variables. Given the time, date and geographic longitude and latitude of an event, this program calculates the local sidereal time (± 0.1 time-seconds), true obliquity of the Ecliptic (± 1.1 arc seconds), Ascendant and Midheaven. The first two parameters are stored in the machines, the latter two are output in the astrological convention: sign no. (x-register); degree-in-sign (y-register). Outside of the range 1800 AD to 2000 AD, errors will be greater than those stated above.

The program calculates the time, in decimal days, from the reference epoch: noon, 31 Dec 1899 AD to obtain the local sidereal time and obliquity. The Ascendant is calculated from:

$$\text{Asc.} = \arctan \frac{\sin(\text{LST} + 90^\circ)}{\cos \epsilon \cos(\text{LST} + 90^\circ) - \sin \epsilon \tan \text{latitude}}$$

Where: LST = local sidereal time; degrees of arc (RAMC);
ϵ= obliquity of the Ecliptic; degrees of arc;
latitude = geographic latitude; degrees of arc;

The calculation for the Midheaven 1) deletes the second term in the denominator and 2) does not add 90° to LST.

This program does not allow for precession.

Operating Limits and Warnings. 1) Calendar validity: any Gregorian date; 2) LST in Rc may be < 0, and/or > 360; 3) Midnight (beginning of day) must be entered as 0h AM; 4) Input and output are in DMS; calculation and storage are in decimal; 5) If ΔT is unknown, enter 0 at step 5.

User Instructions	Input	Keys	Output
1) Load sides 1 & 2 of card			
2) Enter time: If AM;	HH.mmss	A	HH.hhhh
If PM:	HH.mmss	f A	HH.hhhh
3) Enter time corrections:			
Zone difference from GMT(east: +	HH.mmss	f B	HH.hhhh
west: -)	-HH.mmss	f B	HH.hhhh
Daylight Savings Time, or other locat time advancement	HH.mmss	f B	HH.hhhh
4) Enter Longitude (east:-; if west:+)	DDD.mmss	ENT	DDD.mmss
Enter Latitude (north:+;if south:-)	DD.mmss	B	
5) Enter day	DD	ENT	
month	MM	ENT	
year	YYYY	ENT	
ΔT (delta T correction)	SS	C	NN.0000
(NN.0000 represents sign no.)		X↔Y	DD.mmss
6) Calculate Midheaven		D	NN.0000
(DD.mmss represents degree-in-sign)		X↔Y	DD.mmss

7) For new data, return to step 2.

NOTES:

a) midnight must be entered as 0^h; (beginning of day); b) for ΔT correction see tables in American Ephemeris & Nautical Almanac or in back of Michelsen's American Ephemeris 1931-1980; c) Longitude, Step 4, and zone difference, Step 3, are signed oppositely. For a place west of Greenwich, longitude will be +, and zone correction -. For a place east of Greenwich, longitude will be -, and zone correction +. d) If ΔT is unknown, enter 0.

EPHEMERIS OF LOCAL SIDEREAL TIME: RELEVANT EQUATIONS

1) Time from the epoch noon, 31 December 1899 AD, as counted by the Gregorian calendar; units: constant ephemeris days of 86400.0000000000"

(A) = (365.25Y) INT
(B) + (30.6 [M+1]) INT
(C) + D

$$- \left[\frac{(T - 123)}{36525}\right] \text{INT}$$

$$+ \left(\left|\left[\frac{(T - 123)}{36525}\right] \text{INT}\right| \div 4\right) \text{INT}$$

- 694023.5

$$+ \frac{(GMT)}{24}$$

+/- correction for Ephemeris Time

NOTE: Alternately this count of days = JD# -2415020.0

Where: Y = Year (four digits),
M = Month number,
D = Day of month
T = sum of lines (A), (B) and (C).

(2) True Obliquity of the Ecliptic (approximation); units: decimal degrees;

$$\epsilon = \sqrt{550}$$

Where EP = time (decimal days) away from the above epoch.

$$- \frac{Ep}{(41)^2}$$

+ .0025583 cos MEAN LUNAR NODE Ω

NOTE: The last term in this equation is evaluated by steps 160 to 166 in the program. By a fortunate coincidence, sine of .27692° (used in steps 134 to 139 to set the phase of the sidereal-time function) equals a usable close appoximation to the first term in the series for the nutation in longitude.

Thus sine .27692° = .0048331469° [→H.ms]= .001″399329
nutation in longitude (first term) = -17″.2327

By a further happy coincidence, if you divide this coefficient by $10^{.27692}$ you get a similarly useable approximation to the first term in the nutation in obliquity.

Thus $\frac{.0048331469^\circ}{10^{.27692}} = \frac{.0048331469^\circ}{1.891995} = .0025545241 = +9″.196287$

Nutation is obliquity (first term)= +9″.2100. The program would be less obscure if, at steps 163 and 164, I had simply used "2" (ie, 17″.2327/2= 8″.61635), but doing it the way I have gives a closer approximation. Who reads programs anyway!

Sidereal Time; units: revolutions;

$$= \frac{Ep}{365.25 - (1/468.2)^2} = \frac{Ep}{365.2421988}$$ = no. of annual revs since epoch;

+ (1 + 1/365.2421988)(GMT/24)= no. daily revs since midn.

- Geographic Longitude/360 = fract. rev. away from Greenwich;

- .27692 = a constant derived from Newcomb, but diminished by .5 (or 12 hours) because of change of reference from noon to midnight.

the above four terms X 360 to convert from revolutions to degrees;

- sin(.27692) X cos(259 - Ep/18.88434).= first term in the series for the nutation in longitude.

NOTES: 1) I will be the first to admit that this is a rather clumsy and obscure way to evaluate this function. Unfortunately, if you do it the more straightforward way, you'll be out about 12" to 13" per century because of the HP 67's rounding to 10 significant figures. Sidereal time advances because of the Earth's axial rotation as well as its rotation around the Sun, and if you keep track of that full revolution every day, plus the fraction represented by GMT PLUS the fraction of orbital travel represented by the day of the year, you don't have many significant figures left.

2) This approximation of the Moon's Node is close enough for Sidereal time, but not for use in the Moon Ephemeris (another McKinnon program not listed here).

3) The nutation coefficient is negative, therefore the last term is (eventually) subtracted at step 169.

4) The full series for the nutation in longitude, as given by THE IMPROVED LUNAR EPHEMERIS is:

(-17″.2327 - 0″.01737 T) sin Ω MEAN
(- 1″.2729 - 0″.00013 T) sin 2L
(+ 0.2088 + 0.00002 T) sin 2 Ω MEAN
(- 0.2037 - 0.00002 T) sin 2 MEAN MOON
etc.

Where L= MEAN LONGITUDE OF THE SUN.

The full series consists of about 40 to 50 terms of decreading amplitude, and, excluding the first, amount altogether to a little over 2". The series for the nutation in obliquity consists of about 20 to 30 terms and the error caused by neglecting all but the first of these terms is a little under 1".

5) In most of my programs, I don't think I bother reducing intermediate angles to the first circle. I leave it all till the end. In the HP 67, this doesn't affect accuracy (except for loss of significant figures), but this personal sloppiness may not be acceptable on other machines.. For example, Texas Instruments specifies a limit of ± 36,000 degrees for their SR-52.

6) By the way, in case you hadn't noticed a reasonably cheap way to accomplish this reduction is steps 180 to 186 of Card 2 of the Sun Ephemeris. No subroutines are necessary, and the angle is automatically placed so that 0 < z < 360.

Sample Problem for Ephemeris of Local Sidereal Time.

Find the Ascendant and Midheaven for an event at: Longitude: 75°W42'; Latitude: 45°N25'; (Ottawa, Canada) on February 1, 1890 at 1:23 PM EST with a ΔT correction of -7". In addition, recover the local sidereal time and obliquity used in the calculation.

Solution: Ascendant= 3.0000 (X↔Y)= 28.1258= 28 Gemini 12' 58"
Midheaven=11.0000 (X↔Y)= 29.5125= 29 Aquarius 51'25"
LST= RCLC= -3268.0448 (RCLB) (R↑) (→P) (X↔Y) (+)(15)(÷)(→H.ms)=

LST= 22h 7m 49s (underlines are operations performed on the machine to recover LST, etc)

ε = (RCL)(8) (→H.ms)= 23° 27' 12"

Ephemeris of the Sun (apparent; tropical)

PROGRAM DESCRIPTION, EQUATIONS, VARIABLES: This program calculates the apparent tropical longitude and declination of the Sun with an error less than 2 seconds of arc in the range 1800 AD to 2000 AD.

The equation of the program is of the form:

$$\text{Longitude} = k_1 D + K_2 f_{(D)} + K_3 g_{(D)} + \ldots + \ldots;$$

where K_1 = daily mean motion of the Sun; D= number of days from the reference epoch of noon, 31 Dec 1899; k_2, k_3, etc. = coefficients of corrections to the mean longitude caused by 1) the eccentricity of the Earth's orbit and 2) perturbations of the Moon and planets.

In order to minimize program space and execution time, several of the required parameters (time from epoch, nutation, etc...) are picked up from registers into which they have been stored by the preceding program (Local Sidereal Time) which must be run before executing this or the following programs.

If ΔT has been entered into the sidereal-time program, the independent variable in this program is E.T.; if not, U.T.

USER INSTRUCTIONS: Sun Ephemeris

1) Be sure that Local Sidereal Time Program has been executed. (perform steps 2 to 6, inclusive, of that program)
2) Load card 1 of this program; PRESS KEY A
3) Insert card 2 of this program into the machine;
4) Load card two after machine has executed card one
5) Longitude (sign number): NN.0000
(deg-in-sign): (X↔Y) DD.mmss
6) Declination B ±DD.mmss
7) for new data, return to step 1

NOTES: The longitude is output in the deg-in-sign convention; the astrological signs are symbolized as follows: 1.0000= Aries, 2.0000= Taurus, etc. The longitude is also stored in Ri in decimal degrees.
Solution: (data as given in preceding program);
Sun = 11.0000; (X↔Y)= 12.5439= 12° Aquarius 54' 39"
Declination= (B)= -16.5653= 16° S 56' 53"
NOTE: Card 2 must be recorded with machine in FIX 0 for step 175.

EPHEMERIDES OF MERCURY, VENUS AND MARS

The User-Instructions are identical for these planets and will be given only once.

The heliocentric longitude, distance and latitude of the planet are first calculated by Fourier series. These co-ordinates are then converted to equatorial rectangular co-ordinates (x,y,z) and added to the corresponding co-ordinates of the Sun, derived by the preceding program for the Sun. Since the co-ordinates of the Earth are identical to those of the Sun (neglecting the latitude of the Sun, generally less than 1") ± 180 degrees, this latter step is equivalent to subtracting the co-ordinates of the Earth. The result is the geocentric equatorial rectangular co-ordinates of the planet, which are then converted to ecliptic spherical co-ordinates: longitude and latitude. A small correction to account for distance travelled during the light time is made to the longitude; the declination and right ascension are not so corrected, and display greater errors than the longitude.

This same correction also indicates the direction in which the planet is moving, relative to the earth. If this motion is from east to west (retrograde), the sign number displayed by the program is prefixed with a minus (-) sign. Accuracy of retrograde detection is approximately 1 day.

OPERATING LIMITS and WARNINGS. These programs must be preceded by that for the Sun, after which the planets may be run in ANY order.

Notes to MERCURY: Card 1 must be recorded in FIX0 for step 137
Notes to VENUS: The equations used in this program are identical to those in the Mercury program except for the means of correcting the planet's geometric position to the apparent position. In the Mercury ephemeris, this correction was derived by vector subtraction of the Earth's velocity from that of Mercury. Since the velocities of Venus and Earth are more nearly equal, the resulting correction will be less accurate using this method.

An alternate correction may be used: 1) derive the distance to Venus; 2) calculate the light-time for this distance; 3) calculate the geometric position for the initial time less this light time. Unfortunately, the program takes longer to run using this method, but the resultant orbital parameters (longitude, declination, right ascension, etc.) are more accurately calculated.
NOTE that Card 1 requires a preset display status of FIX 0 for step 010, and that Card 2 has flag 0 similarly preset.

Notes to MARS: The equations used in this program are identical to those in the Venus program. The orbital parameters are those of Newcomb (APAE, Vol. 6, part 1) corrected by the derivations of Ross (APAE, vol 9, part 2).
NOTE: Card 1 & 2 require that the display be set to FIX 0 via card status for steps 005 and 197, respectively. Flag 0 is similarly set prior to recording Card 3

Ephemeris of Mercury: Relevant Equations

(note: unless otherwise noted, all units in decimal degrees)

Heliocentric Orbital Longitude:(L)

Mean Mercury + (23.43825278 + 6.3199 X 10^{-8}Ep) sin 1A
+ (2.98132778 + 1.5994 X 10^{-8}Ep) sin 2A
+ (0.52558333 + 0.4221 X 10^{-8}Ep) sin 3A
+ .1058722 sin 4A
+ .0229333 sin 5A
+ .0052000 sin 6A
+ .0012139 sin 7A
+ .0002889 sin 8A
+ .0001975 cos(1V - 1A - 35.47)
+ .0001533 cos(2V - 3A -161.15)
+ .0005833 cos(2V - 2A -161.148)
+ .0010344 cos(2V - 1A - 60.692)
+ .0002025 cos(2V - 0A - 159.76) note: 0 = zero
+ .0003692 cos(3V -2A - 104.78)
+ .0001497 cos(3V - 1A -278.95)
+ .0001903 cos(5V -4A - 349.57)
+ .0007806 cos(5V -3A - 349.86)
+ .0020433 cos(5V - 2A - 347.78)
+ .0004086 cos(5V -1A -347.70)
+ .0001936 cos(1J - 1A - 181.07)
+ .0001594 cos(1J - 0A - 236.72)
+ .0002606 cos(2J - 2A - 36.98)
+ .0009097 cos(2J - 1A - 37.00)

Where Mean Mercury =

178.1790778 + 4.092377023345 Ep + .0003011 $(Ep/36525)^2$

A = 102.2793805 + 4.092334437 Ep = Mean Anomaly Mercury

Values for J,V,Ep are previously defined.

Mercury Longitude of Ascending Node of the Orbit : Ω

Ω = 47.145944 + 3.24492 X 10^{-5} Ep + .0001738 $(Ep/36525)^2$

Mercury Inclination of the Orbit to Ecliptic: i

i = 7.00288056 + 5.0947 X 10^{-8}Ep

Heliocentric Ecliptic Longitude: l_e

l_e = L +R
= L - .2145125 sin 2(L - Ω) + .00040167 sin 4(L - Ω)

MERCURY EQUATIONS (continued)

Common Logarithm of the Radius Vector: $\log_{10} r$

$\log_{10} r$ = -.40756361 + 2.5188 X 10^{-11} Ep
-(.08787882 + 2.31622 X 10^{-10} Ep) cos 1A
-(.01341631 + .71184 X 10^{-10} Ep) cos 2A
-(.00257908 + .20534 X 10^{-10} Ep) cos 3A
- .00054805 cos 4A
- .00012322 cos 5A
- .00002874 cos 6A
- .00000687 cos 7A
- .00000168 cos 8A
+ .00000049 cos(1V - 1A - 305)
+ .00000071 cos(2V - 3A - 71)
+ 237 cos(2V - 2A - 71.188)
+ 90 cos(2V - 1A - 70)
+ 76 cos(2V - 0A - 250) note:0 = zero
+ 54 cos(3V - 3A - 16)
+ 116 cos(3V - 2A - 14.84)
+ 36 cos(4V - 3A - 139)
+ 85 cos(5V - 4A - 259.5)
+ 295 cos(5V - 3A - 259.92)
+ 155 cos(5V - 1A - 77.75)
+ 47 cos(5V - 0A - 77.70)
+ 71 cos(1J - 1A - 91)
+ 118 cos(2J - 2A - 307)
+ 327 cos(2J - 1A - 306.987)
+ 37 cos(2J - 0A - 127)

NOTE: ALL of the terms from +237 and downward: Each coefficient should be "x10^{-8}, for example:
+ 237 cos(2V - 2A - 71.188)
should read:
+"237x10^{-8} cos(2V-2A-71.188)
and so forth.

Where: The independent parameters have been defined and r is expressed in astronomical units (Earth's semi-major axis)

Heliocentric Latitude: b

$b = \sin^{-1}[\sin i \sin (L - \Omega)]$

Equations for an Ephemeris of the Sun with an Accuracy of ± .5"

Ecliptic longitude of the geometric Sun =

Mean Sun + (1.9194603 1.31113 X 10^{-7} Ep) sin 1E
+ (.0200939 - 2.75 X 10^{-9} Ep) sin 2E
+ .0002928 sin 3E
+ .0013439 cos (299.1 + 1V - 1E)
+ .0000322cos (148.9 + 2V - 1E)
+ .0015350cos (148.313 + 2V - 2E)
+ .0006936 cos (315.943 + 2V - 3E)
+ .0001850 cos (177.71 + 3V - 3E)
+.0004331 cos (345.253 + 3V - 4E)
+.0002844 cos (318.15 + 3V - 5E)
+ .0000583 cos (206 + 4V - 4E)
+ .0000400 cos (195 +4V -5E)
+ .0000422 cos (344 + 4V -6E)
+ .0000342 cos (195 + 5V - 7E)
+ .0000428 cos (359.6+5V -8E)
+ .0000758 cos (218 - 1M + 1E)
+ .0005675 cos (343.888 - 2M + 2E)
+ .0004917 cos (200.402 - 2M + 1E)
+ .0000358 cos (294.2 - 3M + 3E)
+ .0001181 cos (338.88 - 3M + 2E)
+ .0001389 cos (105.18 - 4M + 3E)
+ .0001625 cos (334.06 - 4M + 2E)
+ .0000567 cos (101 - 5M + 3E)
+ .0000428 cos (227 - 6M + 4E)
+ .0000281 cos (96 - 6M + 3E)
+ .0000294 cos (223 - 7M + 4E)
+ .0000453 cos (199 - 1J + 2E)
+ .0020022 cos (179.532 - 1J + 1E)
+ .0007222 cos (263.217 - 1J + 0E) (note: 0= zero)
+ .0007586 cos (87.145 - 2J + 2E)
+ .0004472 cos (109.493 - 2J + 1E)
+ .0000456 cos (170.5-3J + 3E)
+ .0001544 cos (82.65 - 3J + 2E)
+ .0000583 cos (98.5 - 3J + 1E)
+ .0001164 cos (100.58 - 1S + 1E)
+ .0000889 cos (269.46 - 1S + 0E)
+ .0000300 cos (290.6 - 2S + 2E)
+ .0000311 cos (293.6 - 2S + 1E)
+ .0017928 sin D
+ .0000492 sin (D + L)
+ .0001178 sin (L - D)
+ .0000478 sin (D - E)
+ .0000739 sin (31.8 + .0032580 Ep)
+ .0017778 sin (231.2 + .0005530 Ep)
- .0005228 sin (57.24 + .0041142 Ep)
+ .0000561 sin (315.6 + .0244572 Ep)

Where:

Mean Sun = 279.6966778+.98564733538 Ep + .0003025 $(Ep/36525)^2$

E = 358.4758 + .985600267 Mean Anomaly of Sun

V = 212.45 + 1.60212171 Ep = Mean Anomaly of Venus

M = 319.58 + .52402395 Ep = Mean Anomaly of Mars

J = 225.28 + .0830822696 Ep = Mean Anomaly of Jupiter

S = 175.6 + .033451 Ep = Mean Anomaly of Saturn

D = 350.74 + 12.19075 Ep = Mean Moon - Mean Sun (Elongation)

L = 296 + 13.065 EP = Mean Anomaly of the Moon

Ep = decimal ephemeris days from the epoch noon, December 31, 1899

Ecliptic longitude of the apparent Sun =
geometric sun + nutation - .0056947/EV

Where: Nutation = - .0047869 sin LN
- .0003536 sin 2(Mean sun)
+ .0000580 sin 2LN
- .0000566 sin 2(Mean moon)
+ .0000350 sin E

LN= 259.1833 - .0529539 Ep + .0020788 $(Ep/36525)^2$ = Lunar Node

Mean moon = 270.434 + 13.176 Ep

EV= Radius Vector of the Earth

NOTE: Only terms of perturbation greater than .1" of arc are given; smaller terms are neglected.

Logarithm of the Earth's Distance from the Sun= Log_{10}R.V.=

.00003057 - 4.1 X 10^{-12} Ep——(constant term in Equation of Centre)
+(-.00727412 + 4.966 X 10^{-10} Ep) cos E
+(-.00009138 + 1.259 X 10^{-11} Ep) cos 2E
+(-.00000145 + 2.738 X 10^{-13} Ep) cos 3E
} Equation of the Centre for log radius vector of sun (earth)
+ 1336 X 10^{-8} cos D
- 133 X 10^{-8}cos (D - L)
} Lunar Perturbation
+ 2057 X 10^{-9}cos(254 - 2M + 2E)———— Mars Perturbation on log R.V.
+ 7067 X 10^{-9}cos(90 - 1J + E)
+ 4026 X 10^{-9}cos(357 - 2J + 2E)
+ 1459 X 10^{-9}cos(19 - 2J + 1E)
+ 803 X 10^{-9} cos(353 - 3J + 2E)
} Jupiter Perturbations
+ 2359 X 10^{-9}cos(209 + 1V - 1E)
+ 6842 X 10^{-9}cos (58 + 2V - 2E)
+ 869 X 10^{-9} cos(227 + 2V - 3E)
+ 1045 X 10^{-9}cos(88 + 3V - 3E)
+ 1497 X 10^{-9}cos(255 + 3V - 4E)
} Venus Perturbations

Where terms are as defined previously. Notes (1) The above equations are not direct translations of the HP programs. They are extracts from Newcomb and the I.L.E that include the major terms of correction. The HP programs were limited by the constraints imposed by a small machine.
(2) The longitude of the true or geometric sun is approximately the apparent sun + 20".45 (seconds of arc). The geometric Sun, not the apparent Sun, should be used to calculate planetary positions. (3) The latitude of the Sun is assumed to be zero, an error of about 1".

NOTE: the 2nd, 3rd and 4th terms of the above can also be read as follows: "+ cosE(-.0072412 + 4.966 X 10^{-10}EP), etc.

ERRATA (continued) Page 18, step 56 "STO 4 35 04"; opposite step 150 read "Perturbations $J_{+2,-1}$"; Page 19 step 70 "D>R 16 45"; Step 72 "P>R 44"; opposite step 143 "Sum nutation to λ"; Page 20, opposite step 41 read "Mean anomaly of Venus"
FLAG STATUS: L.S.T., Card One: all off; Trig: Deg; Disp: FIX 4; MARS CARDS 1&2, FLAGS OFF, TRIG DEG; DISP: FIX 0; CARD THREE: FLAGS: FLAG 0 is on, TRIG: DEG; DISP: FIX 4: SUN CARD ONE;FLAGS OFF; TRIG: DEG; DISP: FIX 4; Card TWO, FLAGS OFF; TRIG: DEG; DISP: FIX 0; MERCury CARD ONE, FLAGS: OFF; TRIG: DEG; DISP: FIX 0; card TWO, FLAGS OFF; TRIG: DEG; DISP: FIX 4; VENUS CARD ONE, FLAGS OFF; TRIG: DEG; DISP: FIX 0; CARD TWO, FLAGS: FLAG 0 is ON, TRIG: DEG, DISP:FIX 4

EPHEMERIS OF VENUS: Relavent Equations

all units are in decimal degrees unless otherwise noted

Heliocentric Orbital Longitude, L

L = Mean Venus + (.7815889 - 1.49776 X 10^{-7}Ep) sin 1V
+ .00333194 sin 2V
+ .0013581 cos(1E - 1V - 119.107)
+ .0031281 cos (2E - 2V - 148.225)
+ .0019800 cos (3E - 3V - 357.435)
+ .0009572 cos (3E - 2V - 135.912)
+ .0002872 cos (4E - 4V - 26.54)
+ .0001881 cos (4E - 3V - 165.32)
+ .0004375 cos(5E - 4V - 193.93)
+ .0003997 cos (5E - 3V - 138.078)
+ .0007750 cos (13E - 8V - 227.943)
+ .0001869 cos (3M - 2V - 221.62)
+ .0003356 cos (3M - 1V - 237.572)
+ .0008239 cos (1J - 1V - 208.086)
+ .0004342 cos (1J - 0V - 268.312) note: 0 = zero
+ .0002469 cos (2J - 2V - 145.16)

Where Mean Venus =
342.7670528 + 1.602168704 Ep + .00030967 $(Ep/36525)^2$
Mean Anomaly of Venus = V
V = 212.603222 + 1.602130154 Ep + .0012861 $(Ep/36525)^2$
other independent parameters described above
Longitude of the Ascending Node of the Orbit: Ω
Ω = 75.7796472 + .0000246366 Ep + .000410 $(Ep/36525)^2$
Inclination of the Orbit to the Ecliptic: i
i = 3.3936306 + 2.7538 X 10^{-8} Ep
Heliocentric Ecliptic Longitude; l_e
l_e = L + R
= L - .050281 sin 2(L - Ω)

Common Logarithm of the Radius Vector: $\log_{10}$ r, where r is in astronomical units (a.u.)
$\log_{10}$ r = -.14065714
-(.00296214 + 5.676 X 10^{-10} Ep) cos 1V
- .00001515 cos 2V
+ .00000225 cos (1E - 1V - 29.110)

(continued) Common Logarithm of Radius Vector of Venus

+ .00000977 cos (2E - 2V - 58.2083)
+ " 827 cos (3E - 3V - 267.4233)
+ 74 cos (3E - 2V - 47.37)
+ 143 cos (4E - 4V - 296.486)
+ 45 cos (4E - 3V -75.70)
+ 51 cos (5E - 5V - 326.64)
+ 157 cos (5E - 4V - 104.208)
+ 72 cos (3M - 2V - 131.60)
+ 299 cos (1J - 1V - 118.09)
+ 134 cos (2J - 2V - 55.167)
+ 46 cos (2J - 1V - 80.95)

NOTE; These should be multiplied by 10^{-8}, example:
827 should read:
.00000827 cos(3E - 3V - etc.
74 should read
.00000074 cos(etc.

EQUATIONS FOR AN APPROXIMATE EPHEMERIS OF MARS

Heliocentric Orbital Longitude; L:

L = Mean Mars + (10.68125364 + 2.8765 X 10^{-7}Ep) sin 1M
+ (.62163853 + .3346 X 10^{-7}Ep) sin 2M
+ (.05016072 + .0405 X 10^{-7} Ep) sin 3M
+ .00462536 sin 4M
+ .0004586 sin 5M
+ .0001731 cos (2M - 1V - 246.03)
+ .0017689 cos (3M - 1V - 57.6016)
+ .0001633 cos (4M - 1V - 57.24)
+ .0001275 cos (6M - 2V - 217.58)
+ .0002425 cos (0M - 1E - 34.34) note: 0= zero
+ .0023775 cos (1M - 1E - 35.097)
+ .0038794 cos (2M - 1E - 20.495)
+ .0004131 cos (3M - 1E - 22.18)
+ .0020431 cos (3M - 2E - 158.638)
+ .0013625 cos (4M - 2E - 154. 093
+ .0001358 cos (5M - 2E - 154.39
+ .0007336 cos (5M - 3E - 280.580)
+ .0002694 cos (6M - 3E - 276.06)
+ .0003211 cos (7M - 4E - 41.64)
+ .0001597 cos (9M - 5E - 164.48)
+ .0004314 cos (15M - 8E - 170.1367)

EPHEMERIS MARS (continued)

+ .0008733 cos (1J - 2M - 46.78)
+ .0070511 cos (1J - 1M - 48.9583)
+ .0010367 cos (1J - 0M - 342.382) note: 0 = zero
+ .0001317 cos (1J + 1M - 325.4)
+ .0005856 cos (2J - 3M - 192.723)
+ .0044542 cos (2J - 2M - 191.8967)
+ .0060747 cos (2J - 1M - 188.3500)
+ .0004058 cos (2J - 0M - 189.6633) note: 0 = zero
+ .0003636 cos (3J - 3M - 168.2700)
+ .0007242 cos (3J - 2M - 228.407)
+ .0008817 cos (3J - 1M - 207.203)
+ .0003753 cos (1S - 1M - 325.9)
+ .0002456 cos (1S - 0M - 288.05) note: 0=zero
+ .0001722 cos (2S - 2M - 35.15)
+ .0004911 cos (2S - 1M - 32.5)

Where Mean Mars=

293.7476278 + .524071164 Ep + .00031067 $(Ep/26525)^2$

Mean Anomaly of Mars = M

M = 319.5294250 + .524020767 Ep + .0003119 $(Ep/36525)^2$

V= 212.388 + 1.6021182. Ep = Mean Anomaly Venus

E= 358.415 + .9855969 Ep = Mean Anomaly Earth

J= 225.209 + .0830790 Ep = Mean Anomaly Jupiter

S = 175.533 + .0334475 Ep = Mean Anomaly Saturn

Note: The mean anomalies of Venus, Earth and Jupiter may be approximated by the values given in the equations for Venus and Mercury with little loss in precision.

Longitude of the Ascending Node of Mars: Ω

Ω = 48.78644167 + .0000211086 Ep

Inclination to the Ecliptic: i

i = 1.8503333 - 1.848 X 10^{-8}Ep

Heliocentric Ecliptic Longitude of Mars: l_e

l_e = L + R
= L - .0149414 sin 2(L - Ω)

Common Logarithm of the Radius Vector of Mars, $\log_{10} r$:
(r in astronomical units)

$\log_{10} r$ = .1838434 + 1868.9x10^{-9}(EP/36525)^2
- (.0403933 + 1.0830 X 10^{-9}Ep) cos 1M
- (.0028212 + .1515 X 10^{-9} Ep) cos 2M
- .0002481 cos 3M
- .0000241 cos 4M
- .0000025 cos 5M
- .0000003 cos 6M
+ .00000068 cos (1M - 1V - 156.14)
+ .00000081 cos (2M - 1V - 155.77)
+ .00000056 cos (3M - 1V - 327.94)
+ .00000062 cos (4M - 1V - 147.28)
+ .00000111 cos (0M - 1E - 304.05)
+ .00000695 cos (1M - 1E - 304.445)
+ .00000288 cos (2M - 1E - 113.202)
+ .00000162 cos (3M - 1E - 112.382)
+ .00000048 cos (2M - 2E - 266.42)
+ .00000641 cos (3M - 2E - 68.622)
+ .00000198 cos (4M - 2E - 244.702)
+ .00000054 cos (5M - 2E - 244.35)
+ .00000059 cos (4M - 3E - 19.17)
+ .00000204 cos (5M - 3E - 190.603)
+ .00000059 cos (6M - 3E - 6.8)
+ .00000075 cos (7M - 4E - 312.67)
+ .00000052 cos (1J - 3M - 316.25)
+ .00000389 cos (1J - 2M - 316.385)
+ .00002312 cos (1J - 1M - 318.869)
+ .00000152 cos (1J - 0M - 117.810)
+ .00000053 cos (1J + 1M - 59.67)
+ .00000304 cos (2J - 3M - 102.888)
+ .00002214 cos (2J - 2M - 101.9847)
+ .00001662 cos (2J - 1M -98.3292)
+ .00000148 cos (2J - 0M - 279.035)
+ .00000214 cos (3J - 3M - 76.243)
+ .00000348 cos (3J - 2M - 139.736)
+ .00000192 cos (3J - 1M - 115.828)
+ .00000134 cos (1S - 1M - 235.850)
+ .00000087 cos (2S - 2M - 305.30)
+ .00000166 cos (2S - 1M - 302.513)

NOTE: THE INDEPENDENT PARAMETERS ARE THE SAME AS GIVEN ABOVE.

USER INSTRUCTIONS FOR MERCURY, VENUS & MARS

	Keys	
1) Execute Local Sidereal Time Program		
2) Execute Sun Program		
3) Read sides 1 & 2 of Card 1 of Mercury, Venus or Mars program.	A	
4) Insert Card 2 into machine while executing Card 1		
5)Read other side of Card 2 after machine has executed Card 1		
6) Repeat for third card if Mars		
7) Longitude: (sign number)		± NN.0000
8) +: Direct; -: Retrograde	X↔Y	DD.mmss
9) Declination	B	± DD.mmss

For New data, return to Step 1

Sample Problem: The same as given in Local Sidereal Time

Solutions:

Mercury: Longitude= -11.0000 (X↔Y)= 6.1114= 6°Aquarius 11'14" R
Declination= (B)= -15.1205= 15° S 12'05"
Venus: Longitude= 11.0000 (X↔Y)= 8.5122= 8°Aquarius 51' 22"
Declination= (B)= -19.0512= 19° S 05'12"
Mars: Longitude= 8.0000 (X↔Y)= 17.0605= 17° Scorpio 06'05"
Declination= (B) -15.3817= 15° S 38'17"

REFERENCES:

1) HP Standard Pac, p. 04-01
2) EXPLANATORY SUPPLEMENT TO THE AMERICAN EPHEMERIS
3) TABLES OF THE SUN, Vol. 6, part 1 of "ASTRONOMICAL PAPERS PREPARED FOR THE USE OF THE AMERICAN EPHEMERIS", 1898
4 SPHERICAL ASTRONOMY FOR ASTROLOGERS, Noonan (with corrections)
5) IMPROVED LUNAR EPHEMERIS. U.S. Naval Obs. 1954
6) TABLES OF MERCURY from "Papers...etc" (given above) Vol.6, part 2, Newcomb, 1898
7) TABLES OF VENUS, Vol. 6, part 3 (from PAPERS..)
8) TABLES OF MARS, Vol. 6, part 4 (from PAPERS...)
9) APAE, (PAPERS..) Vol. 9, part 2

Ian McKinnon
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Canada m5j 1z6

LOCAL SIDEREAL TIME

STEP	KEY	CODE	
1	LBLA	21 11	
2	CLRG	16-53	CLEARS ALL REGISTERS
3	P><S	16-51	
4	CLRG	16-53	
5	HMS>	16 36	
6	1	01	CONVERTS AM OR PM
7	2	02	TIME (H.MS) TO DEC-
8	STOI	35 46	IMAL UNIVERSAL TIME;
9	DSZI	16 25 46	ALSO PREPARES RI FOR
10	X><Y	-41	INDIRECT STORAGE;
11	X>Y?	16-34	
12	FRC	16 44	
13	F2?	16 23 02	
14	+	-55	
15	STO2	35 02	STORES U.T. IN R2
16	RTN	24	
17	LBLa	21 16 11	
18	SF2	16 21 02	SETS FLAG 2 FOR
19	GTOA	22 11	PM TIME;
20	LBLB	21 12	
21	HMS>	16 36	CONVERTS LONGITUDE
22	1	01	& LATITUDE TO
23	P>R	44	DECLINATION; STORES
24	STO1	35 01	LONGITUDE & COS &
25	/	-24	TAN OF LATITUDE;
26	STO6	35 06	
27	RLDN	-31	
28	HMS>	16 36	
29	STO7	35 07	
30	RTN	24	
31	LBLb	21 16 12	
32	HMS>	16 36	ALGEBRAICALLY SUMS
33	ST-2	35-45 02	CORRECTION TO FORM
34	RTN	24	U.T.
35	LBLC	21 13	
36	STO5	35 05	STORES Δ T
37	RLDN	-31	
38	X><Y	-41	CALCULATES NUMBER
39	3	03	OF DAYS FROM BE-
40	X>Y?	16-34	GINNING OF CHRIST-
41	GTO1	22 01	IAN ERA TO DATE
42	RLDN	-31	ENTERED (HP-97
43	1	01	STANDARD PAC,
44	+	-55	PAGE 04-01, EQUAT-
45	X><Y	-41	IONS FOR M' & Y')
46	LBL0	21 00	
47	3	03	NOTE: THE MONTH
48	6	06	CONSTANT OF 30.6001
49	5	05	IS TRUNCATED TO
50	.	-62	30.6 TO SAVE PROG-
51	2	02	RAM STEPS)
52	5	05	
53	STOA	35 11	
54	x	-35	
55	INT	16 34	
56	X><Y	-41	
57	3	03	
58	0	00	
59	.	-62	
60	6	06	
61	x	-35	
62	INT	16 34	STORES
63	+	-55	JULIAN DAY
64	+	-55	COUNT IN R9
65	STO9	35 09	SIMILARLY,
66	1	01	THE CONSTANT
67	2	02	122.1 MAY BE
68	3	03	TRUNCATED TO
69	-	-45	123 .
70	RCLA	36 11	
71	EEX	-23	
72	2	02	
73	x	-35	
74	/	-24	
75	INT	16 34	
76	ST-9	35-45 09	GREGORIAN
77	4	04	CORRECTIONS
78	/	-24	TO DAY COUNT
79	INT	16 34	SUMMED TO R9;
80	ST+9	35-55 09	SUBTRACTS NO.
81	6	06	OF DAYS FROM
82	9	09	BEGINNING OF
83	4	04	CHRISTIAN ERA
84	0	00	TO NOON 31
85	2	02	DEC. 1899 AD
86	3	03	FROM R9 =
87	.	-62	JD- 2415020
88	5	05	= DAYS FROM
89	ST-9	35-45 09	EPOCH
90	5	05	CALCULATES
91	5	05	MEAN OBLIQ-
92	0	00	UITY OF ECL-
93	SQRX	54	IPTIC FOR
94	RCL9	36 09	DAY;
95	4	04	(NEWCOMB, p.10)
96	1	01	
97	X2	53	
98	X2	53	
99	/	-24	
100	-	-45	
101	STO8	35 08	AND STORES
102	RCL9	36 09	CALCULATES
103	RCLA	36 11	LENGTH OF
104	4	04	SOLAR YEAR
105	6	06	& NO. OF
106	8	08	ANNUAL REV-
107	.	-62	OLUTIONS OF
108	2	02	EARTH SINCE
109	1/X	52	EPOCH,
110	%	55	
111	-	-45	STORES SOLAR
112	STO0	35 00	YEAR
113	/	-24	
114	RCL2	36 02	CONVERTS GMT
115	2	02	TO FRACTIONAL
116	4	04	DAILY REV. OF
117	/	-24	EARTH
118	ST+9	35-55 09	AND SUMS TO
119	RCL0	36 00	DAYS FROM
120	1/X	52	EPOCH; ADDS
121	1	01	BOTH NOS. OF
122	+	-55	REVS AND ALSO
123	x	-35	ADDS LONG.
124	+	-55	EQUIV. OF
125	RCL7	36 07	TIME(REVS)
126	3	03	
127	6	06	
128	0	00	
129	ST/5	35-24 05	CONV Δ T TO DAYS
130	ST/0	35-24 00	SAVES STEP
131	STOB	35 12	
132	/	-24	SETS PHASE OF
133	-	-45	L.S.T. BY AD-
134	.	-62	DITION OF CON-
135	2	02	STANT (REVS.)
136	7	07	(NEWCOMB, p.9,
137	6	06	EQ,N FOR τ)
138	9	09	
139	2	02	
140	STOA	35 11	
141	+	-55	
142	RCLB	36 12	CONVERTS L.S.T.
143	x	-35	TO DEGREES
144	2	02	CALCULATES
145	5	05	MOON'S NODE &
146	9	09	FIRST TERM IN
147	ST/5	35-24 05	CONV.ΔT TO DAYS
148	RCL9	36 09	NUTATION IN
149	1	01	LONGITUDE &
150	8	08	OBLIQUITY.
151	.	-62	(I.L.E. p.IX)
152	8	08	
153	8	08	
154	4	04	
155	3	03	
156	4	04	
157	/	-24	STORES NODE FOR
158	-	-45	FUTURE USE
159	STO3	35 02	
160	RCLA	36 11	APPROXIMATES
161	SIN	41	NUTATION IN
162	P>R	44	OBLIQUITY AND
163	RCLA	36 11	SUMS TO MEAN
164	10X	16 33	
165	/	-24	
166	ST+8	35-55 08	APPROXIMATES
167	RLDN	-31	NUT'N IN LONG,
168	STOD	35 14	STORES
169	-	-45	ADDS TO L.S.T.
170	STOC	35 13	AND STORES;
171	9	09	ADDS 90 DEG.
172	0	00	FOR ASCENDANT
173	+	-55	CALCULATION;
174	LBL3	21 03	
175	1	01	
176	P>R	44	CALCULATION FOR
177	RCL8	36 08	BOTH ASCENDANT
178	COS	42	AND MIDHEAVEN
179	x	-35	FOR EQ'N,
180	F2?	16 23 02	
181	GTO4	22 04	
182	RCL8	36 08	
183	SIN	41	
184	RCL6	36 06	
185	x	-35	
186	-	-45	
187	LBL4	21 04	
188	R>P	34	REDUCES ANGLE
189	RLDN	-31	TO FIRST CIRCLE,
190	RCLB	36 12	
191	X><Y	-41	
192	X<0?	16-45	
193	+	-55	STORES ASC IN
194	STOi	35 45	R11, M.C. IN R12;
195	3	03	
196	0	00	
197	STOE	35 15	ASC & MC DISP-
198	/	-24	LAYED IN ASTROL-
199	ENT	-21	OGICAL CONVENT-
200	FRC	16 44	ION.
201	RCLE	36 15	
202	x	-35	
203	>HMS	16 35	
204	X><Y	-41	
205	INT	16 34	
206	1	01	
207	+	-55	
208	RTN	24	
209	LBLD	21 14	PREPARES FOR MC
210	SF2	16 21 02	CALCULATION
211	ISZI	16 26 46	ADDS ΔT TO NO.
212	RCL5	36 05	OF DAYS FROM
213	ST+9	35-55 09	EPOCH TO FORM
214	RCLC	36 13	ET.
215	GTO3	22 03	
216	LBL1	21 01	DAYS CALCULATION
217	RLDN	-31	WHEN MONTH IS
218	1	01	JAN OR FEB
219	3	03	
220	+	-55	
221	X><Y	-41	
222	1	01	
223	-	-45	
224	GTO0	22 00	

MARS CARD ONE

STEP	KEY	CODE	
1	LBLA	21 11	RETRIEVES
2	P><S	16-51	gE & gJ
3	RCL7	36 07	FROM
4	RCL9	36 09	SECONDARY
5	RND	16 24	REGISTERS
6	P><S	16-51	
7	STO4	35 04	
8	RLDN	-31	
9	STO3	35 02	
10	1	01	
11	7	07	
12	STOI	35 46	
13	RCL9	36 09	
14	.	-62	MEAN MARS
15	5	05	
16	2	02	
17	4	04	
18	0	00	
19	7	07	
20	1	01	
21	1	01	
22	6	06	
23	4	04	
24	x	-35	
25	STO1	35 01	
26	6	06	
27	6	06	
28	.	-62	
29	2	02	
30	5	05	
31	2	02	
32	4	04	
33	-	-45	
34	STO7	35 07	
35	RCL1	36 01	MEAN ANOMALY
36	1	01	OF MARS
37	0	00	
38	4	04	
39	1/X	52	
40	%	55	
41	-	-45	
42	4	04	
43	0	00	
44	.	-62	
45	4	04	
46	7	07	
47	0	00	
48	6	06	
49	-	-45	
50	RCL9	36 09	r^2 TERM IN
51	X2	53	
52	2	02	
53	9	09	
54	ex	33	
55	/	-24	
56	STO0	35 00	
57	2	02	r^2 TERM
58	/	-24	CONTINUED
59	+	-55	
60	STO1	35 01	
61	STO6	35 06	
62	4	04	
63	x	-35	
64	STOi	35 45	
65	1	01	CONSTANT
66	8	08	TERM IN
67	3	03	SERIES
68	8	08	FOR
69	4	04	LOG RADIUS
70	3	03	VECTOR
71	.	-62	
72	4	04	
73	RCL9	36 09	
74	2	02	
75	EEX	-23	
76	4	04	
77	/	-24	
78	+	-55	
79	STO2	35 02	
80	RCL1	36 01	SECOND TERM
81	2	02	IN EQUATION
82	x	-35	OF THE
83	2	02	CENTRE
84	8	08	
85	2	02	
86	1	01	
87	RCL9	36 09	
88	8	08	
89	2	02	
90	X2	53	
91	/	-24	
92	+	-55	
93	P>R	44	
94	ST-2	35-45 02	
95	X><Y	-41	
96	4	04	
97	5	05	
98	3	03	
99	8	08	
100	/	-24	
101	ST+0	35-55 00	
102	RCL1	36 01	EQUATION OF
103	3	03	THE CENTRE,
104	x	-35	THIRD
105	2	02	TERM
106	4	04	
107	8	08	
108	P>R	44	
109	ST-2	35-45 02	
110	X><Y	-41	
111	4	04	
112	9	09	
113	4	04	THIRD TERM
114	4	04	CONTINUED
115	/	-24	
116	ST+0	35-55 00	
117	9	09	EQUATION OF
118	0	00	THE CENTRE,
119	ST-i	35-45 45	FOURTH TERM
120	4	04	
121	6	06	
122	GSB1	23 01	
123	2	02	
124	4	04	
125	5	05	
126	GSB2	23 02	
127	ST+i	35-55 45	EQUATION OF
128	5	05	THE CENTRE,
129	GSB1	23 01	FIFTH TERM
130	2	02	
131	3	03	
132	8	08	
133	GSB2	23 02	
134	RCL4	36 04	JUPITER
135	STOi	35 45	PERTURBATIONS
136	1	01	
137	8	08	J1,0
138	ST+i	35-55 45	
139	1	01	
140	0	00	
141	GSB1	23 01	
142	ST+2	35-55 02	
143	1	01	
144	3	03	
145	5	05	
146	ST+i	35-55 45	
147	4	04	
148	GSB1	23 01	
149	X><Y	-41	
150	ST-0	35-45 00	
151	RCL1	36 01	JUPITER
152	ST-i	35-45 45	PERTURBATIONS
153	2	02	
154	0	00	J1, -1
155	2	02	
156	ST-i	35-45 45	
157	7	07	
158	1	01	
159	GSB1	23 01	
160	1	01	
161	0	00	
162	GSB2	23 02	
163	ST-i	35-45 45	JUPITER
164	9	09	J1, -2
165	GSB1	23 01	
166	2	02	
167	0	00	
168	CHS	-22	
169	GSB2	23 02	J1,-2 cont.
170	RCL4	36 04	
171	X><Y	-41	JUPITER
172	-	-45	J2,-3
173	STO5	35 05	
174	ST+i	35-55 45	
175	1	01	
176	4	04	
177	4	04	
178	ST-i	35-45 45	
179	6	06	
180	GSB1	23 01	
181	4	04	
182	1	01	
183	CHS	-22	
184	GSB2	23 02	
185	ST+i	35-55 45	JUPITER
186	ISZi	16 26 45	J2,-2
187	4	04	
188	5	05	
189	GSB1	23 01	
190	3	03	
191	7	07	
192	CHS	-22	
193	GSB2	23 02	
194	ST+i	35-55 45	JUPITER
195	6	06	J2,-1
196	ST+i	35-55 45	
197	6	06	
198	1	01	
199	GSB1	23 01	
200	2	02	
201	4	04	
202	GSB2	23 02	
203	PSE	16 51	INTERFACE WITH
204	RTN	24	CARD 2
205	LBL1	21 01	
206	EEX	-23	SUBROUTINE
207	4	04	CALCULATES
208	/	-24	PERTURBATIONS
209	RCLi	36 45	TO BOTH $\frac{1}{r}$ & log
210	X><Y	-41	r.v.,
211	P>R	44	ASSUMING
212	ST+0	35-55 00	CONSTANT RATIO
213	X><Y	-41	BETWEEN BOTH.
214	>HMS	16 35	
215	EEX	-23	
216	4	04	
217	x	-35	
218	ST-2	35-45 02	
219	RTN	24	
220	LBL2	21 02	
221	%	55	ALTERS
222	ST+2	35-55 02	Δ log r.v.
223	RCL1	36 01	IF NEEDED.
224	RTN	24	

MARS CARD TWO

STEP	KEY	CODE	
1	ST+i	35-55 45	JUPITER
2	2	02	PERTURBATIONS
3	ST-i	35-45 45	J2,0
4	4	04	
5	GSB1	23 01	
6	ST+2	35-55 02	
7	ST+2	35-55 02	
8	RCL5	36 05	JUPITER
9	ST+i	35-55 45	J 3,-1
10	RCLI	36 46	
11	ST-i	35-45 45	
12	9	09	
13	GSB1	23 01	
14	4	04	
15	1	01	
16	GSB2	23 02	
17	ST-i	35-45 45	JUPITER
18	2	02	3, -2
19	1	01	
20	ST-i	35-45 45	
21	7	07	
22	GSB1	23 01	
23	3	03	
24	6	06	
25	CHS	-22	
26	GSB2	23 02	
27	ST-i	35-45 45	JUPITER
28	6	06	J3,-3
29	0	00	
30	ST+i	35-55 45	
31	4	04	
32	GSB1	23 01	
33	2	02	
34	/	-24	
35	ST-2	35-45 02	
36	RCL3	36 03	
37	CHS	-22	EARTH
38	STOi	35 45	PERTURBATIONS
39	3	03	E-1,0
40	4	04	
41	ST-i	35-45 45	
42	2	02	
43	GSB1	23 01	
44	5	05	
45	4	04	
46	CHS	-22	
47	GSB2	23 02	
48	DSZi	16 25 45	EARTH
49	ST+i	35-55 45	E -1,1
50	2	02	
51	4	04	
52	GSB1	23 01	
53	2	02	
54	0	00	
55	GSB2	23 02	
56	ST+i	35-55 45	EARTH-1,2
57	1	01	EARTH
58	5	05	E-1,2
59	ST+i	35-55 45	
60	3	03	
61	9	09	
62	GSB1	23 01	
63	5	05	
64	N!	16 52	
65	GSB2	23 02	
66	ST+i	35-55 45	EARTH
67	2	02	E-1,3
68	ST-i	35-45 45	
69	4	04	
70	GSB1	23 01	
71	ST+2	35-55 02	
72	ST+2	35-55 02	
73	RCL3	36 03	EARTH
74	ST-i	35-45 45	E-2,3
75	1	01	
76	3	03	
77	7	07	
78	ST-i	35-45 45	
79	2	02	
80	0	00	
81	GSB1	23 01	
82	1	01	
83	1	01	
84	GSB2	23 02	
85	ST+i	35-55 45	EARTH
86	5	05	E-2,4
87	ST+i	35-55 45	
88	1	01	
89	4	04	
90	GSB1	23 01	
91	1	01	
92	3	03	
93	9	09	
94	GSB2	23 02	
95	ST+i	35-55 45	EARTH
96	RCL3	36 03	E-3,5
97	ST-i	35-45 45	
98	1	01	
99	2	02	
100	7	07	
101	ST-i	35-45 45	
102	7	07	
103	GSB1	23 01	
104	1	01	
105	9	09	
106	GSB2	23 02	
107	ST+i	35-55 45	EARTH
108	ST+i	35-55 45	E-4,7
109	RCL3	36 03	
110	ST-i	35-45 45	
111	2	02	
112	3	03	
113	9	09	EARTH
114	ST+i	35-55 45	E-4,7
115	3	03	(cont.)
116	GSB1	23 01	
117	3	03	
118	1	01	
119	GSB2	23 02	
120	2	02	EARTH
121	STxi	35-35 45	E-8,15
122	RCL1	36 01	
123	ST+i	35-55 45	
124	8	08	
125	6	06	
126	ST-i	35-45 45	
127	4	04	
128	GSB1	23 01	
129	ST+2	35-55 02	
130	3	03	MEAN
131	2	02	ANOMALY
132	9	09	VENUS: V,
133	.	-62	
134	6	06	
135	RCL9	36 09	
136	1	01	
137	1	01	
138	0	00	
139	7	07	
140	SQRX	54	
141	/	-24	
142	-	-45	
143	STOi	35 45	AND V -1,3
144	1	01	PERTURBATION
145	8	08	OF VENUS.
146	GSB1	23 01	
147	9	09	
148	1	01	
149	GSB2	23 02	
150	RCL9	36 09	MEAN ANOMALY OF
151	2	02	SATURN: S
152	9	09	
153	.	-62	
154	9	09	
155	/	-24	
156	1	01	
157	7	07	
158	6	06	
159	+	-55	
160	STOi	35 45	
161	7	07	SATURN
162	2	02	PERTURBATION:
163	ST+i	35-55 45	S 1, 0
164	2	02	
165	GSB1	23 01	
166	ST+2	35-55 02	
167	RCL1	36 01	S 1,-1
168	ST-i	35-45 45	
169	3	03	S 1,-1
170	8	08	(cont.)
171	ST-i	35-45 45	
172	4	04	
173	GSB1	23 01	S2, -2
174	2	02	
175	STxi	35-35 45	
176	1	01	
177	0	00	
178	3	03	
179	ST-i	35-45 45	
180	2	02	
181	GSB1	23 01	
182	3	03	S2, -1
183	ST+i	35-55 45	
184	RCL1	36 01	
185	ST+i	35-55 45	
186	5	05	
187	GSB1	23 01	
188	RCL0	36 00	
189	STOB	35 12	CHANGE OF
190	RCL2	36 02	REGISTERS
191	STOE	35 15	
192	P><S	16-51	RETRIEVE
193	RCL8	36 08	X,Z FROM
194	STOA	35 11	SECONDARY
195	RCL9	36 09	REGISTERS
196	ENT	-21	
197	RND	16 24	
198	-	-45	
199	STOC	35 13	
200	P><S	16-51	AND
201	RCL8	36 08	RECALCULATE
202	ATAN	16 43	Z
203	PSE	16 51	
204	RTN	24	IDENTICAL TO
205	LBL1	21 01	LBL 1 IN
206	EEX	-23	CARD 1
207	4	04	
208	/	-24	
209	RCLi	36 45	
210	X><Y	-41	
211	P>R	44	
212	ST+0	35-55 00	
213	X><Y	-41	
214	>HMS	16 35	
215	EEX	-23	
216	4	04	
217	x	-35	
218	ST-2	35-45 02	
219	RTN	24	
220	LBL2	21 02	IDENTICAL TO
221	B	55	LBL 2 in
222	ST+2	35-55 02	CARD 1
223	RCL1	36 01	
224	RTN	24	

MARS CARD THREE

STEP	KEY	CODE	
1	/	-24	Z STORED
2	STOD	35 14	FIRST TERM IN
3	LBL3	21 03	THE EQUATION
4	RCL6	36 06	OF THE CENTRE
5	4	04	
6	3	03	
7	5	05	
8	3	03	
9	2	02	
10	LN	32	
11	RCL9	36 09	
12	2	02	
13	EEX	-23	
14	8	08	
15	D>R	16 45	
16	/	-24	
17	+	-55	
18	P>R	44	
19	3	03	
20	7	07	
21	8	08	
22	1	01	
23	.	-62	
24	7	07	
25	x	-35	
26	CHS	-22	
27	RCLE	36 15	ADDED TO
28	+	-55	OTHER TERMS IN
29	EEX	-23	EQUATION OF
30	6	06	CENTRE AND
31	/	-24	PERTURBATIONS
32	STO2	35 02	OF LOG r.v.
33	X><Y	-41	(STORED IN 2)
34	RCLB	36 12	ALSO FOR
35	+	-55	LONGITUDE;
36	RCL7	36 07	
37	+	-55	
38	STO0	35 00	STORED IN R0
39	4	04	
40	8	08	ANGLE FROM
41	.	-62	ASCENDING NODE;
42	7	07	
43	8	08	
44	6	06	
45	4	04	
46	-	-45	
47	RCL9	36 09	
48	8	08	
49	2	02	
50	7	07	
51	R>D	16 46	
52	/	-24	
53	-	-45	
54	STOi	35 45	
55	ST+i	35-55 45	
56	SIN	41	HELIOCENTRIC
57	9	09	LATITUDE
58	5	05	
59	9	09	
60	SQRX	54	
61	/	-24	
62	ASIN	16 41	
63	STO1	35 01	
64	RCLi	36 45	REDUCTION
65	SIN	41	TO THE
66	6	06	ECLIPTIC
67	7	07	
68	/	-24	
69	ST-0	35-45 00	
70	GSB2	23 02	calc. x,y,z
71	RCLA	36 11	CALCULATE
72	ST+3	35-55 03	ξ,η,ζ
73	RCLC	36 13	
74	ST+i	35-55 45	
75	RCLD	36 14	
76	ST+4	35-55 04	
77	RCLi	36 45	DISTANCE IN
78	ENT	-21	ASTRONOMICAL
79	X2	53	UNITS;
80	RCL4	36 04	
81	X2	53	
82	+	-55	
83	RCL3	36 03	
84	X2	53	
85	+	-55	
86	SQRX	54	DISTANCE
87	F0?	16 23 00	
88	STO5	35 05	
89	/	-24	
90	ASIN	16 41	DECLINATION
91	STO1	35 01	
92	RCL8	36 08	CALC. LIGHT
93	RCL5	36 05	TIME FOR THIS
94	3	03	DISTANCE, SUBTRACT
95	3	03	APPROPRIATE
96	0	00	AMOUNT FROM
97	/	-24	MEAN M & M
98	ST-7	35-45 07	
99	ST-6	35-45 06	
100	6	06	AND ALSO
101	2	02	FROM X,Y,Z
102	TAN	43	TO FORM
103	x	-35	X',Y',z'
104	CHS	-22	(APPARENT)
105	RCLD	36 14	
106	RCL8	36 08	
107	COS	42	
108	/	-24	
109	RCLA	36 11	
110	R>P	34	
111	RLDN	-31	
112	+	-55	
113	RLUP	16-31	
114	P>R	44	
115	STOA	35 11	
116	RLDN	-31	
117	P>R	44	
118	STOD	35 14	
119	RLDN	-31	
120	STOC	35 13	
121	RCL4	36 04	RIGHT
122	RCL3	36 03	ASCENSION
123	R>P	34	(DEGREES)
124	X><Y	-41	
125	STO0	35 00	
126	SF1	16 21 01	CALC. GEOCENT-
127	GSB2	23 02	RIC LATITUDE
128	RCL4	36 04	AND LONGITUDE;
129	RCLi	36 45	ALL PARAMETERS
130	ASIN	16 41	THUS FAR ARE
131	STO2	35 02	GEOMETRIC;
132	COS	42	SUBR 4 CLEARS
133	STOi	35 45	FO AND RE-
134	/	-24	STARTS PGM.
135	RCL3	36 03	EXECUTION. AT
136	RCLi	36 45	LBL3 FOR CAL-
137	/	-24	CULATION OF
138	R>P	34	APPARENT
139	RLDN	-31	PARAMETERS;
140	F0?	16 23 00	
141	GTO4	22 04	
142	STOi	35 45	IF RETRO-
143	RCL5	36 05	GRADE, SETS
144	-	-45	FLAG 2,
145	X>0?	16-44	
146	SF2	16 21 02	
147	P><S	16-51	ADDS NUTATION;
148	RCL0	36 00	
149	P><S	16-51	
150	ST-i	35-45 45	
151	RCLi	36 45	REDUCES LONG-
152	3	03	ITUDE TO
153	6	06	FIRST CIRCLE,
154	0	00	
155	P>R	44	
156	R>P	34	
157	X><Y	-41	
158	X<0?	16-45	
159	+	-55	
160	STOi	35 45	
161	3	03	ASTROLOGICAL
162	0	00	CONVENTION
163	STOE	35 15	
164	/	-24	
165	ENT	-21	
166	FRC	16 44	
167	RCLE	36 15	
168	x	-35	
169	>HMS	16 35	AND DISPLAYS
170	X><Y	-41	SIGN NO. (X)
171	INT	16 34	AND DEGREE IN
172	1	01	SIGN (Y).
173	+	-55	
174	F2?	16 23 02	IF RETROGRADE
175	CHS	-22	PREFACES SIGN
176	RTN	24	NO. WITH "-"
177	LBLB	21 12	
178	RCL1	36 01	DECLINATION
179	LBL5	21 05	IN D.ms
180	>HMS	16 35	
181	RTN	24	
182	LBLC	21 13	
183	RCL2	36 02	LATITUDE IN
184	GTO5	22 05	D.ms
185	LBL2	21 02	
186	RCL8	36 08	CONVERTS
187	RCL0	36 00	SPHERICAL
188	RCL1	36 01	CO-ORDINATES
189	COS	42	(l,b and r)
190	P>R	44	to equatorial
191	STO3	35 02	RECTANGULAR
192	RLDN	-31	(x,y, and z)
193	P>R	44	ALSO CONVERTS
194	STO4	35 04	BACK TO
195	RLDN	-31	SPHERICAL
196	F1?	16 23 01	WITH APPRO-
197	CHS	-22	PRIATE CHANGE
198	STOi	35 45	OF REGISTERS;
199	RCL8	36 08	
200	RCL1	36 01	
201	SIN	41	
202	P>R	44	
203	ST+i	35-55 45	
204	X><Y	-41	
205	F1?	16 23 01	
206	CHS	-22	
207	ST-4	35-45 04	
208	F1?	16 23 01	
209	RTN	24	
210	RCL2	36 02	
211	10X	16 33	
212	STx3	35-35 03	
213	STx4	35-35 04	
214	STxi	35-35 45	
215	RTN	24	
216	LBL4	21 04	RETURNS PGM.
217	STO5	35 05	TO LBL3 TO
218	CF0	16 22 00	CALCULATE
219	CF1	16 22 01	APPARENT
220	GTO3	22 03	PARAMETERS.
221	R/S	51	

SUN: CARD ONE

STEP	KEY	CODE	
1	LBLA	21 11	ADVANCES RI
2	ISZI	16 26 46	CALCULATES MEAN SUN
3	2	02	
4	7	07	
5	9	09	
6	.	-62	
7	6	06	
8	9	09	
9	1	01	
10	STO7	35 07	
11	RCL0	36 00	
12	1/X	52	MEAN SUN STORED IN ADDITIONAL REGISTER FOR LATER USE;
13	GSB1	23 01	
14	STO0	35 00	
15	STO2	35 02	STORES;
16	LSTX	16-63	MEAN ANOMALY OF SUN
17	2	02	
18	0	00	
19	9	09	
20	.	-62	
21	4	04	
22	1/X	52	
23	%	55	
24	-	-45	
25	1	01	
26	.	-62	
27	5	05	
28	2	02	
29	4	04	
30	-	-45	
31	STOA	35 11	STORED;
32	1	01	
33	9	09	CORRECTION FOR ELLIPTICITY OF THE EARTH'S ORBIT: EQUATION OF THE CENTRE, FIRST HARMONIC;
34	1	01	
35	9	09	
36	5	05	
37	RCL9	36 09	
38	7	07	
39	6	06	
40	3	03	
41	/	-24	
42	-	-45	
43	GSB3	23 03	CORRECTS LONGITUDE;
44	3	03	CONSTANT TERM IN SERIES FOR $\log_{10}$
45	0	00	
46	6	06	OF EARTH'S RADIUS VECTOR $\times 10^7$
47	RCL9	36 09	
48	4	04	
49	2	02	
50	5	05	
51	R>D	16 46	
52	/	-24	
53	-	-45	
54	STO4	35 04	
55	RCLA	36 11	FIRST-HARMONIC
56	RCL9	36 09	
57	2	02	CORRECTION TO LOG R.V.
58	0	00	
59	1	01	
60	STOC	35 13	
61	/	-24	
62	7	07	
63	2	02	
64	7	07	
65	4	04	
66	1	01	
67	-	-45	
68	GSB4	23 04	
69	RCLA	36 11	SECOND-HARMONIC CORRECTION TO LONGITUDE;
70	2	02	
71	x	-35	
72	STO6	35 06	
73	RCLC	36 13	
74	GSB3	23 03	
75	RCL6	36 06	SECOND-HARMONIC CORRECTION TO LOG R.V.;
76	RCL9	36 09	
77	8	08	
78	9	09	
79	X2	53	
80	/	-24	
81	9	09	
82	1	01	
83	4	04	
84	-	-45	
85	GSB4	23 04	
86	RCLA	36 11	THIRD HARMONIC CORRECTION TO LONGITUDE;
87	3	03	
88	x	-35	
89	STO6	35 06	
90	3	03	
91	GSB3	23 03	
92	RCL6	36 06	THIRD HARMONIC CORRECTION TO LOG R.V.
93	1	01	
94	4	04	
95	CHS	-22	
96	GSB4	23 04	
97	9	09	CORRECTION TO LONGITUDE FOR ONE TERM OF LUNAR PERTURBATION: NEWCOMB P18
98	CHS	-22	
99	ENT	-21	
100	.	-62	
101	9	09	
102	7	07	
103	7	07	
104	4	04	
105	5	05	
106	ACOS	16 42	
107	GSB1	23 01	
108	STO6	35 06	
109	GSB2	23 02	
110	RCL6	36 06	SAME ORDER
111	1	01	
112	3	03	
113	4	04	CORRECTION TO LOG R.V.
114	GSB4	23 04	
115	2	02	NEWCOMB, p.18; EQUATION FOR δ L.
116	3	03	
117	1	01	
118	RCLE	36 15	
119	R>D	16 46	
120	1/X	52	
121	GSB1	23 01	
122	GSB2	23 02	
123	RCL6	36 06	LUNAR PERTURBATION IN LOG R.V; NEWCOMB, p.18, EQUATION FOR δ LOG R.V.
124	1	01	
125	1	01	
126	6	06	
127	RCLI	36 46	
128	.	-62	
129	5	05	
130	%	55	
131	+	-55	
132	GSB1	23 01	
133	-	-45	
134	RCLI	36 46	
135	GSB4	23 04	
136	1	01	
137	R>D	16 46	NEWCOMB, p. 19 EQ'N FOR δ L.
138	2	02	
139	4	04	
140	3	03	
141	1/X	52	
142	GSB1	23 01	
143	5	05	
144	CHS	-22	
145	GSB3	23 03	
146	RCLA	36 11	TERMS OF PERTURBATION, E - 2M; NEWCOMB, p. 15 CORRECTION TO LONGITUDE
147	RCL7	36 07	
148	1	01	
149	.	-62	
150	0	00	
151	4	04	
152	8	08	
153	GSB1	23 01	
154	-	-45	
155	STO7	35 07	
156	7	07	
157	0	00	
158	-	-45	
159	5	05	
160	GSB3	23 03	
161	RCLA	36 11	2E - 2 M NEWCOMB, p.15 CORRECTION TO LONGITUDE.
162	RCL7	36 07	
163	+	-55	
164	STO7	35 07	
165	7	07	
166	4	04	
167	+	-55	
168	6	06	
169	GSB3	23 03	
170	RLUP	16-31	SAME-ORDER CORRECTION TO LOG R.V.
171	1	01	
172	8	08	
173	5	05	
174	X2	53	
175	x	-35	
176	STO4	35 04	
177	1	01	
178	5	05	CALCULATES MEAN ANOMALY OF JUPITER AND STORES FOR USE IN NEXT CARD.
179	STO6	35 06	
180	X2	53	
181	.	-62	
182	0	00	
183	8	08	
184	3	03	
185	1	01	
186	GSB1	23 01	
187	STOi	35 45	
188	2	02	MEAN ANOMALY OF VENUS.
189	1	01	
190	2	02	
191	.	-62	
192	4	04	
193	ENT	-21	
194	.	-62	
195	2	02	
196	0	00	
197	4	04	
198	7	07	
199	10X	16 33	
200	GSB1	23 01	
201	STO7	35 07	
202	PSE	16 51	INTERFACING TO NEXT CARD
203	R/S	51	
204	LBL1	21 01	CALCULATES $y = mx + b$
205	RCL9	36 09	
206	x	-35	
207	+	-55	
208	RTN	24	
209	LBL2	21 02	CALCULATES CORRECTION AND SUMS TO MEAN SUN
210	1	01	
211	8	08	
212	LBL3	21 03	
213	EEX	-23	
214	4	04	
215	/	-24	
216	P>R	44	
217	RLDN	-31	
218	ST+2	35-55 02	
219	RTN	24	
220	LBL4	21 04	CALCULATES CORRECTION AND SUMS TO 10^7 (log r.v.)
221	P>R	44	
222	ST+4	35-55 04	
223	RTN	24	

SUN: CARD TWO

STEP	KEY	CODE	
1	RCLA	36 11	V - E NEWCOMB, p.14; CORRECTION TO LONGITUDE
2	-	-45	
3	STO5	35 05	
4	RCLE	36 15	
5	+	-55	
6	RCLI	36 46	
7	GSB3	23 03	
8	ST+5	35-55 05	SAME-ORDER CORRECTION TO LOG R.V.
9	2	02	
10	0	00	
11	9	09	
12	+	-55	
13	2	02	
14	4	04	
15	GSB4	23 04	
16	1	01	2V - 2E NEWCOMB, p. 14; CORRECTION TO LONGITUDE
17	2	02	
18	2	02	
19	-	-45	
20	RCL6	36 06	
21	GSB3	23 03	
22	5	05	SAME-ORDER CORRECTION TO LOG R.V.
23	8	08	
24	+	-55	
25	6	06	
26	8	08	
27	GSB4	23 04	
28	RCLA	36 11	2V - 3E NEWCOMB, p. 14; CORRECTION TO LONGITUDE;
29	-	-45	
30	ST+5	35-55 05	
31	4	04	
32	6	06	
33	+	-55	
34	7	07	
35	GSB3	23 03	SAME-ORDER CORRECTION TO LOG R.V. ;
36	2	02	
37	2	02	
38	7	07	
39	+	-55	
40	9	09	
41	GSB4	23 04	3V - 4E NEWCOMB, p.14, CORRECTION TO LONGITUDE;
42	RCL7	36 07	
43	RCLA	36 11	
44	-	-45	
45	ST+5	35-55 05	
46	RCL5	36 05	
47	7	07	SAME-ORDER CORRECTION TO LOG R.V.;
48	5	05	
49	+	-55	
50	4	04	
51	GSB3	23 03	
52	2	02	
53	5	05	
54	5	05	
55	+	-55	
56	RCL6	36 06	
57	GSB4	23 04	3V - 5E NEWCOMB, p. 14, CORRECTION TO LOG R.V.;
58	RCLA	36 11	
59	+	-55	
60	8	08	
61	7	07	
62	+	-55	
63	1	01	
64	0	00	
65	GSB4	23 04	SAME-ORDER CORRECTION TO LONGITUDE;
66	RCLA	36 11	
67	-	-45	
68	4	04	
69	8	08	
70	+	-55	
71	3	03	
72	GSB3	23 03	- J NEWCOMB, p. 16; CORRECTION TO LONGITUDE;
73	RCLi	36 45	
74	CHS	-22	
75	7	07	
76	-	-45	
77	7	07	
78	GSB3	23 03	E - J NEWCOMB, p. 16; CORRECTION TO LONGITUDE;
79	RCLA	36 11	
80	RCLi	36 45	
81	-	-45	
82	STO5	35 05	
83	9	09	
84	0	00	
85	-	-45	
86	2	02	
87	0	00	
88	GSB3	23 03	SAME-ORDER CORRECTION TO LOG R.V.;
89	ST+5	35-55 05	
90	SIN	41	
91	7	07	
92	0	00	
93	x	-35	
94	ST-4	35-45 04	E - 2J NEWCOMB, p. 16; CORRECTION TO LONGITUDE;
95	RCL5	36 05	
96	RCLA	36 11	
97	-	-45	
98	RCLC	36 13	
99	+	-55	
100	STOC	35 13	
101	4	04	
102	GSB3	23 03	SAME-ORDER CORRECTION to LOG R.V.
103	RCLC	36 13	
104	RCL6	36 06	
105	CHS	-22	
106	GSB4	23 04	
107	3	03	2E - 2J NEWCOMB, p. 16 CORRECTION TO LONGITUDE
108	-	-45	
109	STOC	35 13	
110	8	08	
111	CHS	-22	
112	GSB3	23 03	
113	RCLC	36 13	SAME-ORDER CORRECTION TO LOG R.V.
114	4	04	
115	0	00	
116	GSB4	23 04	
117	RCLi	36 45	NEWCOMB, p. 16 CORRECTION TO LOG R.V. ONLY
118	-	-45	
119	7	07	
120	-	-45	
121	8	08	
122	GSB4	23 04	NEWCOMB, p.9; t^2 TERM ADDED TO MEAN AND TRUE SUN
123	RCL9	36 09	
124	2	02	
125	EEX	-23	
126	6	06	
127	/	-24	
128	X2	53	
129	ST+2	35-55 02	IMPROVED LUNAR EPHEMERIS, p. IX, 2nd TERM IN NUTATION IN LONGITUDE. ADDED TO TRUE SUN
130	ST+0	35-55 00	
131	RCL0	36 00	
132	2	02	
133	x	-35	
134	4	04	
135	GSB3	23 03	
136	RLDN	-31	
137	ST-2	35-45 02	AND STORED
138	RCLD	36 14	
139	+	-55	
140	ST-2	35-45 02	
141	STOD	35 14	
142	RCL8	36 08	RATIONALIZES LOG R.V. AND TAKES ANTI-LOG
143	RCL4	36 04	
144	EEX	-23	
145	7	07	
146	/	-24	
147	10X	16 33	CONVERTS TO GEOMETRIC SUN
148	RCL2	36 02	
149	1	01	
150	7	07	
151	6	06	
152	1/X	52	
153	ST+0	35-55 00	
154	+	-55	
155	RCL7	36 07	STORES V FOR FUTURE USE
156	P><S	16-51	
157	STO6	35 06	
158	RLDN	-31	
159	RCLD	36 14	
160	STO0	35 00	ALSO NUTATION
161	+	-55	
162	X><Y	-41	CALCULATES EQUATORIAL RECTANGULAR CO-ORDINATES (X,Y,Z,) OF SUN AND STORES
163	P>R	44	
164	STO8	35 08	
165	RLDN	-31	
166	P>R	44	
167	STOD	35 14	
168	RLDN	-31	
169	RCL3	36 03	REDUCES J to FIRST CIRCLE & ROUNDS TO NEAREST DEGREE ADDS Z AND STORES IN S9
170	RCLB	36 12	
171	/	-24	
172	FRC	16 44	
173	RCLB	36 12	
174	x	-35	
175	RND	16 24	
176	DSP4	-63 04	
177	+	-55	
178	STO9	35 09	
179	RCLA	36 11	
180	STO7	35 07	STORES E
181	P><S	16-51	
182	RCL2	36 02	REDUCES APPARENT SUN TO FIRST CIRCLE
183	RCLB	36 12	
184	P>R	44	
185	R>P	34	
186	X><Y	-41	
187	X<0?	16-45	
188	+	-55	
189	STOi	35 45	AND STORES S3
190	RCLE	36 15	AND DISPLAYS IN DEG-IN-SIGN CONVENTION
191	/	-24	
192	ENT	-21	
193	FRC	16 44	
194	RCLE	36 15	
195	x	-35	
196	>HMS	16 35	
197	X><Y	-41	
198	INT	16 34	
199	1	01	
200	+	-55	
201	R/S	51	
202	LBLB	21 12	CALCULATES SUN'S DECLINATION ASSUMING SUN'S LATITUDE = 0 (EXPL. SUPPL. p. 102)
203	RCLi	36 45	
204	SIN	41	
205	RCL8	36 08	
206	SIN	41	
207	x	-35	
208	ASIN	16 41	
209	>HMS	16 35	
210	R/S	51	
211	LBL3	21 03	SIMILAR IN FUNCTION TO SUBROUTINES IN CARD 1.
212	EEX	-23	
213	4	04	
214	/	-24	
215	P>R	44	
216	X><Y	-41	
217	ST+2	35-55 02	AS ABOVE.
218	RCL5	36 05	
219	RTN	24	
220	LBL4	21 04	
221	P>R	44	
222	ST+4	35-55 04	
223	RCL5	36 05	
224	RTN	24	

MERCURY EPHEMERIS

STEP	KEY	CODE	
1	LBLA	21 11	BOOKKEEPING
2	1	01	
3	5	05	
4	STOI	35 46	
5	1	01	
6	STOi	35 45	
7	RCL9	36 09	MEAN MERCURY
8	8	08	IN REVOLUTIONS;
9	7	07	
10	.	-62	
11	9	09	
12	6	06	
13	8	08	
14	4	04	
15	3	03	
16	4	04	
17	5	05	
18	STO1	35 01	
19	/	-24	
20	FRC	16 44	
21	STO0	35 00	
22	RCL9	36 09	
23	RCL1	36 01	MERCURY
24	9	09	M IN
25	6	06	REVOLUTIONS
26	1	01	
27	1/X	52	
28	%	55	
29	+	-55	
30	/	-24	
31	FRC	16 44	
32	STO1	35 01	
33	RCLB	36 12	
34	STx0	35-35 00	CONVERT BOTH
35	STx1	35-35 01	TO DEGREES
36	1	01	
37	0	00	SET PHASE
38	2	02	ANGLE OF
39	.	-62	MEAN
40	2	02	MERCURY &
41	7	07	MEAN ANOMALY
42	9	09	OF MERCURY
43	4	04	
44	ST+1	35-55 01	
45	1	01	
46	7	07	
47	8	08	
48	.	-62	
49	1	01	
50	7	07	
51	9	09	
52	ST+0	35-55 00	
53	RCL0	36 00	
54	RCL1	36 01	PERIHELION
55	-	-45	
56	STO4	35 04	

STEP	KEY	CODE	
57	4	04	CONSTANT
58	0	00	TERM IN
59	7	07	SERIES
60	5	05	FOR r.v.;
61	6	06	
62	4	04	
63	CHS	-22	INITIALIZE
64	STO2	35 02	R2
65	.	-62	EQUATION OF
66	9	09	CENTRE;
67	6	06	FIRST
68	0	00	HARMONIC
69	1	01	
70	6	06	
71	RCL9	36 09	
72	7	07	
73	7	07	
74	R>D	16 46	
75	/	-24	
76	8	08	
77	7	07	
78	8	08	
79	7	07	
80	9	09	
81	+	-55	
82	GSB2	23 02	
83	.	-62	2nd
84	8	08	HARMONIC
85	RCL9	36 09	
86	5	05	
87	R>D	16 46	
88	R>D	16 46	
89	/	-24	
90	1	01	
91	3	03	
92	4	04	
93	1	01	
94	6	06	
95	+	-55	
96	GSB2	23 02	
97	.	-62	THIRD
98	2	02	HARMONIC
99	9	09	
100	SQRX	54	
101	SQRX	54	
102	4	04	
103	5	05	
104	R>D	16 46	
105	GSB2	23 02	
106	.	-62	fourth
107	8	08	HARMONIC
108	3	03	
109	4	04	
110	X2	53	
111	5	05	
112	4	04	

STEP	KEY	CODE	
113	8	08	continued
114	GSB2	23 02	
115	4	04	FIFTH
116	2	02	HARMONIC
117	SIN	41	
118	1	01	
119	2	02	
120	3	03	
121	GSB2	23 02	
122	3	03	SIXTH
123	7	07	HARMONIC
124	D>R	16 45	
125	STOC	35 13	
126	2	02	
127	9	09	
128	GSB2	23 02	
129	RCLC	36 13	SEVENTH
130	7	07	HARMONIC
131	GSB2	23 02	
132	P><S	16-51	
133	RCL8	36 08	RETRIEVES
134	STOA	35 11	X,J,V
135	RCL9	36 09	
136	ENT	-21	
137	RND	16 24	
138	-	-45	
139	STOC	35 13	
140	LSTX	16-63	
141	RCL6	36 06	V, AND NUT-
142	RCL0	36 00	ATION FROM
143	P><S	16-51	SECONDARY
144	STO7	35 07	REGISTERS;
145	RLDN	-31	STORE IN
146	STO6	35 06	PRIMARY
147	RLDN	-31	
148	STO5	35 05	
149	ST+5	35-55 05	
150	RCL1	36 01	PERTURBATION
151	ST-5	35-45 05	V +1,-1;
152	3	03	
153	7	07	
154	ST-5	35-45 05	
155	9	09	
156	GSB3	23 03	
157	RCL6	36 06	PERTURBATION
158	RCL1	36 01	V +2,-2;
159	-	-45	
160	STO5	35 05	
161	ST+5	35-55 05	
162	1	01	
163	6	06	
164	1	01	
165	ST-5	35-45 05	
166	6	06	
167	GSB3	23 03	
168	RCL1	36 01	

STEP	KEY	CODE	
169	ST+5	35-55 05	PERTURBATION
170	1	01	V +2,-1;
171	0	00	
172	GSB3	23 03	
173	7	07	
174	5	05	
175	GSB4	23 04	
176	RCL6	36 06	PERTURBATION
177	RCL1	36 01	V +3,-2;
178	-	-45	
179	ST+5	35-55 05	
180	5	05	
181	6	06	
182	ST+5	35-55 05	
183	4	04	
184	GSB3	23 03	
185	2	02	
186	0	00	
187	GSB4	23 04	
188	PSE	16 51	INTERFACE WITH
189	RTN	24	CARD TWO
190	LBL2	21 02	SUBROUTINE:
191	RCLi	36 45	CALCULATES
192	RCL1	36 01	EQUATION OF
193	x	-35	CENTRE &
194	X><Y	-41	SUMS
195	P>R	44	δℓ,
196	ST-2	35-45 02	& LOG R.V.
197	RLDN	-31	
198	x	-35	
199	6	06	
200	0	00	
201	X2	53	
202	/	-24	
203	ST+0	35-55 00	
204	ISZi	16 26 45	
205	RTN	24	
206	LBL3	21 03	
207	EEX	-23	SUBROUTINE;
208	4	04	CALCULATES
209	/	-24	PERTURBATION
210	RCL5	36 05	& SUMS TO
211	X><Y	-41	δ ℓ,
212	P>R	44	& LOG R.V.
213	ST+0	35-55 00	
214	X><Y	-41	
215	>HMS	16 35	
216	EEX	-23	
217	4	04	
218	x	-35	
219	ST-2	35-45 02	
220	RTN	24	
221	LBL4	21 04	VARIES
222	%	55	& LOG R.V.
223	ST+2	35-55 02	
224	RTN	24	

MERCURY CARD TWO

STEP	KEY	CODE	
1	RCL6	36 06	PERTURBATION
2	ST+5	35-55 05	V +5,-2
3	ST+5	35-55 05	
4	2	02	
5	4	04	
6	3	03	
7	ST-5	35-45 05	
8	2	02	
9	0	00	
10	GSB3	23 03	
11	9	09	
12	6	06	
13	GSB4	23 04	
14	RCL1	36 01	PERTURBATION
15	ST-5	35-45 05	V +5,-3
16	8	08	
17	GSB3	23 03	
18	RCL1	36 01	PERTURBATION
19	ST+5	35-55 05	V +5,-1
20	ST+5	35-55 05	
21	4	04	
22	GSB3	23 03	
23	ST+2	35-55 02	
24	ST+2	35-55 02	
25	EEX	-23	RATIONALIZE
26	6	06	LOG R.V.
27	ST/2	35-24 02	
28	RCL4	36 04	CALCULATE EL-
29	3	03	LIPTICAL COM-
30	R>D	16 46	PONENTS MERC.
31	GSB1	23 01	VELOCITY
32	CHS	-22	STORE;
33	STO3	35 02	ALSO INITIAL-
34	X><Y	-41	IZE STORAGE
35	STO4	35 04	REGISTERS
36	RCL0	36 00	
37	3	03	CIRCULAR
38	5	05	COMPONENTS OF
39	.	-62	MERCURY VEL-
40	8	08	OCITY.
41	GSB1	23 01	
42	RCL0	36 00	ℓ - ϕ
43	4	04	
44	7	07	
45	.	-62	
46	1	01	
47	4	04	
48	6	06	
49	-	-45	
50	RCL9	36 09	
51	5	05	
52	3	03	
53	8	08	
54	R>D	16 46	
55	/	-24	
56	-	-45	

STEP	KEY	CODE	
57	STOi	35 45	
58	ST+i	35-55 45	
59	SIN	41	HELIOCENTRIC
60	8	08	LATITUDE
61	.	-62	
62	2	02	
63	/	-24	
64	ASIN	16 41	
65	STO1	35 01	STORE
66	RCLi	36 45	
67	2	02	REDUCTION TO
68	6	06	HELIOCENTRIC
69	7	07	ECLIPTIC
70	P>R	44	LONGITUDE;
71	1/X	52	
72	D>R	16 45	
73	X><Y	-41	
74	ST-0	35-45 00	ADDED TO
75	x	-35	ORBITAL
76	D>R	16 45	LONGITUDE;
77	ST+0	35-55 00	SECOND TERM.
78	GSB2	23 02	CALC. X,Y,Z
79	RCLA	36 11	CONVERT TO
80	ST+6	35-55 06	GEOCENTRIC
81	RCLC	36 13	X,Y,Z
82	ST+i	35-55 45	
83	RCLD	36 14	
84	ST+5	35-55 05	
85	RCLi	36 45	
86	ENT	-21	
87	X2	53	
88	RCL5	36 05	
89	X2	53	
90	+	-55	
91	RCL6	36 06	
92	X2	53	
93	+	-55	
94	SQRX	54	DISTANCE FROM
95	/	-24	EARTH
96	ASIN	16 41	DECLINATION
97	STOi	35 01	STORE;
98	RCL5	36 05	
99	RCL6	36 06	RIGHT ASCENSION
100	R>P	34	
101	X><Y	-41	
102	STO0	35 00	STORE;
103	SF1	16 21 01	BOOKKEEPING
104	0	00	
105	STO2	35 02	
106	GSB2	23 02	GEOCENTRIC LAT.;
107	RCL5	36 05	GEOCENTRIC
108	RCLi	36 45	LATITUDE &
109	ASIN	16 41	GEOCENTRIC
110	COS	42	LONGITUDE
111	STOi	35 45	
112	/	-24	

STEP	KEY	CODE	
113	RCL6	36 06	
114	RCLi	36 45	
115	/	-24	
116	R>P	34	
117	RLDN	-31	
118	STOi	35 45	STORED;
119	RCLD	36 14	
120	RCL8	36 08	CIRCULAR COM-
121	COS	42	PONENTS OF
122	/	-24	EARTH'S VEL-
123	RCLA	36 11	OCITY CALC-
124	R>P	34	ULATED & ADDED
125	X><Y	-41	TO THE VELOC-
126	5	05	ITY COMPON-
127	8	08	ENTS OF MERC.
128	GSB1	23 01	
129	RCL4	36 04	
130	RCL3	36 03	CORRECTION
131	R>P	34	TO APPARENT
132	X><Y	-41	POSITION;
133	RCLi	36 45	
134	-	-45	
135	SIN	41	
136	x	-35	
137	3	03	
138	/	-24	
139	X<0?	16-45	
140	SF2	16 21 02	IF NEGATIVE,
141	ST-i	35-45 45	SET RETRO.;
142	RCL7	36 07	SUM TO λ;
143	ST-i	35-45 45	
144	RCLi	36 45	SUM NUTATION
145	RCLB	36 12	TO
146	P>R	44	
147	R>P	34	REDUCE TO
148	X><Y	-41	FIRST CIRCLE;
149	X<0?	16-45	
150	+	-55	
151	STOi	35 45	& RESTORE
152	RCLE	36 15	
153	/	-24	DISPLAY IN
154	ENT	-21	ASTROLOGICAL
155	FRC	16 44	CONVENTION;
156	RCLE	36 15	
157	x	-35	
158	>HMS	16 35	
159	X><Y	-41	
160	INT	16 34	
161	1	01	
162	+	-55	
163	F2?	16 23 02	IF RETRO.,
164	CHS	-22	DISPLAY "-";
165	RTN	24	
166	LBLB	21 12	
167	RCL1	36 01	DECLINATION ;
168	>HMS	16 35	

STEP	KEY	CODE	
169	RTN	24	
170	LBL1	21 01	CALCULATES
171	1/X	52	COMPONENTS
172	P>R	4$	OF VELOCITY
173	ST+4	35-55 04	OF PLANETS;
174	X><Y	-41	
175	ST-3	35-45 03	
176	RTN	24	
177	LBL2	21 02	
178	RCL8	36 08	CONVERTS
179	RCL0	36 00	SPHERICAL
180	RCL1	36 01	TO RECT-
181	COS	42	ANGULAR;
182	P>R	44	
183	STO6	35 06	
184	RLDN	-31	WITH AP-
185	P>R	44	PROPRIATE
186	STO5	35 05	CHANGE OF
187	RLDN	-31	REGISTERS,
188	F1?	16 23 01	ALSO PER-
189	CHS	-22	FORMS PART
190	STOi	35 45	CON-
191	RCL8	36 08	VERSION BACK
192	RCL1	36 01	TO SPHER-
193	SIN	41	ICAL
194	P>R	44	COORDINATES.
195	ST+i	35-55 45	
196	X><Y	-41	
197	F1?	16 23 01	
198	CHS	-22	
199	ST-5	35-45 05	
200	RCL2	36 02	
201	10X	16 33	
202	STx5	35-35 05	
203	STx6	35-35 06	
204	STxi	35-35 45	
205	RTN	24	
206	LBL3	21 03	
207	EEX	-23	CALCULATES
208	4	04	PERTURBATION
209	/	-24	& SUMS TO
210	RCL5	36 05	δ ℓ & δ R.V.
211	X><Y	-41	
212	P>R	44	
213	ST+0	35-55 00	
214	X><Y	-41	
215	>HMS	16 35	
216	EEX	-23	
217	4	04	
218	x	-35	
219	ST-2	35-45 02	
220	RTN	24	
221	LBL4	21 04	CHANGES δ R.V.
222	%	55	
223	ST+2	35-55 02	
224	RTN	24	

VENUS EPHEMERIS CARD ONE

STEP	KEY	CODE	
1	LBLA	21 11	BOOKKEEPING
2	1	01	
3	6	06	
4	STOI	35 46	
5	P><S	16-51	RETRIEVES
6	RCL8	36 08	X,Z, J AND
7	STOA	35 11	NUTATION FROM
8	RCL9	36 09	SECONDARY
9	ENT	-21	REGISTERS
10	RND	16 24	
11	-	-45	
12	STOC	35 13	
13	RCL7	36 07	
14	LSTX	16-63	
15	P><S	16-51	
16	STO4	35 04	
17	RLDN	-31	
18	STO3	35 02	
19	RCL9	36 09	MEAN VENUS
20	1	01	
21	.	-62	
22	6	06	
23	0	00	
24	2	02	
25	1	01	
26	6	06	
27	8	08	
28	7	07	
29	0	00	
30	4	04	
31	x	-35	
32	STO1	35 01	
33	1	01	
34	7	07	
35	.	-62	
36	2	02	
37	3	03	
38	3	03	
39	-	-45	
40	STO7	35 07	
41	RCL1	36 01	VENUS: V
42	4	04	
43	1	01	
44	6	06	
45	1/X	52	
46	%	55	
47	-	-45	
48	2	02	
49	1	01	
50	2	02	
51	.	-62	
52	6	06	
53	+	-55	
54	STO1	35 01	
55	STO6	35 06	
56	STOi	35 45	
57	ST+i	35-55 45	V cont.
58	RCL9	36 09	CENTURY TERM
59	X2	53	OF MEAN V
60	2	02	INITIALIZES
61	9	09	REGISTER INTO
62	ex	33	WHICH PERTURB-
63	/	-24	ATIONS SUM'D
64	STO0	35 00	CONSTANT TERM
65	1	01	IN LOG r.v.
66	4	04	
67	0	00	
68	6	06	
69	5	05	
70	7	07	
71	CHS	-22	
72	STO2	35 02	
73	9	09	
74	0	00	SECOND TERM IN
75	ST-i	35-45 45	EQUATION OF
76	3	03	CENTRE.
77	3	03	
78	GSB1	23 01	
79	2	02	
80	2	02	
81	7	07	
82	.	-62	
83	5	05	
84	GSB2	23 02	
85	RCL3	36 03	EARTH 1,1
86	RCL1	36 01	PERTURBATION
87	-	-45	
88	STO5	35 05	
89	STOi	35 45	
90	1	01	
91	1	01	
92	9	09	
93	ST-i	35-45 45	
94	1	01	
95	4	04	
96	GSB1	23 01	
97	5	05	
98	5	05	
99	GSB2	23 02	
100	RCL5	36 05	EARTH 2,2
101	ST+i	35-55 45	PERTURBATION
102	2	02	
103	9	09	
104	ST-i	35-45 45	
105	3	03	
106	1	01	
107	GSB1	23 01	
108	1	01	
109	2	02	
110	GSB2	23 02	
111	RCL5	36 05	EARTH 3,3
112	ST+i	35-55 45	
113	1	01	PERTURBATION
114	5	05	
115	1	01	
116	ST+i	35-55 45	
117	2	02	
118	0	00	
119	GSB1	23 01	
120	RCLI	36 46	
121	CHS	-22	
122	GSB2	23 02	
123	RCL1	36 01	EARTH 3,2
124	ST+i	35-55 45	PERTURBATION
125	2	02	
126	2	02	
127	1	01	
128	ST+i	35-55 45	
129	1	01	
130	0	00	
131	GSB1	23 01	
132	8	08	
133	0	00	
134	GSB2	23 02	
135	RCL5	36 05	EARTH 4,4
136	4	04	PERTURBATION
137	x	-35	
138	STOi	35 45	
139	2	02	
140	7	07	
141	ST-i	35-45 45	
142	3	03	
143	GSB1	23 01	
144	RCLE	36 15	
145	GSB2	23 02	
146	RCL3	36 03	EARTH 5,4
147	ST+i	35-55 45	PERTURBATION
148	1	01	
149	6	06	
150	7	07	
151	ST-i	35-45 45	
152	4	04	
153	GSB1	23 01	
154	RCL1	36 01	EARTH 5,3
155	ST+i	35-55 45	PERTURBATION
156	5	05	
157	6	06	
158	ST+i	35-55 45	
159	4	04	
160	GSB1	23 01	
161	ST+2	35-55 02	
162	RCL9	36 09	EARTH 13, 8
163	2	02	PERTURBATION
164	4	04	
165	3	03	
166	/	-24	
167	1	01	
168	4	04	
169	7	07	EARTH 13,8
170	+	-55	PERTURBATION
171	STOi	35 45	(CONT.)
172	8	08	
173	GSB1	23 01	
174	ST+2	35-55 02	
175	RCL4	36 04	JUPITER 1,0
176	STOi	35 45	
177	9	09	PERTURBATION
178	2	02	
179	ST+i	35-55 45	
180	4	04	
181	GSB1	23 01	
182	ST+2	35-55 02	
183	RCL1	36 01	JUPITER 1,1
184	ST-i	35-45 45	
185	6	06	PERTURBATION
186	0	00	
187	ST+i	35-55 45	
188	8	08	
189	GSB1	23 01	
190	RCL9	36 09	MARS 3,1
191	1	01	
192	.	-62	PERTURBATION
193	5	05	
194	7	07	
195	2	02	
196	x	-35	
197	RCL1	36 01	
198	-	-45	
199	STOi	35 45	
200	3	03	
201	GSB1	23 01	
202	ST+2	35-55 02	
203	RCL0	36 00	CHANGE STOR-
204	PSE	16 51	INTERFACE
205	RTN	24	WITH CARD 2
206	LBL1	21 01	SUBROUTINE TO
207	EEX	-23	CALCULATE PER-
208	4	04	TURBATION AND
209	/	-24	SUM TO CENTURY
210	RCLi	36 45	TERM IN LONG-
211	X><Y	-41	ITUDE AND CON-
212	P>R	44	STANT TERM IN
213	ST+0	35-55 00	LOG r.v.
214	X><Y	-41	
215	>HMS	16 35	
216	EEX	-23	
217	4	04	
218	x	-35	
219	ST-2	35-45 02	
220	RTN	24	
221	LBL2	21 02	CHANGES log r.v.
222	%	55	PERTURBATION.
223	ST+2	35-55 02	
224	RTN	24	

VENUS CARD TWO

STEP	KEY	CODE	
1	STOB	35 12	AGE REGISTERS
2	RCL2	36 02	
3	STOE	35 15	
4	LBL3	21 03	FIRST TERM IN
5	RCL6	36 06	EQUATION OF
6	.	-62	THE CENTRE.
7	7	07	
8	8	08	
9	1	01	
10	6	06	
11	RCL9	36 09	
12	5	05	
13	1	01	
14	X2	53	
15	X2	53	
16	/	-24	
17	-	-45	
18	P>R	44	
19	3	03	SUMMED TO LOG
20	7	07	R.V. PERTURB-
21	9	09	ATIONS
22	0	00	
23	x	-35	
24	CHS	-22	
25	RCLE	36 15	RATIONALIZES
26	+	-55	LOG R.V.
27	EEX	-23	
28	6	06	
29	/	-24	
30	STO2	35 02	
31	X><Y	-41	ALSO WITH
32	RCLB	36 12	Z ORB. VENUS
33	+	-55	
34	RCL7	36 07	
35	+	-55	
36	STO0	35 00	
37	7	07	ANGLE FROM
38	5	05	ASCENDING NODE
39	.	-62	
40	7	07	
41	8	08	
42	-	-45	
43	RCL9	36 09	
44	7	07	
45	0	00	
46	8	08	
47	R>D	16 46	
48	/	-24	
49	-	-45	
50	STOi	35 45	
51	ST+i	35-55 45	
52	SIN	41	HELIOCENTRIC
53	.	-62	LATITUDE
54	0	00	
55	5	05	
56	9	09	
57	2	02	HELIO LATITUDE
58	x	-35	CONTINUED
59	ASIN	16 41	
60	STO1	35 01	
61	RCLi	36 45	REDUCTION TO
62	SIN	41	THE ECLIPTIC
63	.	-62	
64	3	03	
65	4	04	
66	ASIN	16 41	
67	/	-24	
68	ST-0	35-45 00	R0 now=Z ecliptic
69	GSB2	23 02	CALC. X,Y,Z
70	RCLA	36 11	
71	ST+3	35-55 03	CALCULATES
72	RCLC	36 13	ξ,η & ζ
73	ST+i	35-55 45	
74	RCLD	36 14	
75	ST+4	35-55 04	
76	RCLi	36 45	DISTANCE OF
77	ENT	-21	PLANET IN
78	X2	53	ASTRONOMICAL
79	RCL4	36 04	UNITS
80	X2	53	
81	+	-55	
82	RCL3	36 03	
83	X2	53	
84	+	-55	
85	SQRX	54	DISTANCE
86	F0?	16 23 00	
87	STO5	35 05	
88	/	-24	
89	ASIN	16 41	DECLINATION
90	STO1	35 01	
91	RCL8	36 08	
92	RCL5	36 05	CALCULATES
93	1	01	LIGHT TIME
94	0	00	FOR THIS DIS-
95	8	08	TANCE; SUB-
96	/	-24	TRACTS APP-
97	ST-7	35-45 07	ROPRIATE
98	ST-6	35-45 06	AMOUNT FROM
99	3	03	MEAN V & qV
100	8	08	SUBTRACTS COR-
101	SIN	41	RESPONDING
102	x	-35	AMOUNT FROM
103	CHS	-22	X,Y,Z TO FORM
104	RCLD	36 14	X',Y' & Z'
105	RCL8	36 08	
106	COS	42	
107	/	-24	
108	RCLA	36 11	
109	R>P	34	
110	RLDN	-31	
111	+	-55	
112	RLUP	16-31	
113	P>R	44	RECALCULATES
114	STOA	35 11	X',Y' & Z'
115	RLDN	-31	
116	P>R	44	
117	STOD	35 14	
118	RLDN	-31	
119	STOC	35 13	
120	RCL4	36 04	RIGHT
121	RCL3	36 03	ASCENSION α
122	R>P	34	
123	X><Y	-41	
124	STO0	35 00	
125	SF1	16 21 01	CALCULATES β
126	GSB2	23 02	GEOCENTRIC LAT.
127	RCL4	36 04	GEOCENTRIC
128	RCLi	36 45	LONGITUDE; λ
129	ASIN	16 41	ALL PARAMETERS
130	STO2	35 02	SO FAR HAVE
131	COS	42	BEEN GEOMETRIC
132	STOi	35 45	AT 139, PRO-
133	/	-24	GRAM BRANCHES
134	RCL3	36 03	TO LBL 4 TO
135	RCLi	36 45	RECALCULATE
136	/	-24	α,β,λ ALLOW-
137	R>P	34	ING FOR LIGHT
138	RLDN	-31	TIME; THE RE-
139	F0?	16 23 00	SULT IS APPAR-
140	GTO4	22 04	ENT PARAMETERS;
141	STOi	35 45	
142	RCL5	36 05	DETECTS RETRO-
143	-	-45	GRADATION;
144	X>0?	16-44	SETS (?)
145	SF2	16 21 02	FLAG 2.
146	P><S	16-51	ADDS NUTATION
147	RCL0	36 00	
148	P><S	16-51	
149	ST-i	35-45 45	
150	RCLi	36 45	REDUCES λ TO
151	3	03	FIRST CIRCLE
152	6	06	
153	0	00	
154	STOB	35 12	
155	P>R	44	
156	R>P	34	
157	X><Y	-41	
158	X<0?	16-45	
159	+	-55	
160	STOi	35 45	STORES
161	3	03	ASTROLOGICAL
162	0	00	CONVENTION
163	STOE	35 15	
164	/	-24	
165	ENT	-21	
166	FRC	16 44	
167	RCLE	36 15	
168	x	-35	
169	>HMS	16 35	AND DISPLAYS
170	X><Y	-41	SIGN NO. AND
171	INT	16 34	DEGREE IN
172	1	01	SIGN
173	+	-55	
174	F2?	16 23 02	IF RETRO-
175	CHS	-22	GRADE, PRE-
176	RTN	24	FACES SIGN
177	LBLB	21 12	NO. WITH "-"
178	RCL1	36 01	DISPLAYS D.MS
179	>HMS	16 35	DECLINATION
180	RTN	24	
181	LBL4	21 04	STORES GEO-
182	STO5	35 05	METRIC λ FOR
183	CF0	16 22 00	COMPARISON
184	CF1	16 22 01	AND RETURNS
185	GTO3	22 03	TO RECALCUL-
186	LBLC	21 13	ATE λ APPAR.
187	RCL2	36 02	
188	>HMS	16 35	DISPLAYS D.MS
189	RTN	24	LATITUDE
190	LBL2	21 02	
191	RCL8	36 08	CONVERTS SPHER-
192	RCL0	36 00	ICAL CO-ORDIN-
193	RCL1	36 01	ATES (Z,b, r.v.)
194	COS	42	TO HELIOCENTRIC
195	P>R	44	EQUATORIAL
196	STO3	35 02	RECTANGULAR
197	RLDN	-31	(x,y,z)
198	P>R	44	
199	STO4	35 04	WITH APPROP-
200	RLDN	-31	RIATE CHANGE OF
201	F1?	16 23 01	REGISTERS, ALSO
202	CHS	-22	PERFORMS PART
203	STOi	35 45	OF CONVERSION
204	RCL8	36 08	BACK TO GEO-
205	RCL1	36 01	CENTRIC SPHER-
206	SIN	41	ICAL COORDIN-
207	P>R	44	ATES.
208	ST+i	35-55 45	
209	X><Y	-41	
210	F1?	16 23 01	
211	CHS	-22	
212	ST-4	35-45 04	
213	F1?	16 23 01	
214	RTN	24	
215	RCL2	36 02	
216	10X	16 33	
217	STx3	35-35 03	
218	STx4	35-35 04	
219	STxi	35-35 45	
220	RTN	24	
221	R/S	51	

An Introduction to Home Computers for Astrology

by Michael Erlewine

HOME COMPUTER SYSTEMS: WHAT ARE THEY?

The following section is intended for those of you with little or no computer experience. Reading this may help your understanding of the more technical sections to follow.

Not many years ago, the computer was exclusively the resident of a specially air-conditioned room in the heart of large corporations and scientific establishments. The thought of a private individual owning one of these million dollar machines was unheard of. Even the elite of the company that owned a computer had to jockey for it's use and time-sharing (many individuals using a computer through separate terminals) was the only way to go. There were no small computer systems.

A short number of years ago saw the development of large-scale integrated circuits (LSI) and suddenly the pocket calculator became a reality. The microprocessor (computer-on-a-chip) soon followed but available at a cost that kept them out of the hands of the average person. This was the era of sneaking time on the company computer. In January of 1975 an article appeared in POPULAR ELECTRONICS describing the construction of a relatively inexpensive computer, the Altair. Since 1975, the computer hobbyist phenomenon has mushroomed and today there are a wide variety of computers, computer magazines, components and so forth available. However, the hobby computer is still beyond the use of most astrologers. For one, it is assembled and maintained by the hobbyist owner— a task beyond the skill and desire of the average astrologer. For the most part, these systems are octopus-like affairs that consist of home-made components strung together by a maze of wires. Also, these systems are quite expensive— averaging several thousand dollars at minimum.

The first appliance-like home computer systems were announced in 1977 and became available very late in that year. It is these systems that we are reviewing in this article and hundreds of thousands have been sold. There are still but a few brands of home computer systems available and the Commodore PET and Radio Shack TRS-80 (Level II) computers head the list. Both of these system are ready to plug-in and run as soon as you can get them out of the box and both are capable of doing a whole lot of astrology. Let me describe the basic components of the small computer system:

These systems have a T.V. screen that is called the 'video monitor' or more often the 'CRT' (Cathode Ray Tube). It is on this screen that the user may view the written program statements or lines much like you would look at a sheet of program code from this magazine. The CRT is also used to display the results of the computer program when run— like planet positions, aspect grid, even chart wheels. Next to the video screen, perhaps the most obvious component of any system is the keyboard. This keyboard looks almost identical to that of an ordinary typewriter and is the means for the user to instruct and relate with the computer. Letters and words of instruction typed on the keyboard are displayed on the CRT. Data...such as birth information...is input to the computer thru the keyboard. The astrological program (once entered) will prompt the astrologer to enter a particular piece of data at a particular time and so forth.

Deep within the enclosure for the system is the heart and brain of the computer— the microprocessor or 'chip' as it is called. This tiny wafer-thin flake (about as large as half your little fingernail) is the very center of all computer activity. The microprocessor controls and executes all of the countless activites involved in system use. Above all it fetches and dispatches information from one part of the computer system to another. So advanced are today's microprocessors compared with our ability to make use of their abilities that the chip has an extraordinary amount of free time— time that we have not been able to make use of to date. To give you an idea (and a conservative one) as to the capacity for work of modern chips compared to our ability to use them, consider this: the chip waits for activity or instructions— at it's full attention— for something similar (in out time framework) to our waiting for a solid month of days and nights for a single phone call. Now, that's free time!

The last obvious component in a computer system is the tape recorder which is an ordinary cassette deck. Programs are recorded on audio cassettes and read into the computer via the tape deck. Program as well as data storage is inexpensive since a large number of programs may be stored on even a single audio cassette.

Perhaps a few words here on some of the less obvious components in a computer system. The microprocessor or chip communicates throughout the computer and (in particular) with the outside world thru the BUS STRUCTURE-..which consists of a group of leads or wires that carry electronic signals to and from the chip itself. Programs read into the computer via the tape deck are stored in memory locations where they can be accessed by the microprocessor at the appropriate time. This kind of storage or memory is termed RAM for Random Access Memory and is usually designated in units of 8 Kilobytes or multiples thereof. This is as good a point as any to say something about bits and bytes and the like. Bits are the smallest computer instruction and are similar to a light bulb being on or off. Thus, any given 'bit' is either on (positive) or off (negative). These bits can be arranged into varyious sized groups or 'Bytes' to signify letters or numbers— information. A 'byte' is a group of 'bits'. Most of the current crop of microcomputers are designed to handle a byte of 8 bits at a time... while the next generation of computers will handle a byte of 16 bits at a time. If you are still with me, memory or RAM is most often designated in terms of the number of bytes (8 or 16 bit) it contains. It is the size of this RAM that determines how large a program the computer can hold at one time. 8 Kilobytes (8K) of RAM is the minimum amount of storage needed for a complete natal program. One can always add more RAM to a system to increase it's programming capacity.

Another important term is ROM which stands for READ ONLY MEMORY. RAM differs from ROM in that it can hold any program or data that you care to put into it. The program stored in RAM is lost when the computer is turned off at the end of a day. It must be entered in again each time the user decides to use the computer. For instance, I would enter in a natal chart program into the RAM memory after I switch on the power to my computer. I can do as many charts as I want but when I turn off the computer, I lose that program in RAM.

ROM or Read Only Memory cannot be lost by power loss to the computer system. It is a permanent resident and is there every time you switch the system on. The ROMs in home computer systems contain programs needed to operate the system such as instructions to control the tape deck, video screen and so forth. One of the features of the new home computer systems such as the PET and TRS-80 is that they have the computer programming language BASIC hard-wired into ROMs so that it is there when the system is turned on. Previous to this, the hobby computerist had to load in the BASIC language from audio cassette —which could take up to 15-20 minutes! The Digicomp DR-70 astrological computer has all of it's astrological software in ROM and has no user-dedicated RAM whatsoever (see article elsewhere in this issue on the DR-70). This new generation of home computers has the programming language BASIC and operating instructions stored in ROM while user programs are loaded into RAM from audio cassettes or other mass storage devices like high-speed tape transports or floppy disks.

Speaking of floppy disks brings up the whole area of computer peripheral devices. Peripherals include line printers, mass storage devices, extra or external CRTs and a large variety of special task add-ons like music boards, modems (computer to computer communication via phone) and so forth.

For the astrologer, the first and perhaps most important peripheral will be the line printer so that the chart information and aspects grid, etc. can be permanently recorded. In computeresque this is called hard-copy. The other peripheral desired by every astro computer is some sort of mass storage device.

Loading programs from tape cassettes is ever so much faster than doing the same astrological work by hand..but ever so much slower than loading these same programs in the ' wink of an eye'. This kind of instant program loading is possible thru use of the 'floppy disc' storage system. Keep in mind that there seems to be no end to the amount of peripherals (and money spent) required to partake in the state-of-the-art of computer technology. We have detailed how the computer user may add extra RAM to his system... above and beyond the 8K or so RAM necessary for astrological essentials. A 16K or 32K RAM system can do all kinds of astrology and any number of 16K or 32K programs can be loaded one after another— in succession. However, if these programs could be loaded in and out of the computer at high speed, it would be like owning a computer with unlimited RAM memory. This is a large part of what is accomplished thru using a mass storage device such as the floppy disk.

The floppy disk consists of a magnetic coated disk about the size of a 45 record that is rotated at very high speed. The disk contains tracks or 'grooves' similar to a phonograph record but very much finer. A magnetic recording/reading head scans the surface of the disk such that no bit of information is ever further than one rotation. Information stored on the disk can be accessed in a literal flash and even entire large programs loaded 'at once'. The value of such a device is that it makes hundreds of thousands of bytes of information immediately available. One could for instance, store thousands of natal charts on one of these larger disks along with programs to relate the charts to one another.

The components of the computer system and the various add-ons or peripherals make up what is called the 'hardware' of the system. We have yet to say something about the 'software' for these systems. The term 'software' refers to all of the instructions or programs that can be run on the system as well as the programming language in which these programs are written. We mentioned 'bits' and 'bytes' and that the microprocessor worked with these quantities. The average programmer never descends to the level of this machine code... of adding and shifting around various bits of information. Instead most programs are written in a higher level language and this language then is interpreted by the machine and reduced to the actual machine code that will do the desired job. The most popular of the many programming languages is BASIC (Beginners All-purpose Symbolic Instruction Code) for use with the new home computers.

BASIC is easier to learn than most programmable calculator instruction sets but difficult enough to discourage most average astrologers. The kind of calculation involved in astrological work is complex enough to require considerable attention and care. I envision most astrological programs or software as being written by a small group of astrologer-programmers (readers of this magazine for instance)who will make this material available to others. A larger group may learn enough about programming to custom tailor their own programs to their needs but the largest number of astrologers will want to purchase programs recorded on cassette (or disk) and just run them. We will be offering a series of workshops in the spring and summer of 1979 on how to program astrology in BASIC. We are also taking steps to establish an annual conference on the many technical aspects of astrology to be held here in Ann Arbor.

There are many versions or dialects of the computer language BASIC— it has not been standardized. Some of these versions are much more capable than are others. Both the PET and TRS-80 use a form of BASIC with extra features often termed an Enhanced or Extended BASIC. In most of the earlier hobby computers, BASIC is not in ROM and therefore always there. Instead, it must be loaded from tape cassette into RAM which can take as much as 15-20 minutes. Also important to keep in mind is the fact that BASIC in these earlier hobby systems takes up some of the user's RAM memory— since it is not in ROM. In other words, if you are considering purchasing one of these earlier computer systems, keep in mind that the amount of RAM reserved for program storage must be counted above and beyond that amount of memory required to support BASIC and any other operating software.

Keep in mind that the $5 4-Function pocket calculator can greatly improve the accuracy and efficiency of most astrological calculations. The whole range of programmable calculators makes most any kind of astrological computation possible— if time is unimportant and ease of operation of no concern. Thus there is no 'bottom-line' for astrological calculation in terms of machine size. I mentioned earlier that 8K of RAM memory is perhaps the minimum configuration for decent astrological work...considering the expense of investing in a computer system. I paid almost as much for my HP-97 programmable calculator with 224 steps as I did for my 22K PET with 8k of RAM and there is no comparison in terms of calculating power that is anywhere near equal. Let me give those of you with no experience with these home computers some idea as to how these machines might used for doing astrology.

Both the PET and TRS-80 are ready to run when they arrive. In the case of the PET, all that is required is to plug the machine in any wall outlet and turn it on. The screen lights up and tells me that it is ready for instructions or programs as well as indicating how many bytes are free for my use. At this point, I can enter a program for astrological work by snapping a cassette into the tape recorder and typing the word 'LOAD' on the keyboard which is displayed on the CRT or video screen. The CRT then tells me to 'PRESS PLAY ON THE RECORDER'...which I do. The screen now displays the word 'SEARCHING' to let me know that it is scanning the tape to see if there are any programs on it. When it finds a program, it will display the program title on the screen. For instance, it may say 'FOUND "SOLAR ARC"' and so forth. The machine will proceed to load the program from the cassette into computer RAM memory after which it will display the word 'READY' on the screen to let me know that the program is in memory and ready to go. I now type the word 'RUN' on the keyboard and the program begins. I have a great many different programs that I use for my work. Let me continue with the example of the Solar Arc program. When I run the program, the screen blanks out and I receive a series of prompts asking me for the basic natal or event information required to cast a chart. I am asked for the date, time and Geographic Longitude and Latitude for the event as well as the time zone involved. At each prompt, I type in the required information. The program then calculates the planet positions and displays them on the screen. This takes about half a minute! The program then asks me if I would like to direct planets using solar arc or instead scan a given period of time for aspects that become exact within that period. If I chose to scan for aspects, I may select a time scan of either a week, month, 6 months or a year on either side of any date I select. The program will display all aspects (I may chose to include the minor aspects too) that occur within that period of time and display the aspect along with the date when that aspect is exact. The other option I have in this program is to direct planets by solar arc. For example, I may direct my Venus to a Sextile aspect with my Sun and the computer will display the date on which this aspect is due ...and so forth. Using this program requires no technical experience other than some knowledge of the astrological technique involved (solar arc direction) and the ability to enter birth data when prompted by the machine. In other words, even the minimum 8K RAM configuration is capable of very complex astrological work... and additional memory provides even greater possibilities.

In addition to running programs as described above, these systems can be used in 'immediate' mode much as we would use a calculator. In other words I can add, subtract and so forth right on the display screen. In addition to this I can write my own programs. Let me give an example. Suppose I want to write a program that will give me the midpoint between two planets. I can write such a program and run it as many times as I please or even store it on tape for future use. The computer will execute any sentence of program instructions that I write following a simple but rigid set of rules. I must indicate what each symbol I use stands for. If I wish to write a program to calculate midpoints, I must tell the computer that a certain symbol (letter combination)..say 'P1' stands for planet one's position and and that 'P2' stands for the position of the second planet in the zodiac.

If I have a planet at 2 degrees Aries and a second planet at 24 degrees aries, I can tell the computer that "P1=2" and that "P2=24" after which I can indicate that what I want the computer to do is to ADD P1 and P2 and divide by 2 to get the midpoint. The program code for this might look like this: " P1=2, P2=24" with the midpoint (MD) derived by " MD=(P1+P2)÷2" which reads "the midpoint equals the sum of P1 plus P2 divided by two". What I am trying to get across here is that while programming is very exact and often complex, no single step is all that complex in itself. No great knowledge of mathematics is required to do astrological programming since almost all of the formulae necessary for our work are available. One need not know WHY a formulae works as long as we know how and when to use the formulae to get the results we are after. After becoming aquainted with the BASIC programming language (reading in a book on the subject), the best way to learn programming is by doing it. Beginning with simple operations like the calculation of a midpoint described above, we can link several simple steps into a more comprehensive program until we develop a large program capable of doing just what we need for our work. I am not suggesting that the majority of astrologers will learn programming, but instead I am indicating that the road to programming is not difficult in itself. It consists of simple and very practical steps that can lead to mastering more complex and comprehensive programming techniques. Programming can function as a kind of therapy or remedy for the tendancy of many astrologers towards vagueness and generality since the computer will not tolerate these qualities but rather demands precise definition at all times.

I have tried to give you some idea about computer hardware and software— an introduction at least. I would like to say something about doing astrology on these new systems. Computer technology is is being developed in these years. The spirit that pervades this entire industry is as close to that of the "Wild West" as any that I have seen in my lifetime. As consumers we are used to having all of our products available in a finished or refined state— perhaps after years of testing and prototypes. The computer industry is wide open right now. It is so understaffed that individuals with the vaguest electronic background are able to land top positions with companies. There are so few standards that every new successful product is followed by a rush on the part of small companies (sometimes operated out of the family garage) to support that product with peripheral devices of one kind or another. The mother company seldom has time to develop and market their own peripherals so great is the demand for the basic product itself. Estimates for the delivery of the Radio Shack TRS-80 computer now average at least 3 months and I am told that this interval is increasing rather than decreasing at this time! It is common in this industry to pay cash up-front for an item that is delivered months later and may not even be in production yet! Unless one is quite knowledgeable concerning computers I do not suggest that you purchase a computer system that has not been tried and tested by other astrologers...and there will be dozens of such system available within the year and at very attractive prices too! There are many ways you could end up with a machine of little use for astrological work.

For instance, one of the most attractive and flexible of the new home computer systems is the Exidy SORCERER computer. It is a marvel indeed but not for astrological work since it has precision of only 6-7 digits and astrologers should want to get at least 9 digits or more. (The PET has 10 digit precision and the TRS-80 Level II has 16 digits) There are ways to get around this but these methods may not be available for some time to the user of these systems. Another problem that can occur is to purchase a system that can never be serviced since the company might fail..or almost as bad have a service department that requires months for repair. This is why giant companies like Radio Shack and Commodore are so attractive. Radio Shack has centers in almost all major cities where the TRS-80 can be taken for repair and Commodore has over 100 service centers across the nation (see notes elsewhere this issue for more details) that can fix the PET. No doubt, within several years we will see a much larger number of home computer systems that can be easily serviced. We are all waiting for Texas Instruments to bring out their computer to see if it will be fit for astrological work. The professional astrologer with no desire for the trials and anguish inherent in working with offbrand equipment had better stay with one of these well established systems and peripherals for these systems that can be easily serviced. We have a very nice printer for our computers that we bought because we needed one at the time and could not afford to wait until the Commodore or TRS-80 printers were made available but if it breaks down, I am at the mercy of overworked local technicians who often refuse to work on any but the most standard machines...or if they will agree to even touch it...I can expect to pay and pay for this service. It is either that or shipping my printer round-trip to Phoenix by air! Watch out.

The above is not meant to frighten you but rather to warn you that in this pioneer field the bargain may be to pay more money for the convenience of a machine that is quickly and inexpensively repaired rather than to scrounge around for ways to cut costs. I am told that Robert Hand's system has been down and out since the beginning of October. If your practice depends on having these computer calculations always at hand then a two month wait is no joke. Both the TRS-80 and the PET are small enough to be shipped by UPS to the nearest service center and this is far more convenient than arranging for air-freight pick-up and so forth. As more and more of these computer systems become available, it will become tempting to purchase one of the off-brand systems at a savings rather than to shell out for the name brand. Money is not everything.

Just as important is the software for the system of your choice. If you are not proficient at programming, you will want to purchase astrological programs to fit your particular machine and programs on cassette that fit one brand will not run on any other brand system. PET programs do not run on the TRS-80 without considerable modification and vice versa. Those of us who are interested in writing astrological software will not be able to afford to buy every new system that comes on the market. Instead, astrological software (in the widest selection) will be available only for the most popular machines.

MATRIX SOFTWARE (an offshoot of the magazine) will try to gather together programs from astrologers around the globe to fit any and all kinds of machines yet there will no doubt be many more programs for the PET and the TRS-80 written than for say the Heath H-80 computer since there are so many more of these machines in the hands of astrologers. For instance, at this time we have a fair selection of astrological programs on cassette to fit the PET and the TRS-80 but only one or two for the APPLE II and only one in-the-works for the users of the Heath H-8. The point here is that it is of no value to purchase an off-brand computer system for which there is no software written. Of the many kinds of activities in which I have engaged in the course of my life, none has been so absolutely time-consuming and demanding as computer programming. It takes a very great amount of time to write and debug a program or even to modify an existing program to fit another machine. I would suggest that the most important consideration for astrologers interested in owning a computer system concerns the availablity of good astrological software to fit the system rather than merits or cost of the system itself. You can be sure of obtaining plenty of software for the PET and TRS-80 and perhaps even the APPLE II but who knows about the many other systems available now or soon to be available.

In concluding this brief introduction a few remarks about what kind of programs are possible on these small machines. If you can afford a computer system with 32K there is no reason you cannot have planetary positions with ephemeris accuracy. Programs with this kind of precision are available (see MATRIX Software ad). However, thanks to the fine work of James Neely, we can get quite high accuracy for planet positions in as little as 8K RAM for most machines. Accuracy of about a minute of arc for the sun and inner planets and slightly more (2-3 minutes of arc) for the outer planets is now a fact. This is a vast improvement over the up-to 45 minutes of arc possible until the 'Neely' values became available. We are working on new methods (Chebyshev analysis- detailed elsewhere this issue) that will allow very high levels of precision to be attained but will be more time consuming to use. These new methods should be adaptable to even the 8K RAM machines provided the user is not in an ultra-hurry (they may take a couple of minutes to run).

Programs can be linked together in the smallest machines to achieve effects similar to larger ones. For instance, planetary positions can be calculated by one program and these positions then passed to a second program that goes on to perform various auxiliary operations such as aspects, midpoints, harmonics, what-have-you? Using this proceedure almost anything is possible. If there is anything I have learned in the years from my first 4-Function calculator through the various programmables I have owned and upto the current micro systems I use is that I will make the most out of what I have without all that much discomfort or complaint. I make due. If you cannot afford a micro system at this point, perhaps a programmable calculator is possible..or even a 4-Function machine. Although I would love to have the possibilites gained through owning a system like Robert Hand uses..and of course Neil Michelsen has...I do not need this kind of system as much as I need something to work with and learn on. I am quite happy with my PET at this point.

With these thoughts in mind, let us examine and compare the two major computer systems available now, the Commodore PET and the Radio Shack TRS-80. Of course, five years from now these comments will be worthless and I do agree with John McCormick (see his review of these machines) that a microcomputer is a microcomputer is a...and so forth. However there are differences that are worth making clear to those of you faced now with a choice of systems to purchase. I own and have worked with both the PET and the TRS-80 systems in their original forms and in expanded versions. While I must say that my first love was the PET, I am coming also to love and appreciate the qualities of the TRS machine. Those of you who are not up for this kind of nit-picking are advised to skip over this section. Let me divide my comments into two sections: some general thoughts for the astrologer considering these two systems as an investment and then some more technical remarks perhaps sensible only to those who already own one of these systems.

A GENERAL COMPARISON OF THE PET AND THE TRS-80

Need I repeat that both of these systems are more than adequate for astrological use? It is difficult to obtain objective information concerning these two systems. This is partly due to pure ignorance on the part of everyone involved and sometimes due to the rivalry that does exist between owners of these two systems. I have spent much energy via both the phone and the mails trying to ascertain the facts relative to these two systems. In particular this was true before I had purchased either of them. Of course, owning them clears up most questions but this wont help those of you with no computer experience.

To me the most important information to emerge about these two systems has to do with how they were conceived and came into being. Commodore is probably the world's largest manufacturer of inexpensive pocket calculators. Radio Shack is familiar to all as the chain outlet for inexpensive electronic equipment and gadgets. Neither company had any background in the hobby computer scene and both companies received raised eyebrows (if not open contempt) from the hobby folks when they announced their computer systems. I dont know how many hobby computerists have told me that the PET or the TRS was " not a real computer". Unfortunately my respect of authority had me going from "expert" to expert accepting their pronouncement on these machines. It took me months to have the courage to know that not only were these 'real' computers but that I knew a whole lot about these particular systems if only due to the fact that the so-called experts refused to inquire into them with an open mind.

The origin of the TRS-80 as it is today came from an earlier desire on Radio Shack's part to market a computer-like board that could be assembled from a kit and would flash some lights and do little else (this history is taken from an address by TRS-80 designer Steven Leininger). The original idea for a computer light-board gave way to a simple computer that supported the minimum possible higher-level computer language BASIC. It was at this point that Radio Shack hired Steven Leininger who was then actively working with TINY BASIC which is just what it's name suggests. Leininger convinced them the public would much rather have an assembled and tested computer than to have a computer in kit form. A prototype was assembled and a go-ahead for TRS-80 production given in February of 1978. Leininger states that the TRS-80 as it exists today is a stop-gap to hold their place in the market while they put together the second and third generation of the TRS. He goes on to point out that the external power source on the TRS-80 is due to the fact that FCC approval of an internal power source might have taken some six weeks longer and so forth.

On the other hand, the Commodore PET was anything but hastily designed. First of all, the PET is not the brainchild of Commodore Business machines. It was created by Chuck Peddle of MOS technology...which company Commodore aquired lock, stock, barrel and of course Chuck Peddle. Chuck peddle came along with MOS over to Commodore and the PET was conceived and designed by this man. Chuck Peddle was part of the design team that created the Motorola 6800 microprocessor chip (one of the originals). He was personally responsible for the architecture of that chip. Subsequently, he was the leader of a team of technicians that designed the 6502 microprocessor chip— one of today's two most-used chips (the other being the Z-80 used in the TRS-80).

If the PET and TRS-80 machines are compared to the standard features of the hobby computer systems it should be clear that the PET has been well thought out in almost every detail while the TRS-80 system lacks this kind of overall design. I shall attempt to explain this in detail.

Before we examine and compare the components of these two system let me point out what I believe to be the major fault of Commodore and this is user documentation, advertising and service. While ads for the TRS-80 can be found on national T.V. and in many major magazines, I have yet to see a single ad placed by Commodore altho there are a few poor ads taken out by some of the PET distributors. They have not yet advertised their machine. Why this is so, I dont know. Perhaps they want to fill back orders before promoting their machine...perhaps they lack the money for such promotion..perhaps they prefer word-of-mouth advertising. Regardless, how can they expect consumer confidence in this modern world if they refuse to ever keep their product before the public eye? An even greater criticism of the PET is that to-date they do not have a manual on how to use the PET. Instead they issue a tiny booklet with new machines that lists the BASIC commands but leaves the inexperienced user of computers at a total loss as to how to use and program the machine. This is inexcusable! Thankfully, there are books available that will solve this mystery for the beginner-not the least of which is the user manual that comes with the TRS-80! And finally, my last criticism (which no longer holds true) is that Commodore took their own sweet time about establishing service centers around the country that could repair and service their machine. I have a list of 100 service centers around the country (as of Nov. 1, 1978) where PETs can be sent that I received recently. Readers concerned with where they can get PET service can send me a SASE (envelope) and the name of their state and I will send you the service centers for that state.

The TRS-80 can be taken to your nearest Radio Shack store (regardless where you originally purchased the unit) from which it will be sent by UPS to their nearest service center. Until recently, this kind of service has been a great 'plus' in favor of the TRS-80 system but Commodore seems to be establishing a wider service base at this time for their machines than they did previously.

The CRT or VIDEO MONITOR

The PET appears to have a real video monitor for a CRT while the CRT on the TRS is it's worst feature. I am not a technician, but as I understand it the difference between an normal T.V. tube and a real video monitor is that the video monitor is specially designed for the high resolution required in computer displays while the T.V. tube is not. The PET offers a 9 inch (diagonal) screen that provides not only clearer but also larger characters than the 12 inch (diagonal) screen on the TRS-80. The PET screen is sharp and clear while the TRS is not well resolved and thus difficult to read at a glance. A more important criticism from the astrological viewpoint involves the way information can be displayed on these two screens. The TRS-80 can display 64 vertical columns of 16 characters each (16 lines of 64 characters) or 1024 characters in all while the PET displays 40 columns of 25 characters (25 lines of 40 characters) for a total of only 1000 characters. In other words, we can display longer lines of type on the TRS but more lines on the PET. For astrological work where we want to display facsimiles of chart-wheels, aspects grids and the like the 16 horizontal lines of the TRS are not quite enough and the 25 lines on the PET only somewhat better. Better yet would be a display of 30 lines of 64 characters each (found in the Exidy Sorcerer). The PET format is better balanced for chart-like display than is the TRS.

GRAPHICS CAPABILITY

Here the PET is hands-down the better machine and one only has to see a chart-wheel facsimile on these two machines to appreciate this statement. The TRS-80 has the rudimentary computer graphic style associated with the early systems...that of X & Y coordinate plots. This is fine provided that we are working with high resolution graphics. However, the graphic capabilities of the TRS are very crude and of little value for astrological purposes. For instance, it is not even possible to draw a line under a verbal heading without using up one of the 16 lines on the screen. Even tho there is a large space between each of the sixteen lines on the TRS-80 screen, this space can not be used for graphics without wiping out a line of print above or below the line we would like to highlight in some fashion.

On the other hand the PET uses a pseudo-graphics system that consists of 64 different characters (lines, curves, circles, etc.) that may be displayed side-by-side to form a wide variety of shapes, boxes and so forth. A second feature of the PET graphics is the fact that any of the graphic characters or the alphanumeric characters may be displayed in what is termed 'Reverse Field' format— in any combination. In other words, any given character may be displayed as white against a dark background or as dark against a white background. This is of real use to astrologers in making certain important features stand out on the wheel or aspect grid. For instance, I can make the retrograde symbol 'R' light-up on the screen or particular aspects, harmonics or whatever light-up when found and catch my attention. I have found this feature and the PET graphics in general of great value in adding a real fine quality to what otherwise would (or could) appear as a kind of dull format. For instance, I can carefully box-in certain sections of the screen that contain important information, I can underline headings or phrases,raise certain columns of figures above the background using the reverse-field...and so on. As unessential as this graphics capability may appear at first glance, I have found this additional feature of the PET (and Sorceror) to be very satisfying.

The KEYBOARD

Both the PET and the TRS-80 make use of a keyboard with letters and numbers arranged as on an ordinary typewriter. The TRS-80 keyboard is standard-sized and easy to use while the PET reduced the size of their keyboard and, in many respects, this is the worst feature on this machine. Mechanically the PET keyboard is very well made and has the additional feature of a separate calculator-like keypad for number entry which I appreciate. However, due to the reduced size of the PET keyboard and it's 'springy-ness' fast typing will never be possible on such a keyboard.

The TRS keyboard is spacious and easy to type on...well adapted for word processing (fast typing, letters, etc.). It has some problems however. Poor spring contacts under the individual keys cause some keys to print a bunch of a character where only one was desired. Thus I may type the number 510 only to notice (further down the line) that the number 5100 was entered instead. This is not funny at all if this was part of an input to a running program.

External standard-sized keyboards are available for the PET for around $125 for those who have the need to use the PET for word processing.

TAPE RECORDERS AND FORMAT

Both the PET and the TRS-80 make use of inexpensive tape decks for program storage and retrieval. The TRS-80 has the advantage of having a tape-counter built into it and all-around may be a more expensive machine than the unit Commodore uses. Commodore's tape deck is built into the computer enclosure and has special heavy-duty wiring to insure better communication between computer and recorder. The cassette recorders on both systems have all of the ordinary problems associated with tape-decks and must have their heads cleaned and de-magnitised from time to time. Some PET owners have had to have their heads aligned before they could easily load tapes recorded on another PET.

Radio Shack has had a whole lot of trouble with their entire recording scheme. Tapes are often difficult to load...sometimes impossible for reasons not apparent. I have very seldom had any kind of tape-load error on my PET but must hold my breath quite often when working with the TRS-80...praying I have a successful recording of a program. As I understand it Commodore has a redundant type recording scheme that eliminates most program read/write errors while Radio Shack does not. To my mind, this kind of anguish over whether or not a program (you have spent all day writing) is or is not surely recorded is the worst and could have been avoided by investing in a recording scheme similar to the one used on the PET.

It should be pointed out that for the average astrologer who does not do much (any) programming the reliability of the TRS recorder will not be so important since he can load the program over again until he gets a successful load. For the programmer, this feature is a fearful one. Steve Blake who owns a TRS-80 system tells me that life is very much better with the floppy disk which obviates the need to use the tape recorder. Any TRS owner will know whereof I speak and any PET owner will be oblivious to this kind of reliability problem at least within his own system (he may have trouble with other peoples tapes...as mentioned).

It should be mentioned that the PET comes with a built-in additional cassette interface for a second tape-deck. For the user who can not afford dual floppy disks at this time, the use of twin cassettes for data and file storage is a great help. A user can read in data from one recorder (for instance, an address file or client's record)..update that file in the computer and write out the updated file to the second recorder. The TRS user gets a 2nd cassette interface on the Expansion unit.

SPEED OF PROGRAM EXECUTION

The PET is much faster than the TRS-80 although why this is so I dont really know. The TRS uses the Z-80 microprocessor which is the most advanced 8-bit chip around but the 6502 took 4 out of the top five places in terms of speed in a timing comparison of current BASICS (KILOBAUD # 10). In a timing comparison listed in TRS-80 COMPUTING (August 1978), the PET BASIC scored 6.5 seconds on a bechmark test that the Level II TRS accomplished in 11.5 seconds. Comparing nearly identical astrological programs on the two machines it takes the TRS-80 about 1½ minutes to calculate and list out the planetary positions for a given date while the PET can do the same task in less than half a minute. This difference is trivial compared to doing a chart by hand but becomes a factor when working with any astrological technique (such as transits) where chart after chart must be output. No less an authority than Robert Hand talks of little else in regard to his computer work than the speed factor. I am told that the new 16 bit machines (in the near future) will be six times faster than today's machines.

INPUT/OUTPUT (IO) CAPABILITY

Input/Output capability or IO as it is called is an important part of any computer since it is thru the IO that the computer communicates with the outside world via line printers, floppy disks and so forth. We have mentioned the keyboards for these machines above. The TRS-80 in its original form has almost no IO features but these have been made available thru purchase of the Expansion Interface. Without getting over-technical, let me say something about some of the problems relating to I/O flexibility. In a field as 'wide open' as that of micro systems there is a great need for some set of standards used by the entire industry. This is not the case at the present time. There has been no agreement on recording schemes for recording/playback of computer information on cassette tapes and dozens of different methods exist. The result is that programs recorded on one brand of machine will not read into other brands.The status of the various 'Buses' for communication within a computer and to the outside world is not much better. While several standards have been attempted, the field is moving so fast that many companies opt for their own newly designed or specially designed bus rather than make use of current ones. The most popular bus to date is the S-100 Bus and there are hundreds of different products available that fit this bus. The advantage of using a bus like the S-100 is that you can be assured of the availablility of inexpensive memory as well as a wide selection of special video and music boards and so forth. In some respects, the professional astrologer will not be as concerned with all of these special extra computer features since he will be using a computer as a tool rather than a hobby or end in itself.

The TRS-80 has very little I/O capability in its un-expanded state. There is a 40-pin non-standard connecter and that's it. The PET comes with a 40-pin connector for memory expansion, an 8-bit parallel user port (good for running things around the house or for certain kinds of peripherals), a port for a 2nd cassette and an IEEE-488 port. The IEEE-488 (reads I triple E 488) port is a wise choice by Commodore. It is said to be the bus of the future since it depends upon intelligent peripherals rather than trying to do all of the thinking for these external devices. Thus the IEEE-488 is little more than an open channel to the outside world able to relate to almost any kind of device that we may come up with over the next few years. This is as opposed to limiting the bus to only presently known configurations. A sign of the future of the IEEE-488 is the fact that Japan has adopted it as the standard for its micro-ware which will soon be appearing in this country.

Radio Shack provides a 2nd cassette interface, sockets for more memory, a disk controller for up to four mini-disks, a parallel port, real-time clock and card slot for an RS-232 interface with their Expansion Port. A real time clock is useful since it enables the user to build in any normal clock function into a program. The PET comes with a real-time clock as part of its standard equipment.

SOFTWARE resident in these machines.

The Radio Shack Level I BASIC is worthless for astrological purposes and will not be mentioned here again. Both the Radio Shack Level II BASIC and the PET BASIC have been designed by the same company..MICROSOFT probably the best name in the business. In most important respects the two versions of BASIC are equivalent and it is a joy to use such a sophisticated and powerful language. The TRS has a 12K version of the MICROSOFT BASIC while Commodore uses about a 9K version. The TRS includes several useful features not found in the PET BASIC such as PRINT USING and DOUBLE PRECISION. The TRS version allows the user to specify single (6 digit) or double precision (16 digit). The PET offers all floating point operations in 10 digit precision. The PRINT USING statement is of real value to astrologers in that it allows the printing of numbers in columns with automatic round-off and other special format possibilities. However TRS left out one very important tool for the astrologer, the USER DEFINED FUNCTION. The Defined Function allows great flexibility in writing astrological programs and I really miss having this feature. The PET has the defined function but otherwise has little that is not present in the TRS BASIC. It does have some powerful commands for working with machine language code such as WAIT, CMD, SYS as well as USR which both Basics have.

The operating system refers to special routines stored in ROM that are used for running and monitoring the entire system. Such routines include those used for screen format, handling the tape recorder and the like. There is no question that the PET has a powerful and superior operating system compared with the TRS-80. We have already mentioned the redundant recording scheme. The PET is able to search for and find program labels (on tape) of up to 16 characters in length while the TRS unit is limited to a single letter. What this means is that I can ask the PET to find my SOLAR ARC program and to ignore my SOLAR RETURN program. The PET also lets you know a lot more about what it is doing at any time. For instance if I ask it to LOAD from a tape, it will display the word SEARCHING on the screen, will list every program it finds by name (i.e. FOUND SOLAR RETURN) and display the name of the program I want and proceed to load it into RAM memory...displaying LOADING SOLAR ARC, etc. The TRS-80 instead displays nothing but two asterisks in the upper right-hand corner of the screen..one of which (hopefully) is flashing and that's it. Such differences are differences in the operating systems of the two machines.

Another feature of the PET operating system is a 1K built-in diagnostic system. While this is of no direct use to the user, it allows the entire computer system to be analyzed quickly by a technician. The inside of the PET consists of three snap-out boards so that when the problem has been found, only the offending board need be removed for work or to be replaced. The TRS has no such on-board diagnostic system. What such a diagnostic system does is to insure that it is very easy for service centers to work on the PET.

PROGRAM EDITING AND SCREEN FORMAT

In my experience, this particular area represents perhaps the most dramatic difference between the two systems. Let us examine the way these systems can edit program lines. The editing features on the PET are no-doubt one of its finest features. A program line is listed on the screen. The user then moves the cursor to the line and ads or deletes characters by positioning the cursor. For instance if I want to change a single letter, I move the cursor over the letter that is incorrect and type the correct letter. When editing is finished, I hit RETURN and the corrected line is locked into memory and ready to run. The TRS-80 editing scheme is very much more difficult to work with. One must use a whole set of editing commands that involve counting over to the letter to be removed or changed..deleting the offending character and entering another command to insert the corrected character. This kind of approach is clumsy and difficult to use compared to the elegant editing system on the PET. Another fact is that on the TRS-80, the cursor can never be moved manually upwards on the screen. If I want to arrange text or try different formats on the PET, all I do is move the cursor to any area of the screen and arrange letters and graphics to get an idea of what I might want in the way of format. More important is the fact the on the PET I can reproduce program lines by merely substituting a new line number and hitting return..or I can chop out part of an existing line, give it a new number and I have a new line. On the TRS I must always retype the entire line. The editing features on the PET make debugging of programs very easy and speedy.

SYSTEM HARDWARE

Both Commodore and Radio Shack are large vertically integrated companies who turn out their machines via an assembly line with a careful eye to production costs. The TRS-80 and peripheral devices are housed in tough hard plastic cases and the PET resides in heavy metal case. Both machines are attractively styled. The PET is a self-contained unit whose one cord is a heavy power cord. The TRS consists of four units strung together by patch cords...three of which plug into a wall outlet. The patch cord system on the TRS-80 is less than ideal. Aside from the wires running here and there is the fact that the tape deck cannot rewind while the computer has control of it. Rewinding the tape is accomplished in one of two ways: 1) opening a small door at the back of the keyboard case, reaching in and depressing a small button which resets the computer and releases its hold the tape deck, or (2) unplugging a tiny jack to the tape recorder, rewinding the tape and plugging the jack back in. I can see no excuse for this kind of set-up and this feature is more than an inconvenience, it is clearly an oversight in design. Some of the wire-tangle is removed when the user buys the Expansion Interface which can contain both of the power modules needed to run the TRS in its expanded form.

A note concerning lowercase letters on these machines. The PET is capable of lower case thru a POKE command but one has to shift for lower case— not too much fun at all. There are external keyboards that plug into the PET which provide the standard kind of keyboard use. Lowercase is unavailable from Radio Shack at this time but there are several companies that will wire the TRS so that it can have lower case.

PERIPHERALS for the PET and the TRS-80

Radio Shack has made a number of valuable peripherals available for its machine. These include the Expansion Interface, a screen printer, a line-printer and a mini-disk system. The screen printer is a joke at $599 and should not be considered. Their line-printer at $1299 is the CENTRONICS dot-matrix printer. It does a fine job but is available for under $1000 when ordered from companies other than Radio Shack. Their mini floppy disk is a bargain at $499 although it is small (80K) compared to other systems on the market.

Commodore has a printer for $695 to be released after the turn of the year. It is a dot-matrix using the Practical-Automation mechanisms (one of the best avaialable) and it will print both upper and lower case as well as the complete set of PET graphics. The printer plugs right into the PET and requires no other interface. Commodore has shown their floppy disk unit in Chicago and will release it in 1979. It has 160K per disk. No price has been specified.

NOTE: The latest rumors in the computer industry suggest that 1979 will see mini-floppy disks available for under $200!

There are a number of other companies that market both disk systems and printers for the PET and the TRS-80. Ads for both of these systems increase at a high rate from month to month in the computer magazines. In other words, there is great support for both machines.

Well, that's my review of these two machines. It is obvious that I find the PET the better buy. The following articles are from TRS-80 owners John McCormick and Steve Blake and PET owner Charles A. Jayne to give you some added perspectives. I list below some of the prices for the various options on these systems as well as where you can purchase peripherals not made by the mother company.

I list several books on the computer language BASIC that can be used with the PET or the TRS-80. The question of service for these machines (in particular the PET) should be clear at this point. Radio Shack has (to date) about 50 service centers across the country where the TRS-80 can be repaired while Commodore has over 100 such centers where the PET can be bought or serviced. I hope this kind of analysis is useful for those of you shopping for computer systems. Feel free to call me if you have questions: (313) 663-6677

Books to read for either system:

USER'S MANUAL FOR LEVEL 1 by Dr. David Lien (very good beginning) — available at or thru Radio Shack Stores.

THE BASIC COMPUTER PROGRAMMING LANGUAGE HANDBOOK by Dr. David Lien This book covers almost 80 versions or dialects of BASIC! and can be ordered from: Compusoft, 8662 Dent Dr., San Diego CA 92110 for $16.30 (includes postage)

BASIC FOR HOME COMPUTERS by Bob Albrecht, Finkel and J. Brown at $5.95 is another good way to learn programming. From John Wiley & Sons., 605 Third Ave., New York, N.Y. 10016

PETs can be ordered from over 100 dealers across the country. Call me for the address and phone of the dealer nearest you. TRS-80s can be ordered from your local store. The 8K PET retails for $795. The 16K (Level II) TRS-80 sells for $989. (this is the minimum unit for astrological work). TRS Expansion units are $299, 16K of extra memory is $290 for these units, Mini-Disk is $499 and line-printer is $1299. from Radio Shack.

I purchased by TRS from a Radio Shack dealer in Texas at a 10% discount. The address is 1117 Conway, Mission, TX 78572 and phone is (512) 585-2766. I got immediate UPS delivery on the system, the interface and some extra memory. This is a good outfit.

When they are in stock I can order then for you from a local distributor. Call me at the above number. PETs and TRS-80s can be ordered from the ASTROLOGER'S MEDIUM in Chicago at this phone number: (312) 871-5601

Expanding the PET RAM memory (without adding external modules) can be accomplished by contacting CONVENIENCE LIVING SYSTEMS, 648 Sheraton Drive, Sunnyvale, CA 94087 (408) 733-0688

A variety of printers, disks and what not for both the TRS-80 and the PET are available from MICROTONIX, Post Office Box Q, Philadelpha, PA 19105 phone 1-800-523-4550

ALTERNATIVE SYSTEMS TO THE PET & TRS-80

The PET and the TRS-80 are not the only home computer systems that are available although they are the first real appliance-like systems. Here is some information about some of the other smaller micro systems on the market.

I am excluding from this brief survey those hobby systems that are priced from around $3000 and up although if money is no object, there are some fantastic systems around. I am concentrating on those companies who are competing for the same market as the PET and the TRS— the mass market.

The HEATH H-8 Computer System

Heath of do-it-yourself Heath Kit fame has brought out both an 8-bit and a 16-bit computer. We will ignore the 16-bit machine for now since it is expensive compared to the money guidelines laid down above. The Heath H-8 computer system appeared first only in a kit form but now is also available as an assembled and tested computer. With the exception of exceptions like John McCormick very few astrologers would take any joy in building their own computer from a kit. I shudder at the thought of the responsibility. Here is what I figure one would have to purchase in order to run a simple 8K astrological program (kit prices are a little less).

Heath WH-8 assembled and tested computer	$475
WH-8 Memory Board with 16K	$395
8K additional board with 4K on it	$125
Serial I/O and Cassette Interface	$150
Video Terminal	$550
Cassette Player	$ 60
	$1755

That's a lot of dough for what can be done on a PET or a TRS-80 for much less. Also the Heath BASIC (which is extra!) must be loaded from tape and has only 6 digit precision...too small for most astrology needs. There have been complaints about the video screen being too small for astrological format and so forth. Aside from Heath's name and service, there is little I can see to recommend this system to us.

The APPLE-II System

In the APPLE we have a different story since this is one of the more attractive of the new computer systems. The Apple is not really new since it appeared (Apple I) among the hobbyists at a higher price but has recently dropped down to a somewhat lower price level and taken on new dimensions. The Apple II is the system for any astrological work and then only with their APPLESOFT floating-point BASIC (previous Apple BASIC was integer only). The Apple has some attractive features such as color graphics and high-resolution graphics that are not found on the PET or the TRS. Everyone seems to agree that the APPLE II is a "sweet" machine. For astrological work you would need an APPLE II with at least 24K of RAM..which should run you around $1885. This does not include the Video Monitor and tape deck you will need before programs can be run. The APPLESOFT BASIC is by Microsoft and a variety of peripherals (line printer, disk) are now available for this machine

The price for an APPLE system ready for astrological work is a little high for my taste.

The SORCERER by Exidy

Perhaps the most interesting of the new systems to appear since the advent of the PET and the TRS is the Exidy Sorcerer. The Sorcerer is an attempt on the part of some well-known hobbyists folks to combine some of the best features of the PET and the TRS systems into a single package and add some striking new features on top of that. The Sorcerer has a Microsoft BASIC in ROM like the other computers but instead this ROM is a cartridge that snaps in and out of the computer. What this means is that in the future the owner of a sorcerer can snap in a FORTRAN ROM instead of BASIC...or an Assembly Language ROM and have the benefit of multiple languages resident in a single machine. The Sorcerer has a standard sized keyboard with a separate number pad as well. Another nice feature is the user defined graphic symbols. Astrological glyphs such as planet and zodiac symbols can be programmed into the Sorcerer and used in programs. The machine also has a variety of other very nice features but has one very unfortunate feature as well: the Sorcerer has only 6 digit precision— too small for our needs. The Sorcerer with 8K of RAM sells for $895 (16K at $1150) but this price does not include either a video monitor or tapedeck which are required for system operation.

There are several other systems that might qualify as belonging to the appliance-computer market. Systems like the SOL and the CHALLENGER IIP series from Ohio Scientific. These systems, however attractive they appear, price out (when all items needed for astrological work are added on) considerably beyond the level of the PET and TRS.

Texas Instruments: The Mystery Guest

The most exciting, threatening and possibly wonderful bit of news has to do with what Texas Instruments will do in response to these home computer sales. Everyone seems to agree that IBM and other dinosaur-like companies will be unable (or unwilling) to respond to the challenge issued by PET and friends. Only Texas Instruments (TI) appears young enough in spirit and large enough (vertically integrated) to accept this challenge and they have been attempting to keep what they are doing a very dark secret. However, some information has leaked and rumors are rampant. One fact is that TI has submitted a machine for FCC approval this fall and this act cannot be kept secret. It appears their machine is a 16-bit 9900 microprocessor (about 6 times as fast as today's 8 bit machines). Another fact is that it can generate three simultaneous tones..of interest to music buffs but not to astrologers.

It appears that there may be two machines in the offing. One has been given to their calculator department and thus will appear (at discount!) in every possible store in the country. A second...perhaps larger machine..is an integrated unit like the PET with built-in dual tape transports that can search a tape bi-directionally at high speed! This would provide a solution for those of us who cannot afford floppy disks.

Texas Instruments has not been much on software and documentation in the past and has made some notable boo-boos in the way they handled their programmable calculators (cards not reliable between machines, poorly made, etc.). It is more than possible they could bring out a thoroughly respectable machine at an envious price that would take the market. We can expect them to announce the product in January and begin delivery in the very late spring of 1979.

Digicomp's DR-70: An Astrological Computer

By now, most of you know something about the DR-70 Astrological desk-top computer. It was shown at the convention in Atlanta and the NCGR conference in Chicago to the amazement of astrologers. We have received a good number of phone calls from astrologers who want to know whether this machine will do what it claims to do?..is it the machine to buy?...to buy it or a PET or TRS?...and so forth. I have yet to get my hands on a DR-70 but Digicomp has been kind enough to send me their complete user-instruction manual. Here is a presentation of some of the DR-70's major features along with a comparison of these features to those in the home computer systems. (Also see article elsewhere in this issue and on page 57 of MATRIX I for more information; better yet write to Digicomp for their attractive brochure.)

The DR-70 is a self-contained unit 10x13¼x5½ inches in size and weighing six pounds. It's major features are a specially designed keyboard and display panel. It is very portable and comes complete with a carrying case. A companion printer is available that fits into this case. The DR-70 sells for $2475 and the printer for $600 ($3075 total). Leasing and financing is available.

The DR-70 uses the fast 6502 microprocessor along with about 32K of ROM (not RAM). The machine does not use cassettes for program storage since all of it's programs are permanently recorded in ROMs and are available when the machine is switched on. The DR-70 has been programmed in assembly language rather than in one of the higher-level program ming languages (such as BASIC, FORTRAN, etc.) and thus it is both fast and memory-efficient. Any astrologer-programmer will marvel at the amount of astrological software available thru this machine— it does a whole lot of astrology! For instance:

Aside from having a fairly accurate ephemeris built into it for 10,000 years! it has accuracy to within one minute of arc for any date between 1850-2000 and accuracy to within two seconds for the sun and 40 seconds for the moon in this time period. It also has the four major asteroids available. It can cast charts in both Geocentric and Heliocentric modes in your choice of tropical or sidereal zodiacs. Right Ascension and Declination are available as well as various coordinate exchange functions. Built into the machine are six house systems: Koch, Placidus, Campanus, Meridian, Porphyry and Regiomontanus..available at the turn of a dial. The unit can erect and keep track of two charts at once along with derivative charts (total of four charts in all) for these two. Primary and Solar Arc Directions, Secondary and Tertiary progressions, Transits, Aspects, Midpoints are there as well as 90-degree dial functions, ayanamsha, harmonics, par-

allels, Cosmobiology dials, and of course the Angles— including the vertex. This is not even a complete list of what this machine can do.

Digicomp has received the MARC EDMUND JONES award for their efforts and I am told that they sold out every machine that they brought to Atlanta in a matter of hours.

I have tried to give you an idea of what this remarkable machine can do. I want to further describe how the DR-70 functions and to offer my criticisms too. I would like readers to get an idea as to how this machine stacks up to the home micro systems like the PET and TRS.

I have pointed out that the DR-70 (aside from some scratch-pad memory) is not user-programmable. It has all of the programs built into it..although there is some flexibility in how these programs may be combined thru Key manipulation on the part of the user. It does have almost everything most astrologers could think of to want and probably several capabilities we might not think of (Novian moon). The idea here is that the DR-70 cannot accept programs on cassette..or programs written by other authors on other astrological techniques and so forth. The DR-70 is limited to what the designers of the machine have found desirable for astrologers to have in the way of astrology. Should some new technique emerge, owners of a DR-70 would not be able to experiement with it unless the technique conformed with the possibilities of the Digicomp keyboard. One of the attractive features of the PET and TRS machines is that a large (unlimited) variety of software is available (potentially) from many authors. It is a fact that at this time software is not available that will do all that the DR-70 can now do..but the selection is growing and within a year we will see most if not all of the options available in the DR-70 and a lot of possibilities that are not in that machine— not to mention educational, business and plain old fun tapes.

This is not meant as a major criticism of the DR-70 since they have chosen almost all of the popular astrological techniques for their machine. It may be important, however, for those of you who do not understand the difference between a machine dedicated to one task...doing astrology..and one open for many possible uses.

The DR-70 does not have a CRT (video monitor) for information display but instead uses a specially designed panel built around an LED display unit. This panel has a variety of symbols built into it...zodiac and planet symbols as well as other symbols for retrograde, stationary points and so forth. Any of these symbols can be lit up (from behind) to cause them to stand out from the others. In the center of this panel is a LED display that is similar to (but larger than) those found on an ordiary pocket calculator. All information calculated by the DR-70 is displayed to the user thru this panel or printed out by the DR-70 printer (to be described below). The computer displays information...such as planet positions...one by one on this display panel.

For example, the planet Mars at 5 degrees Taurus 53 minutes would be displayed on the LED portion of the panel as 2.05.53...indicating that the 2nd sign, 5th degree and 53rd minute was the Mars position. In addition the symbol for Mars and for Taurus would light up elsewhere on the panel. Each of the planets, aspects or other information can be presented...one-by-one...to the user and has to be copied out by hand. Digicomp has made a printer available that can print this indormation out for the user.

This panel display is quite primitive compared to the CRT or video screen on the home computers. The computer display screens can present not only much more data at once but can switch whole sets of data at the touch of a key. The lack of a video display on the DR-70 is a serious criticism of it and is only somewhat alleviated by the use of the companion printer.

The printer does do a nice job. It can print almost any of the chart information calculated by the DR-70 including a small chart wheel with astrological symbols for the planets and signs of the zodiac. The printer uses paper that is four inches wide rather than the standard 8½ inch width (or larger) of most line printers and this is somewhat of a limitation.

The Keyboard on the DR-70 and the way it works is very interesting. A set of 46 keys (most of which do double duty) are arranged in a non-standard configuration. Aside from the number keypad, there are keys for the planets as well as for most of the astrological functions..eg. MDPT, PART, SOLAR ARC, SEC, TERT and so forth. These keys can be pressed in an almost infinite series of combinations to bring about desired effects. A feature of the DR-70 allows repeated key sequences to be performed automatically by the pressing of a single key (ENTER). In this way (for instance) all of the planets, aspects or what-have-you can be output to the display panel...planet-by-planet...at the touch of a button.

As ingenius as this keyboard and it's operation is, I do have some criticism. My major criticism is that the user is tied to the keyboard and key sequences for most of the more sophisticated operations (harmonics, coordinate conversions, etc.). The printer will list out the chart wheel after the birth info has been entered and does several other automatic jobs. However, many of the built-in astrological features require some if not a lot of button pressing...and often for each planet or whatever...one-by-one and this is not too attractive to me.

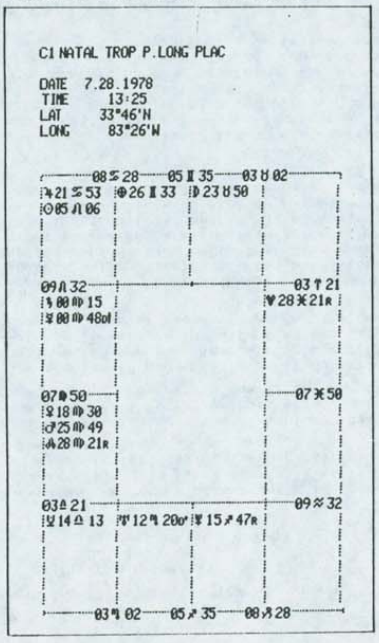
Let me sum up my critique of this machine. Had the DR-70 made it's appearance even one year earlier, it would have had a clear field in the astrological market. The advent of the new home computers like the PET and the TRS-80 do provide an alternative. At $2475 the DR-70 is three times the cost of an 8K PET and the printer is an additional expense.

I would not find the DR-70 useful...from a professional standpoint...if purchased without the printer. For that kind of money I dont want to copy planet positions from an LED display.

The DR-70 with it's powerful software has a lot going for it and it's extreme portability may recommend it to many traveling astrologers. The handbook for the DR-70 is not only very complete but it is also well put together. Some of us ought to read it if only to get an idea as to the many astrological techniques currently in use.

We wish Digicomp great success with their machines. I hope that the 2nd generation of the DR-70 will include a full video display and some kind of user programmability. It would not be too difficult to offer various additional astrological techniques in snap-in ROM cartridges.

Here is a sample of the Print-Out from the DR-70 Companion Printer



Some BASIC Midheaven Solutions

```
2 REM SINE WHEN WORKING IN DEGREES
3 DEFFNS(X)=SIN(X)*PI/180
5 REM TANGENT WHEN WORKING IN DEGREES
6 DEFFNT(X)=TAN(X)*PI/180
8 REM COSINE WHEN WORKING IN DEGREES
9 DEFFNC(X)=COS(X)*PI/180
10 REM ARCTANGENT WHEN WORKING IN DEGREES
11 DEFFNZ(X)=ATN(X)*180/PI
12 REM
13 REM MIDHEAVEN ROUTINES     (Programmed in the PET BASIC)
14 REM
15 REM PI=3.141592654
16 REM
18 REM RA=RIGHT ASCENSION OF MIDHEAVEN
20 REM
22 REM OB=OBLIQUITY OF ECLIPTIC
24 REM
42 REM IF RA & OB ARE IN DEGREES,
43 REM AND TRIG FUNCTIONS ARE DEFINED (AS ABOVE)
44 REM USE THESE STEPS
45 REM SPEED=13 JIFFIES (60 JIFFIES = 1 SECOND)
48 REM
50 MC=FNZ(FNT(RA)/FNC(OB))
60 IF MC<0 THEN MC=MC+180
70 IF FNS(RA)<0 THEN MC=MC+180
71 PRINT MC
72 REM
74 REM
110 REM IF RA & OB ARE IN RADIANS,
112 REM USE FOLLOWING PROGRAM
113 REM SPEED= 11 JIFFIES
114 REM
120 MC=ATN(TAN(RA)/COS(OB))
130 IF MC<0 THEN MC=MC+PI
140 IF SIN(RA)<0 THEN MC=MC+PI
141 PRINTMC*180/PI
142 REM
144 REM HERE IS A POLAR/RECTANGULAR
146 REM SOLUTION TO THE M.C. IF RA
148 REM AND OB ARE IN RADIANS
149 REM SPEED=14 JIFFIES
150 REM
152 A=RA: R=1:GOSUB 930
154 X=X*COS(OB):GOSUB 950: MC=A
155 PRINT MC*180/PI
158 REM ROUTINES CAN BE USED FOR OTHER
160 REM JOBS TOO, THEY ARE:
162 REM POLAR TO RECTANGULAR
930 IFA=0THENA=1.75453E-09
931 X=R*COS(A): Y=R*SIN(A): RETURN
932 REM
949 REM RECTANGULAR TO POLAR
950 IFY=0THENY=1.75453E-09
951 R=(X*X+Y*Y)^.5: A=ATN(Y/X)
952 IF A<0 THEN A=A+PI
954 IF Y<0 THEN A=A+PI
956 RETURN
```

COMMENTS AND REPORT ON THE TRS-80

by John McCormick
Box 1413
Bloomfield, N.J. 07003

Fanciers of microcomputers are a chauvinistic lot and almost any of them may be heard extolling his particular unit at the drop of a hat. This syndrome is particularly evident among aficionados of the Commodore PET and the Radio Shack TRS-80.

Sit down to write an article about the miraculous advantages of one over the other and you will learn in short order that a microcomputer is a microcomputer once certain qualifications have been met.

Both the PET and the TRS-80 are comparatively dollar-desirable versions of your basic microcomputer. They are both relatively inexpensive units, each implements an adequate version of the BASIC language, and either will do what the language (by its own structure) permits.

In my opinion neither is in the running as a candidate for commercial use because, in both units, flexibility has been sacrificed in the interest of the lower production costs that have enabled their manufacturers market them at such attractive prices. For the home user either is eminently adequate if he has the necessary software to accomplish the tasks for which he has intended his microcomputer. Without software the finest micro will sit there and contemplate some electronic Nirvana with a determined patience that would rouse the envy of any human guru.

MATRIX has asked me to discuss the TRS-80 and, in an earlier false start, I found myself writing a beginner's text on microcomputers. I was defining and discussing bits and bytes, ROM and RAM, mass storage, input and output, and interfacing along with an indefensibly complex commentary on bus structures. These factors, while of undeniable importance, are the same for any computer and they have been discussed ad nauseam in the pages of a variety of journals and textbooks.

After the differences in operation introduced by the peculiarities of the particular version of BASIC in a given microcomputer are considered the remaining comparisons must concern themselves with a limited set of variables:

A) Speed of execution
B) Ease of operation
C) Availability of service
D) Availability of software and hardware peripherals
E) Ease of interface

At this point in time the S-100 bus has established itself as a de facto standard. It was designed to accomodate the pecularities of the 8080 microprocessor and it will eventually pass from the scene but, at the moment, it is the most widely employed bus structure and the one for which most designers have provided us with a variety of sophisticated peripherals.

Both Commodore and Radio Shack have elected to employ other buses (good business, no doubt,) and this choice has denied the users of the PET and the TRS-80 the opportunity to use the marvelous variety of specialized circuits available for the S-100 bus without extensive and expensive modifications to the original equipment. It may be noted that Commodore has, at least, chosen a bus that is already supported by Hewlett-Packard and now by the Association of Japanese Electronic Manufacturers. Radio Shack has no excuse whatever for the whimsical, in-house, 40-pin bus they have designed to make theirs an excusively Radio Shack unit.

It has been rumored that one cannot substitute a different CRT for the unusually poor one supplied by Radio Shack. That is not true but it is true that anyone who attempts to interface the Radio Shack CRT with another computer will find himself in grave difficulty. It is, quite simply, awful. It should be a tip-off to the buyer when he notices a place on the case for an antenna.

Lets look at the other points in order!

A) Speed of execution

The TRS-80 is somehwat slower than the competition. I emphasize that, when we are talking about 'speed' we are measuring micro or milli-seconds and the relative slowness of the TRS is no drawback to any but the most pressed-for-time commercial user whose unit runs for long periods at a time. The slower internal clock rate promises a greater freedom from errors but this too is misleading because errors are almost non-existent in any micro however fast it may be. If lightning speed is of real importance to you the TRS-80 is a less-then-perfect choice.

B) Ease of operation

Here the standard keyboard of the TRS-80 gives it some significant advantage over the competition. It is consummately easy to use ...a factor to be considered by most of you backward klutzes.

C) Availability of Service

In this respect the TRS-80 is a clear winner. Immediate service is as close as the nearest Radio Shack store (and these have proliferated like fruit-flies). The owner need only take the offending module to the store and it will be returned to him in a few days completely operative. Although this was my first consideration in deciding upon the purchase of the TRS-80 I have had no need of the service... the unit has performed perfectly. I have voided my guarantee by breaking the seals on the various cases to get at the interior but mine is a special madness and need not trouble the rest of you. In the case of self-contained units the user has the problem of crating and shiping the entire computer to a national service center...a task I would despise and one which, in my opinion, makes the TRS-80 an immediate favorite...and an overwhelming one.

D) Availability of Software and Hardware Peripherals

The TRS-80 is well supported with in-house software and peripherals ...better than most. The software available from Radio Shack is business oriented for the most part but quite extensive and being added to every day. Kilobaud magazine is presently advertising a variety of software for the PET and TRS-80 and neither has an edge in this department.

Where hardware is concerned it is difficult to make any decision. The PET's bus structure will join easily with a large variety of laboratory equipment and this could affect your decision but it is probably well to mention that such equipment is itself expensive and useless unless one owns a hospital or a laboratory or has some need to interface analog devices to his digital computer.

While it is true that anything can be interfaced if money and time are of no concern most users of inexpensive micros will confine themselves to equipment designed to fit with their computer as it stands without modification. The TRS-80 has a variety of peripherals available over-the-counter from Radio Shack. [editor's note: As of December 1978 ..a call to several local Radio Shack stores resulted in the information that peripherals such as the Expansion Interface involve a three month wait] There is an expansion interface which is essential if one plans to use a line printer or the Shugart disc drive and , in fact, the only peripheral that can be attached without the expansion interface is the screen-printer (essentially a toy) that merely provides the user with a printed copy of whatever is on the screen at a chosen moment.. hardly a very useful capacity. It should be remarked in Radio Shack's favor that they have spared the cost of the interface to those who want only the smaller version of the TRS-80 and who have no immediate plans to use a printer or a disc mass storage.

E) Ease of Interface

Here it is hard to approve of either of the popular units. The TRS-80 does not interface easily with any heretofore available peripherals designed for the 8080 or Z-80 microprocessor. So many units of the TRS-80 have been sold, however, that it is only a matter of time before interfaces will be available to connect the TRS with the variety of boards already available for the S-100 bus. It must be remembered that any such interface will cost about $150 (if it cost less the manufacturer would not waste his time producing it) and it is probable that each interface will require an additional card...expensive! The TRS-80 is not alone in this respect...it applies to any computer designed to exclude the S-100 bus structure.

For the dyed-in-the-wool experimenter I suspect that none of the self-contained units is the way to go...but, if all the reader wants is computing capacity, he is well-advised to buy a working unit from a well-established manufacturer instead of committing himself to the agony of successive decisions and choices attendant upon the purchase of a variety of non-amenable components...trouble-shooting is not an unmitigated joy.

Let me say for the record that I am entirely satisfied with my TRS-80 with the exception of the CRT which is a continual embarrassment. Buy it without the CRT (don't let the salesman tell you it can't be done) and add a little 9 inch Sanyo or Hitachi...you'll be glad you did.

K costs money. If you buy 16K from Radio Shack it will cost you $295. The same can be purchased from second sources for as little as $96 but it must be remembered that it is necessary to break the factory seal to install the chips (uPD 416's). Installation is simply a matter of plugging them into already existing sockets but one's guarantee is voided the moment the seals are broken. The same chips are used in the expansion interface as in the TRS-80 itself. I payed $295 for the first 16K but I'm getting the 32K that the interface will support from another source so I'll have a total of 48K for an additional $198.....a year ago 48K of anything would have cost a thousand bucks...it still can if one isn't cautiously thrifty.

Finally let's talk about what the TRS-80 can do. It can compute horoscopes, calculate aspects, Solar Returns and, in fact, anything of which any micro is capable. The microcomputer is a well-defined instrument and one is much like another just as one piano is like another. The genius lies with the composer and the performer. The programmer composes the music and the performer plays it on the computer (a far easier task than to play it on the piano).

The analogy is a good one. The BASIC language makes provision for loops, strings, arrays, matrices, and graphics and these may be combined in a wonderful variety of ways to yield certain predictable results. The manner in which this is accomplished is of no more concern to the user than is the working of a carburetor to an autoist... if he does his part the computer will do what is expected.

The Level I BASIC manual provided by Radio Shack is the best I have seen for learning the language and how to use it. Even if you choose a different computer I recommend that you run right down and buy one...about $5.95 at the Radio Shack nearest you. The Level II Manual is less complete. It presumes that you are aquainted with Level I and is more designed to acquaint the reader with what the machine can do rather than to instruct him how to get it to do anything.

Some of the commands are, apparently, quite useless and at least one, (the User Defined Function) is not implemented on the TRS-80 which is one hell of an inconvenience. The function can be simulated by GOSUB statements but it would have been much kinder of Radio Shack to include it. It is included in the disc version of the language but that is of little solace to the user who owns only the basic unit.

I would much prefer that it had been included in preferance to the 'PEEK' and 'POKE' commands which are of limited utility unless one is of the machine language persuasion— in which case he should have bought a different unit entirely. [Editor's note: The PEEK and POKE commands are important if you purchase astrological software from programmers who make use of these values in their programs— which is common.]

Despite my kvetching I am quite happy with the TRS-80. It does the job it was designed to do and it does it well.

Its greatest over-all advantage is the ready availability of service...an overwhelming plus...a factor which, by itself, would have led me to purchase it...but, if there is a God who is concerned with electronics, Radio Shack will burn in hell for that CRT (display screen).

I have improved it to some extent by splitting a capacitor and, if any of you are interested get in touch with me and I'll tell you how to do it (easy). I didn't want to include the information here because, once again, the tinkerer's warranty will be voided and, if you don't know whereof you tinker, you could blow your little hand off.

One final tip...the keyboard contacts become dirty after some use and the result is that the slightest touch on a key will result in three or four of that character appearing on the CRT. I have designed a small tool which will remove the key-cap without the necessity to break the seal on the case. It is a bent giant paper-clip and it works very well. After removing the key-cap spray some tuner-cleaner on the contacts and replace the cap. The tuner-cleaner can be obtained from any electronic supply house...even Radio Shack has it!

To sum up I'd suggest that we realize that one micro is much like another and that the PET, the TRS-80, the SOL, the APPLE II, the POLY 88 and the Northwest HORIZON are all but tools to implement the capabilities of the BASIC language. Small differences exist but they are of negligible importance and many individuals will bu each of these units and learn to employ it adequately to satisfy his needs.

Each month will see new starters on the market and the nature of Progress ordains that, as an advantage is gained, the older equipmet becomes obsolescent. The computer differs from the auto in this respect in that it seldom wears out, it doesn't rust, and it doesn't collide with other computers. So, if you are the kind of person that has to have everything that is new, you are in trouble because each day sees wonderful advances. Right now my mouth is watering for an EXIDY SORCERER which permits the implementation of an unlimited number of languages in plug-in modules but I know that, if I buy one, it will only be a few weeks before a new girl on the block attracts my fickle eye.

I would suggest to those of you with a passion for experimentation that you buy a TRS-80 to do your computing and another little unit to use as a toy...a KIM, perhaps, or a Cosmac ELF, or a VIP. You can play with the newcomer to your heart's content without sacrificing the ready availability of your working slave.

For the rest of us software is the answer. With the proper software any of the units mentioned above can do damned near anything you require of it. I think that it is more important that we recognize this than that we extol the relative merits of one unit above the other.

I call your attention to the SR-52 calculator...a marvel at the time of its introduction...that was superseded so rapidly that no decent software was ever written for it. BASIC saves us from that danger in the case of micros because it is a universal language and may be implemented on a variety of instruments...but even BASIC will be superseded eventually...already PASCAL and APL are making their presence felt and FORTRAN has never been far from the center of activity.

If you must form an alliance form it with a language instead of with an instrument...learn BASIC or one of the others and then choose your computer to accomodate your abilities.

If you know what you can do, the choice of the tool is automatic and you won't require any mayven to direct your choice.

In short, I dont think it matters greatly what computer you buy at this time...their all good and about to be improved upon... sic transit, gloria mundi !

THE "IN THING"

by Charles A. Jayne

While this is hardly a journal of fantasy I can't help but describe the present state of astrology in imaginative terms. Over a far hill there is a faint piping as Dane Rudhyar as the pied piper of Hamelin, leads his humanistic devotees on floating cloud vehicles to the Promised Land where no calculations may ever intrude. Nearby is a small grim band on their knees before their sacred machines with the enraptured look on their faces of the true calculator. It is a condition of rabid schizophrenia. While as always the merchants of astrology weave in and out making money and with no interest in what they are hawking, i.e. magazine and book publishers and others. It is a curious scene.

Those who consider that they "love" Astrology, but who shudder deliciously when they have to add two and two, ought really to take heart for they can have something for nothing, or nearly so, as a result of the current "in thing", the programmable calculator and microcomputer. With the DR-70 and the new cheap micros plus the software programs for them of Erlewine and others they still won't have to do much figure work while wresting all kinds of charts and progressions from their black boxes. Indeed, it may even be that that esoteric humanist on his or her cloud nine may have the black box on it too! What an extraordinary prospect. It might even end the split. All of this is a skirling pipe prelude to some thoughts on the micro revolution, already under way.

I have been the proud possesor of a PET microcomputer myself these past six months. With astrologers, the two most popular and least expensive Micros are Commodore's PET and Radio Shack's TRS-80. And there is much bickering back and forth as to their respective merits. Indeed, if humans didn't bicker we can be sure that the fabled millenium would be at our doorstep! I also have had a Wang 500 programmable calculator for over a year. It is not the hand-held type but is a formidable desk top type which cost some $3000 five years ago. But that is a very long time in this very very uranian field of constant change and innovation! At this point while there are some fine hand-held calculators by Texas Instruments, Hewlett-Packard and others it is really worth the extra money to buy one of the less costly Micros. For one thing since the latter are nearly all programmable in BASIC they are considerably easier to program than the calculators are, while also capable of doing much more for you. If you really don't care to invest in a Micro then by all means buy a calculator. For with the efforts of Neely, McKinnon, Erlewine and others you can do much with them.

I don't own a DR-70, which is wholly preprogrammed and will do many things for you, so I will only say about it that for about one-third as much money one can buy, say an 8K PET with MATRIX Software that will do most all of those things, too. If your going to do considerable programming you won't find it easy, but it has a strange fascination and can give you a very satisfying sense of accomplishment as well as enabling you to do things that you were long unable to do. And once written, a good program can be used for many years.

I have seen a friends TRS-80 and also the one at MATRIX headquarters. Frankly I prefer the PET as better engineered. The various components of the TRS-80 all hang out whereas the PET is all together in one neat package, i.e. keyboard, computer, cassette recorder and CRT display screen. Although that screen is smaller than that of the TRS-80 it has clear and sharper definition! Tests by Erlewine and benchmark tests by the well-known magazine KILOBAUD reveal that the PET is a good twice as fast as the TRS-80 with Level II. The 12K Level II BASIC in the TRS has a few commands that the PET does not have with its 8+K BASIC, yet the PET has the valuable (to astrologers) user-defined functions that you only get with the TRS-80 when you get a disc! The PET is easier to edit and program, although its small keyboard is inferior to that of the TRS. Fortunately many of the BASICs written for Micros have been written by Microsoft so that they are not too different. Both the fast PET BASIC and the Extended BASIC of the TRS-80 were written by that firm and are in ROM memory (permanent) in both of them and so immediately available when you turn them on. The PET sells for $795 (8K), the TRS-80 Level II (16K) for $989. And even with more memory, which can be added, the PET is somewhat less expensive than the TRS-80.

Not generally realized is the fact that Commodore now has a large number of Service Centers (100) which is, of course, true of Radio Shack (50) too. Unfortunately Commodore has been very slow at coming out with their peripherals. They swear that their $695 printer, which ought to be a good one, will be out early in 1979 and that their 172K Mini-disk will be out before the end of the first quarter of 1979. We can only hope that this time they will deliver as promised. No price has been set on the Disc— one can have as many as 15 on them via the IEEE-488 Port on the PET! [Editor's note- since this article was written Commodore has announced that their dual-floppy disk with 172K will retail for under $1000] As of late December 1978 one can buy a Dual Mini-Disk with the essential DOS (Disk Operating System) for $1295 from Compu-Time. This will have a capacity of 100K each or 200K for the two as devised by competent engineer Richard Tobey of Sunnyvale, California. The distributor in the eastern half of the USA, New England Electronic Corp. (NEECO), promises Double Density for an additional $75 by early April 1979, or 400K for $1370. Right now (end of November of 1978) one can buy a single complete Mini-Floppy Disk of 80K with DOS for $695 from CGRS Microtech of South Hampton, Pennsylvania. And they are working on making a full 8" Floppy Disk available by early 1979. A Mini-Floppy is a 5¼" Disk. An 8" one holds 256 thousand bytes (256K) of fast bulk storage. Extra memory (RAM) may be obtained from them (static) and from Mr. Tobey's CONVENIENCE LIVING SYSTEMS (dynamic). Thus although Commodore has been draggin its heels the essential peripherals are available or will be very soon. It all depends on your application. You may only need the basic computer with its included Cassette Recorder or require a printer plus Disk.

If much text is going to be entered, a better keyboard will be needed as well as a Disk. NEECO of Springfield, Massachusetts will have one for $129.95 by the beginning of 1979 which does not interfere with the operation of the regular keyboard. ARTISAN ELECTRONICS of Parsippany N.J. has a useful calculator board (Model 85) that plugs directly into any Micro for $189. While it does not have the speed of a Floating Point Board it will do many things that the PET BASIC will not do, i.e. they are hardwired and need not be programmed in BASIC: Inverse Sine and Cosine, Rectangular to Polar Coordinates and vice versa, Radians to Decimal Degrees and vice-versa, Antilog (base 10), Factorials, Change Sign, Mean and Standard Deviation, and other commands. It has its own display too.

Very little is standard (Saturn) in the Micros (Uranus), but the S-100 bus is nearly so. Thus many peripherals are easily connected to it. A number of firms make interfaces from and to the PET with the S-100 bus: CONVENIENCE LIVING SYSTEMS, CGRS MICROTECH (both already mentioned), FORETHOUGHT PRODUCTS of Coburg Oregon, and HUH ELECTRONICS of San Mateo, California. Thus many vistas are already opening out for the PET owners as well as for those with the TRS-80. For other firms have developed similar interfaces from the TRS-80 to the S-100 bus. All of this promises to mark a new phase in the long evolution of our ancient art.

Useful addresses for PET peripherals.

HUH ELECTRONICS
P.O. Box 259
Fairfax, CA 94930

FORETHOUGHT PRODUCTS
Box 386
Cóburg, OR 97401

CONVENIENCE LIVING SYSTEMS
648 Sheraton Dr.
Sunnyvale, CA 94087

COMMODORE BUSINESS MACHINES
901 California Ave
Palo Alto, CA 94304

New England Electronics Co
248 Bridge St
Springfield, MA 01103

CONNECTICUT MICROCOMPUTER
150 Pocono Rd
Brookfield, CT 06804
(RS-232/IEEE Interface)

THE NETWORKS
5014 Narragansett #6
San Diego, CA 92107
(2-way RS-232 Interface)

PET GAZETTE
4108 Buckeye
Madison, WI 53704
(FREE PET Magazine)

PET USER GROUP
Box 371
Montgomeryville, PA 18936
(Valuable user facts)

USER REPORT ON THE RADIO SHACK TRS-80 COMPUTER SYSTEM

by Steve Blake
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The first thing that should be stressed is my background— I am primarily a counselling astrologer and teacher— I am not by nature a "number-cruncher" and my expertise (what there is of it) in advanced astrological techniques has been painfully aquired through reading the works of men like Erlewine, Jayne and McCormick and through the patience and encouragement of good friend Rob Hand. I am living proof that someone who flunked Trig in high school can begin to feel comfortable talking about the derivation of house division systems, co-ordinate systems, and computer languages. I would like to encourage any astrologer who feels drawn to using a TRS-80 buy is somehow intimidated by its seeming "complexity" to contact me by phone & I'd be glad to give them a pep talk.

Now to the system itself. I have experienced the TRS-80 in three different transformations. Because I ordered each level as soon as they hit the market, I suffered the "curse of the pioneer"— i.e. initially faulty hardware and software. At the time, these problems were extremely frustrating, but they were all made right by Radio Shack with extreme alacrity and good humor as soon as they occurred. Most of the "bugs" are out of my system now and it has been error-free for the last two months. Any criticisms I have of the system now are mainly "nit-picking" and inspired by knowledge of better and more expensive systems and refinements. In other words, I am extremely pleased with my microcomputer. The price I paid was quite reasonable (less than the cost of a new small car— about $3500); the computer language BASIC is easy to use; and the system is capable of expansion beyond my foreseeable needs.

My initial purchase was the Level I 16K model. I would not recommend Level I BASIC to anyone , other than to use it as a toy. It is almost useless for astrological purposes. Trig functions were not hard-wired, there was limited number of possible variable names, virtually no string handling capability, and only one possible array. Hardware and software both worked flawlessly, though. My SR-52 programmable calculator is less cumbersome to use and program than a Level I TRS-80. This system does have one outstanding feature that I would recommend to anyone who is afraid to get involved with a computer; its instruction manual. It is written in a humorous yet clear and concise style and is an excellent introduction to the basics of BASIC and to an understanding of how a computer works. Even though I recommend beginning at Level II BASIC everyone should read the Level I instruction manual. The Level II manual is quite dry and very lacking in examples.

The next version of the system was when I converted to Level II BASIC and added the expansion interface, an additional 16K of memory and the line printer. Program and data storage was still limited to the extremely slow, clumsy, and sometimes randomly inaccurate cassette method. I would earnestly recommend anyone who can swing the additional $500 to purchase the MINI DISK. It is so much easier to use that cassette storage and retrieval! The main frustration I have had with this version of the system is with cassette loading. Every once in a while after a program has been loaded into the computer and you run the program it will stop and list a "syntax error" in a certain line. You examine the line and it looks perfect— there is an ASCII read error in the line. It can be corrected by retyping the line, but it is quite frustrating to have to run your program a few times to get all the ASCII errors out...and they occur randomly! My suggestion to avoid this problem is to use only very high quality recording tape and also to be very careful when typing letters not to have the SHIFT key depressed— this causes an invisible ASCII error. When I first received this system the CPU and Expansion Interface were incompatible. I sent the system out for repair. The repair was completed in 48 hours, the machine was hand-carried 50 miles to the Radio Shack repair facility by the manager of the store where I purchased it and hand-carried back, any repairs have been accomplished with a minimum of 4 and maximum of 7 days 'down-time'. I doubt that any other system can offer that kind of service. Rob Hand's system has been 'down' for repairs for 6 weeks now. I have had absolutely no problems with the Centronics Line Printer. It has been completely reliable. Level II BASIC is everything I could have asked for in a computer language.

The next addition to the system was the MINI DISK. I have one and am lusting for a second one. Having a disk system makes program running and writing and editing so much easier! My drive arrived with two major hardware problems and a software problem that made the first month of ownership quite frustrating. The transformer had to be replaced and the heads had to be aligned. The original disk operating system (Version 2.0) was unusable. This problem was solved by the issuance of version 2.1 which seems to work pretty well. The DISK BASIC and the TRS DOS use up 10K of RAM which leaves me with 22K of usable RAM. So far this lack of full RAM capacity has not been a problem for me. The only complaint I have with the disk system now is that there is a glitch (computerist word for 'bug') in it that will only allow me to use 80% capacity of the disk— there is apparently an error in the operating system. All I have to do is recopy my system diskette.

Errata in MATRIX ONE

A few more typos' from MATRIX ONE have been found. On page 10, formula (14) in the denominator, last term should read TAN ϕ.
On page 16, step 168 of ASTRO 2, the code should read 16 23 02.
On page 16, ASTRO 3, step 007 should read 007 STO$\emptyset$ 35 $\emptyset\emptyset$.
On page 29, the section ECB=43429.85846 should read ECB=43429.85486.
On page 31, top of page should read:

θ = Local RAMC
ϕ = Northern latitude
ϵ = Obliquity of ecliptic

On page 47, the three "if" statements at the top of the page, the 2nd and third "if" statemtents, between the R+S/2 and the 180 there should be the symbol "$\geq$" and "<", respectively.

Errata in MATRIX TWO

We had such a great crop of errata in MATRIX TWO that I got a chewing-out from Mr. Neely himself. We have instituted a new policy in which each author is sent proofs to check-out themselves and return to us. Errors are particularly forbidden in a magazine such as this and thanks to those who wrote in and pointed them out to us. Errors and program 'bugs' are alive and well— this I can testify too.

On page 3, $R_3(-\theta)$ matrix, lower right hand "0" should be a "1"
On page 3, bottom line, subscript J should read 'subscript H'.
On page 5, line 275, the part "E=FND(S)" should read "E=S"
On page 7, section 'REDUCTION TO THE ECLIPTIC', last line should read 'l—Ω' and 'l' instead of 'λ—Ω' and 'λ'.
On page 14, missing step 281 is a '281 01 1'. On page 15, step 308 should read '308 03 3"... and step 316 should read "316 01 1". On page 17, step 644 should read "644 01 1" and step 47 (same page) should read "047 42 STO".
On page 27, the name is Cochrane...and not Cohrane. On page 28, 4th line up should read 'inaccurate'.
On page 35, line of code 3060 should have the final ',0' removed.
On page 37, quote from Neely, 3rd line from bottom, should read " I dont know what happens without that term though".
On page 37, top line, middle matrix should read '1 0 0' instead of '1 1 0'.
On page 49, step 193, note should read "F+2D-l'".
On page 53, in "NOTES TO GEOGRAPHIC COORDINATES", geographic longitude of Brisbane is 153E21...and not 153W21.
On page 56, line 1065 should read '1065 MB=MB-624..etc.'

And last but not least..for my grand finale..on page 42, I left out the symbol for the Mean Moon..which is a '☽' in no less than five places! Starting from the 'Program Equation' section...those parts affected should read: (☉ = 973563,etc.), (☽ = 933060,etc), (l=☽-Γ') (l=☽-D), (F=☽-☌) and at the end of the "Longitude" equation is a (+☽).

Not only has Mr. Neely taken up arms on this issue..but infinitely worse...so has my wife! I will make an even greater effort to learn to be careful and meticulous in my work. Please let me know of any errors you find so that we can correct them.

ERRATA MATRIX TWO

On page 55,56 lines should read:

```
400 RX = R — COS(FNR(C1)- FNR(C))
470 R$ = "": IF RX < 0 THEN R$= " R"
1105 A=FNR(FNP(MB)):RX=0;GOTO 470
```

Received from Guy Le Clercq and COSMOPLAN..center for cosmoplanetary research, Rue Du Cardinal Lavigerie 35, 1040 Bruxelles, Belgium:

International Abbreviations for Cosmic Elements (ICN)

Symbol	ICN	Symbol	ICN	Symbol	ICN
SUN	SO	EARTH	TE	ARIES	AR
MOON	MO	NORTH NODE	NN	TAURUS	TA
MERCURY	ME	SOUTH NODE	SN	GEMINI	GE
VENUS	VE			CANCER	CN
MARS	MA	ASCENDANT	AS	LEO	LE
JUPITER	JU	MIDHEAVEN	MC	VIRGO	VI
SATURN	SA	VERTEX	VX	LIBRA	LI
URANUS	UR	ANTIVERTEX	AV	SCORPIO	SC
NEPTUNE	NE	IM C	IC	SAGITTAR.	SG
PLUTO	PL	DESCENDANT	DS	CAPRICORN	CP
		ARIES POINT	AR	AQUARIUS	AQ
CERES	CE	EAST POINT	EP	PISCES	PI
PALLAS	PA	APEX	AX		
JUNO	JO	GALACTIC C.	GC	PART F.	PF
VESTA	VA	HYPERGALACTIC		RIGHT ASC.	RA
CUPIDO	CU	CENTER	HG	TRANSPLUTO	TP
HADES	HA				
ZEUS	ZE	HELIO	H before two letters		
KRONOS	KR				
APOLLON	AP				
ADMETOS	AD				
VULCANUS	VU				
POSEIDON	PO				

Editor's note: One of the problems with erecting a set of standards is getting everyone to agree with one particular collection. Perhaps American astrologers will feel more comfortable with 'SU' rather than "SO' for the SUN, I, for one, will never feel comfortable with 'TE' for the 'EA'..EARTH I am used to...much less the symbol they propose (not given here) of ♁ where ⊕ is what I am used to..and so on. Perhaps we could have some discussion of this at the ANNUAL TECHNICAL CONFERENCE here in Ann Arbor..next Spring-Summer?

It would be good to have some standard variable names for astrological programming too. Perhaps we could agree on variables for loops, variables common to subroutines and so forth. Any thoughts? Certainly the term "EAST POINT" should be abandoned and some other term such as EQUATORIAL ASCENDANT be adopted.

ASTROLOGICAL ROUTINES ON THE TI-59/PC-100A PROGRAMMABLE

Authored by James Neely
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Editor's note: Here are two more routines for the TI-59 that many of you have written to ask for. Both the ASPECT & MIDPOINT and the PLACIDUS HOUSE CUSPS routines are designed to be used with the Neely ASTRO program listed in issue two of MATRIX (also available from MATRIX Software).

Notes on These Programs: PLACIDUS HOUSE CUSPS

Inputs: None Outputs: Cusp number, degree-in-sign (DD.MMSS), and Sign for cusps 10, 11, 12, 1, 2, and 3 in either the tropical or the sidereal zodiac.

Instructions:

1. Execute ASTRO (see MATRIX Two)
2. Read program card (banks 1 and 2).
3. Either:
   a. Press A for tropical cusps, or
   b. Press E for sidereal cusps.
4. Zero is displayed when computations are complete

ASPECTS AND MIDPOINTS

Input: None required for aspects and midpoints of the 10 planetary bodies. Longitudes of up to 9 additional bodies and/or sensitive points may be entered as an option.

Output:

Aspects:
1. Body 1-body 2 symbols.
2. Aspect angle: DDD.MM

Midpoints:
1. Body 1-body 2 symbols.
2. Degree-in-sign and Sign of conjunction midpoint.
3. Degree-in-sign and Sign of opposing midpoint.

Instructions:

1. Execute the PLANETARY COORDINATE program.
2. Read the program card (banks 1 and 2)
3. Optional input of additional bodies:
   a. Press C.
   b. The number 11, for eleventh body, will display.
   c. Key in degree-in-sign, DD.MM, of the body.
   d. Press R/S.
   e. Key in Sign (1-Aries, 2-Taurus, etc.).
   f. Press R/S
   g. A new number (12, 13, ...,19) for the 12th, 13th, etc. body will display. Repeat from step 3c if desired.
4. Press A to computer aspects.
5. Press A' to computer midpoints.

Equations for Placidus Method (Exact). The House Cusps are computed by the exact method of Placidus.

Let λ_N denote the (tropical) degree (ecliptic longitude) of the Nth cusp. Compute:

$$f_N = (N-10) \div 3$$

Solve: $\cos \xi_N = -\sin(\alpha_{MC} + f_N \xi_N) \tan\phi \tan\epsilon$

for ξ_N using the Newton-Raphson Method then,

$$\lambda_N = \tan^{-1}\left(\frac{\sin(\alpha_{MC}+f_N\xi_N)}{\cos(\alpha_{MC}+f_N\xi_N)\cos\epsilon}\right) \quad \text{for } N=7,8\ldots,12$$

Also, $\lambda_N = \lambda_N + 6 + 180°$ for $N=1,2,\ldots,6$

Sidereal longitudes, λ_S, are computed from the tropical longitudes above by adding SVP to λ_N (see MATRIX I, ASTRO 1,2,3)

Where: α_{MC} = RAMC(Right Ascension of the Midheaven)
ϕ = Geographic Latitude
ϵ = Obliquity of the Ecliptic

Equations for Aspects and Midpoints. Let λ_i denote the ecliptic longitude of the i^{th} body (i= 1,2,...,N; N <= 20).

The aspect between bodies i and j is γ, where

$$\gamma = \cos^{-1}[\cos(\lambda_j - \lambda_j)]$$

Midpoints:

Let $\xi = \lambda_j - \lambda_i$. If $|\xi| > 180°$, replace ξ by $\xi + 360°$.

Then the conjuncting midpoint (within 90° of either body) is

$$MP_1 = (\lambda_i + \xi/2) \text{ MOD } 360°,$$

and the opposing midpoint is

$$MP_2 = (MP_1 + 180°) \text{ MOD } 360°$$

TI-59/PC-100A PLACIDUS CUSPS

```
000  76 LBL  subroutine
001  85  +   to add the
002  85  +   SYNETIC
003  43 RCL  VERNAL POINT
004  14  14  (SVP)
005  54  )
006  92 RTN  ----------
007  76 LBL
008  95  =   SUBROUTINE
009  55  ÷   FOR
010  03  3   360-degree
011  06  6   MODULAR
012  00  0   ARITHMETIC
013  54  )
014  22 INV
015  59 INT
016  85  +
017  01  1
018  54  )
019  22 INV
020  59 INT
021  65  x
022  03  3
023  06  6
024  00  0
025  54  )
026  92 RTN  ----------
027  76 LBL  SUBROUTINE
028  75  -
029  58 FIX
030  04  04
031  22 INV
032  88 DMS
033  42 STO
034  19  19  [PRT]  DEGREES
035  55  ÷   [R/S]
036  03  3
037  00  0
038  54  )
039  59 INT
040  42 STO
041  18  18
042  85  +
043  01  1
044  54  )   [R/S]
045  43 RCL
046  18  18
047  55  ÷
048  02  2
049  54  )

050  42 STO
051  06  06
052  22 INV  UNPACK SIGN
053  59 INT  FOR PRINTING
054  32 X-Y
055  00  0
056  67  EQ
057  35 1/X
058  73 RC*  UNPACK LEFT-
059  06  06  HAND PORTION
060  59 INT
061  61 GTO
062  45 Y^x  ----------
063  76 LBL
064  35 1/X
065  73 RC*
066  06  06  UNPACK
067  22 INV  RIGHT-HAND
068  59 INT  PORTION
069  65  x
070  01  1
071  52 EE
072  04  4
073  22 INV
074  52 EE   ----------
075  76 LBL
076  45 Y^x
077  54  )
078  69 OP   PRINT
079  04  04 DEGREE-IN-
080  43 RCL  SIGN
081  19  19 AND
082  75  -   SIGN
083  03  3
084  00  0
085  65  x
086  43 RCL
087  18  18
088  54  )
089  69  OP
090  06  06  [R/S]
091  92 RTN  ----------
092  76 LBL
093  15  E   COMPUTER
094  22 INV  CUSPS IN
095  86 STF  SIDEREAL
096  00  00  ZODIAC
097  61 GTO
098  47 CMS  ----------
099  76 LBL

100  11  A   COMPUTE
101  86 STF  CUSPS IN
102  00  00  TROPICAL
103  76 LBL  ZODIAC
104  47 CMS
105  98 ADV
106  69 OP
107  00  00
108  03  3
109  03  3
110  02  2
111  07  7
112  01  1
113  03  3
114  01  1
115  05  5
116  02  2
117  04  4
118  69 OP
119  01  01
120  01  1
121  06  6
122  04  4
123  01  1
124  03  3
125  06  6   PRINT
126  00  0   HEADING
127  00  0
128  00  0
129  00  0
130  69 OP
131  02  02
132  69 OP   Initialize:
133  05  50
134  43 RCL  Latitude
135  12  12
136  50 IxI
137  75  -
138  09  9
139  00  0
140  95  =
141  32 X-T
142  43 RCL  Obliquity
143  11  11
144  22 INV
145  77  GE  Error for
146  90 LST  Polar Latitude
147  89  π    PI
148  42 STO
149  36  36
```

TI-59/PC-100A PLACIDUS HOUSES

```
150  01  1
151  32 X-T
152  43 RCL
153  11  11
154  37 P/R
155  55  ÷
156  32 X-T
157  42 STO  COS ε
158  35  35
159  95  =
160  65  x
161  43 RCL
162  12  12
163  30 TAN
164  95  =
165  42 STO  TANφ TANε
166  39  39
167  00  0
168  42 STO
169  37  37
170  42 STO  f_N
171  32  32
172  43 RCL  α_MC (DEGREES)
173  13  13
174  65  x
175  89  π
176  55  ÷
177  01  1
178  08  8
179  00  0
180  95  =
181  42 STO  α_MC (RADIANS)
182  38  38
183  03  3
184  07  7
185  42 STO
186  07  07  CUSP CONT-
187  01  1   ROL REG.
188  00  0
189  42 STO  CUSP NO.----
190  31  31
191  76 LBL  INITIAL
192  70 RAD  GUESS
193  70 RAD
194  89  π
195  55  ÷
196  02  2
197  95  =
198  42 STO  ξ_N
199  33  33

200  58 FIX
201  08  08  ----------
202  76 LBL  begin
203  80 GRD  NEWTON-
204  43 RCL  RAPHSON
205  39  39  ITERATION
206  32 X-T
207  43 RCL
208  32  32
209  65  x
210  43 RCL
211  33  33
212  85  +
213  43 RCL
214  38  38
215  95  =
216  42 STO
217  34  34  α+f_N ξ_N
218  37 P/R
219  85  +
220  43 RCL
221  33  33
222  39 COS
223  95  =
224  55  ÷
225  53  (
226  32 X-T
227  65  x
228  43 RCL
229  32  32
230  94 +/-
231  85  +
232  43 RCL
233  33  33
234  38 SIN
235  54  )
236  95  =
237  44 SUM
238  33  33  ξ_N
239  52 EE
240  22 INV
241  52 EE
242  32 X-T
243  00  0   LOOP IF
244  22 INV  NO CONVER-
245  67  EQ  GENCE
246  80 GRD  ----------
247  01  1
248  32 X-T
249  43 RCL

250  33  33
251  65  x
252  43 RCL
253  32  32
254  85  +
255  43 RCL
256  38  38
257  85  +   COMPUTE CUSP
258  73 RC*  LONGITUDE
259  07  07
260  95  =
261  37 P/R
262  55  ÷
263  43 RCL
264  35  35
265  95  =
266  60 DEG
267  22 INV
268  37 P/R
269  87 IFF
270  00  00
271  50 IxI
272  71 SBR  SIDEREAL
273  85  +   ZODIAC?
274  76 LBL  ----------
275  50 IxI
276  71 SBR  MOD 360-degrees
277  95  =
278  42 STO
279  30  30
280  43 RCL
281  31  31
282  58 FIX
283  00  00
284  98 ADV  PRINT CUSP NO.
285  99 PRT
286  43 RCL
287  30  30
288  71 SBR  SIGN & DEGREE-
289  75  -   IN-SIGN
290  01  1   ROUTINE
291  03  3
292  32 X-T
293  43 RCL
294  31  31
295  85  +   SET NEW
296  01  1   CUSP NUMBER
297  95  =
298  22 INV
299  77  GE
```

TI-59/PC-100A PLACIDUS CUSPS

```
300  57 ENG
301  01  1
302  76 LBL
303  57 ENG
304  42 STO N
305  31  31
306  32 X-T
307  04  4
308  67  EQ LAST CUSP?
309  42 STO
310  06  6
311  77  GE
312  48 EXC
313  07  7
314  76 LBL
315  48 EXC
316  85  +
317  03  3
318  00  0
319  95  =
320  42 STO
321  07  07
322  43 RCL
323  32  32 SET UP
324  85  +  FOR
325  03  3  NEXT
326  35 1/X CUSP
327  95  =
328  42 STO
329  32  32
330  52 EE
331  22 INV
332  52 EE
333  32 X-T
334  01  1
335  22 INV
336  67  EQ
337  70 RAD
338  01  1
339  94 +/-
340  42 STO
341  32  32
342  61 GTO
343  70 RAD TRANSFER
344  76 LBL
345  42 STO RESET MODE OF
346  22 INV DISPLAY FOR
347  58 FIX NEXT CARD
348  00  0
349  91 R/S
```

MIDPOINTS & ASPECTS ROUTINE

```
000  76 LBL
001  85  +
002  85  +
003  43 RCL
004  14  14
005  54  )
006  92 RTN
007  76 LBL
008  95  =
009  55  ÷
010  03  3
011  06  6
012  00  0
013  54  )
014  22 INV
015  59 INT
016  85  +
017  01  1
018  54  )
019  22 INV
020  59 INT
021  65  x
022  03  3
023  06  6
024  00  0
025  54  )
026  92 RTN
027  76 LBL
028  75  -
029  22 INV
030  88 DMS
031  58 FIX
032  02  02
033  42 STO
034  19  19
035  55  ÷
036  03  3
037  00  0
038  54  )
039  59 INT
040  42 STO
041  18  18
042  85  +
043  01  1
044  54  )
045  43 RCL
046  18  18
047  55  ÷
048  02  2
049  54  )
```

SUBROUTINE TO ADD THE SYNETIC VERNAL POINT (SVP)

SUBROUTINE FOR 360 DEGREE MODULAR ARITHMETIC

SUBROUTINE

FIND SIGN AND DEGREE-IN-SIGN

INDIRECT ADDRESS

```
050  42 STO
051  06  06
052  22 INV
053  59 INT
054  32 X-T
055  00  0
056  67  EQ
057  35 1/X
058  73 RC*
059  06  06
060  59 INT
061  61 GTO
062  45 Y^x
063  76 LBL
064  35 1/X
065  73 RC*
066  06  06
067  22 INV
068  59 INT
069  65  x
070  01  1
071  52 EE
072  04  4
073  22 INV
074  52 EE
075  76 LBL
076  45 Y^x
077  54  )
078  69 OP
079  04  04
080  43 RCL
081  19  19
082  75  -
083  03  3
084  00  0
085  65  x
086  43 RCL
087  18  18
088  54  )
089  69 OP
090  06  06
091  92 RTN
092  76 LBL
093  87 IFF
094  87 IFF
095  04  04
096  66 PAU
097  01  1
098  00  0
099  42 STO
```

unpack sign for printing

UNPACK LEFT-HAND PORTION

UNPACK RIGHT-HAND PORTION

PRINT SIGN AND DEG-IN-SIGN

SUBROUTINE

test flag 4.

SET DEFAULT TO 10 BODIES ONLY.

TI-59/PC-100A ASPECTS & MIDPOINTS

```
100  39  39
101  76 LBL
102  66 PAU
103  92 RTN
104  76 LBL
105  16 A'
106  71 SBR
107  87 IFF
108  22 INV
109  58 FIX
110  22 INV
111  52 EE
112  98 ADV
113  69 OP
114  00  00
115  03  3
116  00  0
117  02  2
118  04  4
119  01  1
120  06  6
121  03  3
122  03  3
124  01  1
125  03  3
126  02  2
127  02  2
128  04  4
129  03  3
130  01  1
131  03  3
132  07  7
133  03  3
134  06  6
135  86 STF
136  06  06
137  61 GTO
138  28 LOG
139  76 LBL
140  11  A
141  71 SBR
142  87 IFF
143  22 INV
144  58 FIX
145  22 INV
146  52 EE
147  98 ADV
148  69 OP
149  00  00
123  69 OP
```

DO NOT SET TO 10. RETURN

MIDPOINT ROUTINE ENTRY

PRINT "MIDPOINT" HEADING

SET FLAG 6

ASPECT ROUTINE ENTRY

```
150  01  1
151  03  3
152  03  3
153  06  6
154  69 OP
155  01  01
156  03  3
157  03  3
158  01  1
159  07  7
160  01  1
161  05  5
162  03  3
163  07  7
164  03  3
165  06  6
166  22 INV
167  86 STF
168  06  06
169  76 LBL
170  29 LOG
171  22 INV
172  58 FIX
173  69 OP
174  02  02
175  69 OP
176  05  05
177  03  3
178  06  6
179  04  4
180  01  1
181  42 STO
182  40  40
183  03  3
184  00  0
185  03  3
186  02  2
187  42 STO
188  41  41
189  03  3
190  00  0
191  01  1
192  07  7
193  42 STO
194  42  42
195  04  4
196  02  2
197  01  1
198  07  7
199  42 STO
```

PRINT "ASPECT" HEADING

CLEAR FLAG 6

STORE BODY NAMES IN REGISTERS 40 thru 49

(REGISTERS 50 THRU 58 ARE AVAILABLE TO STORE THE NAMES OF ADDITIONAL BODIES OR SENSITIVE POINTS)

```
200  43  43
201  03  3
202  00  0
203  01  1
204  03  3
205  42 STO
206  44  44
207  02  2
208  05  5
209  04  4
210  01  1
211  42 STO
212  45  45
213  03  3
214  06  6
215  01  1
216  03  3
217  42 STO
218  46  46
219  04  4
220  01  1
221  03  3
222  05  5
223  42 STO
224  47  47
225  03  3
226  01  1
227  01  1
228  07  7
229  42 STO
230  48  48
231  03  3
230  03  3
233  02  2
234  07  7
235  42 STO
236  49  49
237  02  2
238  00  0
239  42 STO
240  08  08
241  76 LBL
242  47 CMS
243  43 RCL
244  08  08  INDEX
245  85  +   FOR
246  01  1   BODY i
247  95  =
248  42 STO
249  09  09
```

TI-59/PC-100A ASPECTS & MIDPOINTS

```
250  76 LBL
251  48 EXC  TAKE BODY i
252  43 RCL  AND BODY j
253  09  09
254  85  +
255  02  2
256  00  0
257  95  =
258  42 STO
259  07  07
260  73 RC*
261  07  07
262  42 STO
263  19  19
264  43 RCL
265  08  08
266  85  +
267  02  2
268  00  0
269  95  =
270  42 STO
271  07  07
272  73 RC*
273  07  07
274  65  x
275  01  1
276  52 EE  PACK BODY
277  06  6   NAMES FOR
278  85  +   PRINTING
279  02  2
280  52 EE
281  05  5
282  85  +
283  43 RCL
284  19  19
285  95  =
286  22 INV
287  52 EE
288  69 OP
289  00  00
290  69 OP
291  01  01
292  69 OP
293  05  05  PRINT
294  87  IFF GTO
295  06  06  MIDPOINT
296  49 PRD  ROUTINE IF
297  73 RC*  REQUIRED
298  08  08
299  75  -
```

```
300  73 RC*
301  09  09
302  95  =
303  39 COS  COMPUTE
304  22 INV  ASPECT
305  39 COS
306  22 INV
307  88 DMS
308  58 FIX
309  02  02
310  99 PRT
311  61 GTO
312  36 PGM
313  76 LBL
314  49 PRD  MIDPOINT
315  01  1   ROUTINE
316  08  8
317  00  0
318  32 X-T
319  73 RC*
320  09  09
321  75  -
322  73 RC*
323  08  08  ξ=λj−λi
324  95  =
325  42 STO
326  59  59
327  50 IxI  |ξ|>180
328  22 INV
329  77  GE
330  38 SIN
331  43 RCL
332  59  59
333  85  +   IF YES,
334  03  3   ADD 360
335  06  6   to ξ
336  00  0
337  95  =
338  42 STO
339  59  59
340  76 LBL
341  38 SIN
342  43 RCL
343  59  59
344  55  ÷
345  02  2   CONJUNCTING
346  85  +   MIDPOINT,
347  73 RC*  MP1=λi+ξ/2
348  08  08
349  95  =
```

```
350  42 STO
351  59  59
352  71 SBR
353  95  =
354  71 SBR  PRINT MP1
355  75  -
356  43 RCL
357  59  59  OPPOSING
358  85  +   MIDPOINT
359  01  1   MP2=MP1+180
360  08  8
361  00  0
362  95  =
363  71 SBR
364  95  =   PRINT MP2
365  71 SBR
366  75  -
367  76 LBL
368  36 PGM
369  02  2
370  00  0
371  85  +
372  43 RCL  INCREMENT
373  39  39  INDEX
374  95  =   FOR
375  32 X-T  BODY j
376  43 RCL
377  09  09
378  85  +
379  01  1
380  95  =
381  42 STO
382  09  09
383  22 INV
384  67  EQ
385  48 EXC
386  32 X-T  IF INDEX j
387  75  -   IS MAXIMUM,
388  01  1   THEN IS
389  95  =   INDEX i
390  32 X-T  MAXIMUM?
391  43 RCL
392  08  08  IF NOT,
393  85  +   CONTINUE
394  01  1
395  95  =
396  42 STO
397  08  08
398  22 INV
399  67  EQ
```

TI-59/PC-100A ASPECTS & MIDPOINTS

```
400  47 CMS
401  00  0
402  22 INV OTHERWISE
403  58 FIX STOP
404  91 R/S
405  76 LBL INPUT
406  13  C  ADDITIONAL
407  01  1  BODIES OR
408  00  0  SENSITIVE
409  42 STO POINTS (NOT
410  39  39 TO EXCEED 9)
411  86 STF
412  04  04
413  03  3
414  00  0
415  42 STO
416  08  08 INITIALIZE
417  05  5
418  00  0
419  42 STO
420  09  09
421  76 LBL
422  57 ENG SET TO
423  02  2  INPUT NEW
424  00  0  BODY
425  32 X-T
426  43 RCL
427  39  39
428  85  +
429  01  1
430  95  =
431  67  EQ ERROR IF
432  30 TAN TOO MANY
433  42 STO POINTS
434  59  59
435  91 R/S DISPLAY BODY
436  88 DMS NUMBER
437  73 ST*
438  08  08 STORE LONG-
439  91 R/S ITUDE
440  75  -  (DEG-In-SIGN)
441  01  1
442  95  =
443  65  x
444  03  3
445  00  0  ADD DEGREES OF
446  95  =  SIGN TO GET
447  74 SM* LONGITUDE IN
448  08  08 DEGREES
449  01  1
```

```
450  07  7
451  32 X-T
452  43 RCL
453  59  59
454  42 STO
455  39  39
456  22 INV  GENERATE
457  77  GE  BODY
458  88 DMS  NUMBER
459  85  +
460  02  2
461  76 LBL
462  88 DMS
463  75  -
464  09  9
465  95  =
466  72 ST*  store body
467  09  09
468  69 OP
469  28  28
470  69 OP
471  29  29  READ ANOTHER
472  61 GTO  BODY
473  57 ENG
474  91 R/S
475  91 R/S
476  91 R/S
```

The DR-70 Design Process

by Digicomp Research Corp.
Terrace Hill
Ithaca, N.Y. 14850

The founders of Digicomp, although themselves not professional astrologers (Dr. Om P. Gupta, an electrical engineer with extensive experience in missles, radar, and pattern recognition, and Dr. David J. Lewis, a specialist in computer science), have always had a keen interest in astrology. There are some very fine astrologers in the Ithaca area, and through them we realized the astrologer's problems and his need for a computer. We considered the various ways in which such computing power could be made available to an astrologer. The announcement of microprocessor chips by Intel was the first major breakthrough in technology that really made a dedicated astrological computer economically feasible. We started designing our first astrological computer around the 4040, the first microprocessor chip announced by Intel.

Early in the design stage we considered the needs and the working environment of the professional consulting astrologer. We realized that there were several different types of astrological work: consultation, research, and instruction. The consultant has a strong need for a rapid, interactive instrument that allows his access to many techniques, without distracting his attention from the discussion with his client— for example, the need for verification may become evident after a consultation has begun, or, the client may need to discuss a relationship— both important and somewhat time-consuming projects. The researcher needs vast ephemerides and techniques for analytic astrology. The teacher, we discovered, often wants to provide each student with personal examples to best illustrate the approach being presented in a lesson. This means that either the teacher must rely on each student's mathematical capacity, or must do all of the work himself.

Interactive, rapid, accurate— these considerations strongly indicated to us the need of designing a dedicated computer rather than developing software for an off-the-shelf microprocessor system.

The advances in semiconductor technology in terms of component density and speed of operations have become spectacular. A series of high-speed 8-bit microprocessor chips became available after our research had begun. These made some of the important astrological functions economically feasible on the DR-70. Changing to the 6502, a 8-bit microprocessor, reduced the planetary calculations to one-tenth the time required by the 4040. It also allowed us to store and compare two charts and their derivatives in RAM. Such a chart comparison feature is extremely useful to an astrologer during consultation hours. The 8-bit CPU also provided us with a much larger ROM field within which we could program many more astrological techniques. As Digicomp was interested in providing a useful tool and not a toy, we didn't hesitate to scrap our man-years of design efforts on the 4040 system.

The most important considerations when designing the DR-70 were:

- Speed
- Accuracy
- Necessity to be simple and interactive to use
- Incorporation of maximum posiible astrological techniques.
- Cost

All of the above factors are interdependent, and a continuous trade-off was made among them. The block diagram outlines the various steps involved in the design of the DR-70.

The first step was to carefully research and define the astrological techniques. We chose techniques that were astronomically coherent. However, several arithmetic modes— zodiac, 60 base, and 10 base— and functions such as coordinate conversion enable a practicioner to work from our basic techniques to any permutation in a matter of a few steps.

The DR-70 is programmed in machine language, the reasons for which are obvious. It would have been easier to program the DR-70 in some high-level language like BASIC. However, programs written in BASIC are very slow in execution time, and thus wouldn't have made DR-70 interactive.

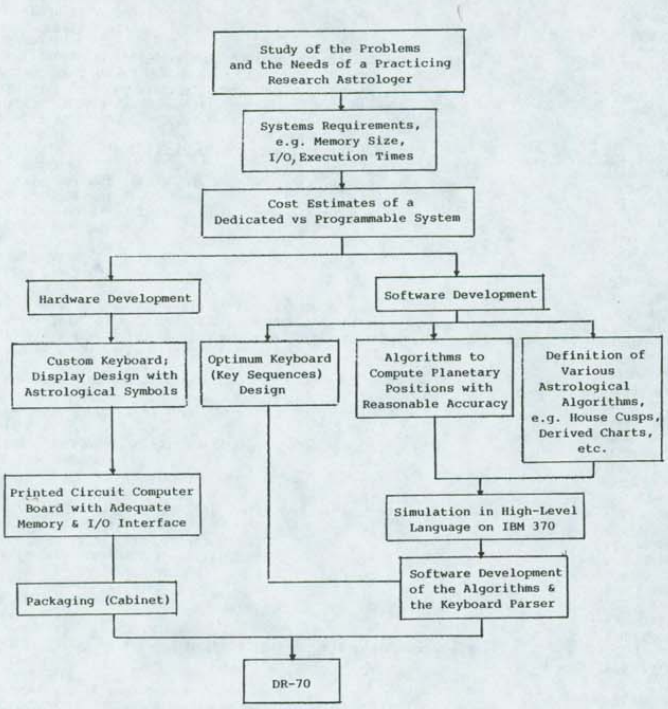
The astrological techniques to be programmed were first simulated in a high-level language (FORTRAN) on an IBM 370. This allowed us a very careful check of the accuracy of our algorithms. The planetary computations for the periods between 1800-2000 A.D. were checked against tapes supplied by the U.S. Naval Observatory. The Sun and Moon computations were checked for the years back to 100 B.C. Such an extensive check of the algorithms is not possible on a small microprocessor development system.

Our design goal was a computer simple and interactive to use. The keystroke sequences had to be carefully designed so that they were simple enough and in line with the thinking processes of an astrologer during his consultation hours. The design of an optimum keyboard with simple as well as flexible key sequences was the single most difficult part of the whole project. To achieve this we chose a dedicated rather than a general-purpose keyboard.

An important feature of the DR-70 is the display of the current state of the machine in symbols very familiar to the astrologer. With such a carefully thought out display, an astrologer can focus his attention more on the astrological study than on the mathematical computations. As manufacturers of keyboards and displays were not exactly familiar with astrological symbols, there were some problems in getting them to do an adequate representation of these symbols on the key tops and the display panel. The rest of the hardware design, although not simple by any means, was more typical, e.g. a PC board with adequate memory and I/O, an attractive packaging with enough heat dissipation, etc.

These were some of the considerations involved in the design of the DR-70. Nearly ten man-years were required to complete the project. We hope that astrologers find the DR-70 an invaluable tool for their work.

DESIGN FLOW CHART



BOOK REVIEW DEPARTMENT

From EDITIONS DE'APOTELESMATIQUE PUBLICATIONS, Avenue de Mai, 156 -B- 1200 Bruxelles, Belgium we have received their first volume "600 PERSONALITIES OF THE CAPRICORN" in their series ENCYCLOPEDIA OF BIRTH DATA by Jacques de Lescaut. This first volume is $12.08 (postpaid).

This collection of birth-data consists of that data as published in books, magazines and so forth...around the world. This first volume contains 600 tropical Capricorns indexed by birthdate and by alphabet. Each individual has the birth date, time and place of birth and death (when appropriate) as well as a brief line or two describing the major contributions made by the individual.

I am impressed by the large number of birth-times included and, in general, the great care taken in presenting this collection. The book is a large 8½x14 paperback with leatherette cover. The typesetting is very well done. I have not had time to check this material out but from appearances I would say that this is the best birth-data collection I have seen to date (and we publish the CIRCLE BOOK OF CHARTS!). The text is in French and English. If you are a collector of birth data for well-known individuals..this will be a great series to subsribe to.

Volume 2. Number 2 of the JOURNAL FOR GEOCOSMIC RESEARCH

Postpaid $4 from NATIONAL COUNCIL FOR GEOCOSMIC RESEARCH, 436 West 22nd St., New York, N.Y. 10011

Aside from being well put together and full of interesting material, this issue contains two large articles that will interest MATRIX readers. The first is by our own James Neely, (we dont own him) THE ORBITS OF THE TRANSNEPTUNIANS. This is an analysis of the Witte and Sieggrun ephemerides of hypothetical planets and shows that the calculations are consistent both internally and with Newtonian mechanics.

A second article of interest is FINDING INHERENT PERIODICITIES IN ASTROLOGICAL DATA by. G.C. Noonan. Noonan takes a look at the work of John Addey...in particular his work with polia data..from the point of view of Fourier analysis. Included is an appendix: PERIODIC FUNCTIONS: A BRIEF INTRODUCTIONS and HOW TO FIND INHERENT PERIODICITIES as well as a fascinating exchange of letters between Noonan and James Williamsen of Cambridge Circle.

Other articles in this issue include: THE NEW YORK SUICIDE STUDY by Nona Press, ASTROLOGICAL RESEARCH INTO SUICIDE AND RELATED MATTERS by Ruth Hale Oliver, NATAL CHARTS OF WELFARE CHILDREN by Lillian Celic and Charles Salvaggio and STAGES IN ADULT DEVELOPMENT by Joan Negus.

Program to calculate Sun to ± 2", Moon's longitude to ±3", Moon's latitude ±1' of arc.

By Robert Hand, 217 Rock Harbor Rd., Orleans, Mass 02653

```
1 INPUT"Do you wish date or JD entry, Date=0, JD=1";X:IF X=1 GOTO 7
2 INPUT"Date: format MM,DD,YYYY";M,D,Y
3 INPUT"U.T.: format HH,MM,SS";HU,MU,SU
4 INPUT"Delta T in seconds";DT
7 DIM LG(20),LA(20),LP(15)
8 LWIDTH80
20 'Definition of pi and of functions that do trig functions on angles
30 'in degrees.
40 PI=4*ATN(1)
50 DEF FNSI(D)=SIN(D*PI/180)
60 DEF FNCO(D)=COS(D*PI/180)
70 DEF FNTA(D)=TAN(D*PI/180)
80 DEF FNAS(D)=ATN(D/SQR(1-D*D))*180/PI
90 DEF FNAC(D)=ATN(SQR(1-D*D)/D)*180/PI
100 DEF FNAT(D)=ATN(D)*180/PI
110 'Definition of a function that casts out circles, a modulus function
.
120 DEF FNMO(A)=(A/MODUS-INT(A/MODUS))*MODUS
125 IF X=1 THEN225
130 DATA 0,31,59,90,120,151,181,212,243,273,304,334
140 DIM N(12)
150 FOR J=1TO12:READ N(J):NEXT
160 PART=(HU+MU/60+SU/3600)/24+DT/86400
170 CENT=INT(Y/100)*100:YEAR=Y-CENT
180 J=M
190 DAY=YEAR*365+INT(YE/4)+N(J)+(D-.5)+PART
200 IY=YEAR/4:IF (IY-INT(YE/4)=0)AND(M<3)AND(YE<>0) THEN DAY=DAY-1
210 JD=DAY+2415020:IF CENT=1800 THEN JD=JD-36524:DAY=DAY-36524
220 IF CENT=1700 THEN JD=JD-73048:DAY=DAY-73048
222 IF X<>1 THEN 230
225 INPUT "JD";JD:DAY=JD-2415020
230 T=DAY/36525
240 T2=T*T
250 'Lunar Elements
260 ML=270.4341639+13.1763965268*DA+(.0000019*T-.001133)*T2
265 MO=360:ML=FNMO(ML)
270 LP=334.3295556+.1114040803*DA+(-.000012*T+.010325)*T2
275 LP=FNMO(LP)
280 LN=259.183275-.0529539222*DA+(.000002*T+.002078)*T2
285 LN=FNMO(LN)
720 MS=279.6966778+36000.76892*T+.0003025*T*T:'Mean Long. of Sun
730 MA=358.4758444+35999.04975*T-.00015*T*T:'Mean anomaly of Sun
740 EC=.01675104-.000041180*T-.000000126*T*T:'eccentricity of Sun
750 MO=360:MA=FNMO(MA):MS=FNMO(MS)
760 'Definition of functions that convert degrees to radians and vice
     versa.
770 DEF FNDR(X)=X*PI/180
780 DEF FNRD(X)=X*180/PI
790 AX=1.00000023:'Semi-major axis of Sun
800 MA=FNDR(MA)
810 E=MA:'This and the following loop calculate the eccentric anomaly
    iteratively using Kepler's equation.
820 FOR I=1TO5:E=MA+EC*SIN(E)
830 NEXT
840 'The following function is one that calculates the true anomaly from
     the eccentric anomaly.
850 DEF FNVA(EC)=2*ATN(((1+EC)/(1-EC))^.5*TAN(E/2))
860 TA=FNVA(EC)
870 TA=FNRD(TA)
880 MA=FNRD(MA)
890 C=C/3600
900 LE=TA-MA+MS:'#270 and 280 calculate the Long. without perturbations
    for comparison purposes.  This may be omitted.
910 MODUS=360:LE=FNMO(LE)
930 'The following is the equation for long term perturbations in mean
      longitude and anomaly.
940 DL=6.40*FNSI(231.19+20.20*T)+(1.882-0.016*T)*FNSI(57.24+150.27*T)+.2
66*FNSI(31.8+119.0*T)+.202*FNSI(315.6+893.3*T)
950 DL=DL/3600
960 MA=MA+DL
970 QU=165.94905+16859.069667*T:'QU is the argument for Mars.
980 NO=360
990 QU=FNMO(QU)
1000 SA=193.1323+34777.259042*T:'Argument for Saturn
1010 SA=FNMO(SA)
1020 VE=63.07037+22518.442986*T:'Argument for Venus
1030 VE=FNMO(VE)
1040 JU=221.647742+32964.466939*T:'Argument for Jupiter
1050 JU=FNMO(JU)
1060 'Equation for the perturbations of Venus.
1070 VP=4.838*FNCO(VE+90)+5.526*FNCO(2*VE+90.12)+2.497*FNCO(2*VE-MA+257.
75)+1.559*FNCO(3*VE-MA+77.96)+1.024*FNCO(3*VE-2*MA+50.85)+.666*FNCO(3*VE
+270.41)+.210*FNCO(4*VE+89.8)+.154*FNCO(5*VE-3*MA+34.1)+.152*FNCO(4*VE-2
*MA+227.4)+.144*FNCO(4*VE-MA+79)
1080 VP=VP/3600
1090 'perturbations of Mars
1100 MR=2.043*FNCO(2*QU+89.76)+1.77*FNCO(2*QU-MA+306.27)+.585*FNCO(4*QU-
MA*2+185.82)+.500*FNCO(4*QU-MA+317.70)+.425*FNCO(3*QU-MA+317.70)+.204*FN
CO(5*QU-2*MA+185.5)
1110 MR=MR/3600
1120 'Perturbations by Jupiter
1130 JP=7.208*FNCO(JU+91.09)+2.731*FNCO(JU*2+270.25)+2.6*FNCO(JU-MA+174.
77)+1.610*FNCO(2*JU-MA+292.60)+.556*FNCO(3*JU-MA+177.31)
1140 JP=JP/3600
1150 'Saturn perturbations
1160 SP=.419*FNCO(SA+90.34)+.320*FNCO(SA-MA+259.22)
1170 SP=SP/3600
1180 'Moon perturbations
1190 DEE=350.7374861+445267.114166*T-.001436111*T*T
1200 LL=296.1046083+477198.8489*T+.00919166666*T*T
1210 MP=6.454*FNSI(DEE)+.424*FNSI(DE-LL)
1220 MP=MP/3600
1230 LE(1)=LE+DL+VP+MR+JP+SP+MP:'The corrected value of the Sun.
1250 'Aberration
1260 AB=-(20.47+.342*FNCO(MA)):AB=AB/3600:'Aberration
1270 'Nutation
1280 'Moon's node
1300 NU=-(17.2327+.01737*T)*FNSI(LN)-1.273*FNSI(2*MS)
1310 NU=NU/3600
1320 LE(2)=LE(1)+NU+AB
1330 LO=LE(2):GOSUB1360:GOTO1370
```



```
1350 'Prints out Sun in DMS
1360 MI=LO-INT(LO):MI=MI*60:SE=(MI-INT(MI))*60:RETURN
1370 PRINT"Sun"; INT(LO);INT(MI);SE
1380 'Resumption of Moon
1390 'DE from Sun routine
1400 ELP=MA
1410 LL=ML-LP
1420 FF=ML-LN
1425 'LL,ELP,FF and DE are the values l, l', f, d from the Improved
      Lunar Ephemeris.
1426 'The values PT(1-4) are coefficients for long-term perturbations,
    which are applied to the mean values of the elements.
1430 PT(1)=FNSI(51.2+20.2*T)
1440 PT(2)=FNSI(193.4404-132.87*T-.0091731*T2)*14.27
1450 PT(3)=FNSI(LN)
1460 PT(4)=-15.58*FNSI(LN+275.05-2.3*T)
1470 ML=(.84*PT(1)+PT(2)+7.261*PT(3))/3600+ML
1480 LL=(2.94*PT(1)+PT(2)+9.337*PT(3))/3600+LL
1490 DE=(7.24*PT(1)+PT(2)+7.261*PT(3))/3600+DE
1500 ELP=-6.40*PT(1)/3600+ELP
1510 FF=(.21*PT(1)+PT(2)-68.699*PT(3)-15.58*PT(4))/3600+FF
1515 'Each of the terms summed as the values LP(1-10) are short-term
     perturbations.
1520 LP(1)=22639.55*FNSI(LL)-4586.465*FNSI(LL-2*DE)+2369.912*FNSI(2*DE)+
769.016*FNSI(2*LL)-668.1469*FNSI(ELP)
1530 LP(2)=-411.608*FNSI(2*FF)-211.6562*FNSI(2*LL-2*DE)-205.962*FNSI(LL+
ELP-2*DE)+191.953*FNSI(LL+2*DE)-165.145*FNSI(ELP-2*DE)
1540 LP(3)=147.687*FNSI(LL-ELP)-125.154*FNSI(DE)-109.673*FNSI(LL+ELP)-55
.173*FNSI(2*FF-2*DE)-45.099*FNSI(LL+2*FF)
1550 LP(4)=39.529*FNSI(LL-2*FF)-38.428*FNSI(LL-4*DE)+36.124*FNSI(3*LL)-3
0.773*FNSI(2*LL-4*DE)+28.475*FNSI(LL-ELP-2*DE)-24.42    *FNSI(ELP+2*DE)
1551 LP(5)=18.609*FNSI(LL-DE)+18.023*FNSI(ELP+DE)+14.577*FNSI(LL-ELP+2*D
E)+14.387*FNSI(2*LL+2*DE)+13.902*FNSI(4*DE)-13.193*FNSI(3*LL-2*DE)+9.703
*FNSI(2*LL-ELP)+9.366*FNSI(LL-2*FF-2*DE)-8.627*FNSI(2*LL+ELP-2*DE)-8.466
*FNSI(LL+DE)
1552 LP(6)=-8.096*FNSI(2*ELP-2*DE)-7.649*FNSI(2*LL+ELP)-7.486*FNSI(2*ELP
)-7.412*FNSI(LL+2*ELP-2*DE)-6.382*FNSI(LL-2*FF+2*DE)-5.741*FNSI(2*FF+2*D
E)-4.391*FNSI(LL+ELP-4*DE)-3.996*FNSI(2*LL+2*FF)+3.215*FNSI(LL-3*DE)-2.9
21*FNSI(LL+ELP+2*DE)
1553 LP(7)=-2.74*FNSI(2*LL+ELP-4*DE)-2.494*FNSI(2*LL-ELP-2*DE)+2.58*FNSI
(LL-2*ELP)+2.533*FNSI(LL-2*ELP-2*DE)-2.152*FNSI(ELP+2*FF-2*DE)+1.979*FNS
I(LL+4*DE)+1.938*FNSI(4*LL)-1.877*FNSI(ELP-4*DE)+1.75*FNSI(2*LL-DE)
1554 LP(8)=-1.44*FNSI(ELP-2*FF+2*DE)-1.298*FNSI(2*LL-2*FF)+1.267*FNSI(LL
+ELP+DE)+1.225*FNSI(2*LL-3*DE)-1.187*FNSI(3*LL-4*DE)+1.181*FNSI(2*LL-ELP
+2*DE)-1.167*FNSI(LL+2*ELP)-1.089*FNSI(LL-ELP-DE)+1.06*FNSI(3*LL+2*DE)
1556 LP(9)=-.992*FNSI(LL+2*FF+2*DE)-.952*FNSI(4*LL-2*DE)-.570*FNSI(2*LL-
6*DE)+.636*FNSI(LL-4*DE)+.560*FNSI(ELP-DE)+.757*FNSI(LL-2*ELP+2*DE)-.586
*FNSI(2*LL+DE)
1557 LP(10)=.584*FNSI(2*FF-DE)-.551*FNSI(3*LL+ELP)+.681*FNSI(3*LL-ELP)+.
557*FNSI(2*LL+2*FF-2*DE)+.538*FNSI(2*LL-2*FF-2*DE)
1560 PT=LP(1)+LP(2)+LP(3)+LP(4)+LP(5)+LP(6)+LP(7)+LP(8)+LP(9)+LP(10)
1565 'All of the above perturbations are in seconds of arc and must be
     converted to degrees by dividing by 3600.
1570 PT=PT/3600
1580 LO=ML+PT
1590 MO=360:LO=FNMO(LO):LO=LO+NU
1600 GOSUB 1360
1610 PRINT "Moon";INT(LO);INT(MI);SE
1615 'What follows are two sets of perturbations that lead to latitude.
     The first set is applied to FF, while the second set is applied
     directly to the latitude.
1620 PL(1)=22609*FNSI(LL)-4578.1*FNSI(LL-2*DE)+2373.4*FNSI(2*DE)+768*FNS
I(2*LL)+192.7*FNSI(LL+2*DE)-182.4*FNSI(LL+ELP-2*DE)-165.1*FNSI(ELP-2*DE)
-152.5*FNSI(2*LL-2*DE)-138.8*FNSI(ELP-LL)-127*FNSI(ELP)-115.2*FNSI(LL+EL
P)
1630 PL(2)=-112.8*FNSI(DE)-85.1*FNSI(2*FF-LL)-52.1*FNSI(2*FF-2*DE)+50.64
*FNSI(3*LL)-38.6*FNSI(LL-4*DE)-34.1*FNSI(2*LL-4*DE)
1640 FP=FF+(PL(1)+PL(2))/3600
1650 SCREW=(1-.00004664*FNCO(LN)-.0000754*FNCO(LN+275.05-2.3*T))*FNSI(FP
)
1655 'SCREW is an intermediate perturbation.  Beta is the latitude.
1660 BETA=(18519.7*SCREW-6.2*FNSI(3*FF))/3600
1670 P2(1)=-526.1*FNSI(FF-2*DE)+44.3*FNSI(LL+FF-2*DE)-30.6*FNSI(-LL+FF+2
*DE)-24.6*FNSI(-LL+FF)-22.6*FNSI(ELP+FF-2*DE)+20.6*FNSI(-LL+FF)+11*FNSI(
-ELP-2*DE)-6*FNSI(LL+FF-4*DE)
1680 BETA=BETA+(P2(1)/3600)
1690 GOSUB 1700:GOTO 2000
1695 'Subroutine 1700 converts a signed number to degrees and minutes.
1700 SN=SGN(BETA):BE=ABS(BE):DG=INT(BE):M1=(BE-DG)*60
1710 IF DG=0 THEN DG=.00000001
1715 DG=DG*SN
1720 RETURN
2000 !'LLLLLLLL +## ##.#
2010 PRINTUSING2000;"Latitude";DG;M1
2020 END
```

NEWSNOTE

Commodore has just announced spring delivery of the following equipment: a 16K PET in the $900 range and a 32K PET in the $1100 range as well as a PET with a standard sized keyboard. Also announced were three versions of the Commodore line printer including a $500 range electrostatic printer and a heavy duty tractor-feed model. Also announced are two disk systems for spring 1979 delivery. A $500 range single floppy disk with about 170K and a dual-disk with 340K for around $1000. These disks are able to use the BASIC in ROM in the PET rather than requiring RAM use for the language. Also their user-manual is at last ready.

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The determination of the 'Julian Day Number'

The conversion from a given date to its corresponding 'Julian Day Number' (abbreviated: JD) is the first problem one encounters when preparing astronomical data. The 'Julian Day Number' is defined to be 0 for the day starting at 12 h Universal Time (UT) on January 1, 4713 B.C. (or -4712 in astronomical notation, because there was no year 0) and represents a continuous count of days, each of them containing exactly 24 hours according to the standard definition of the second used to determine the time scale UT1 (UT1 is synonymous to UT). This second is defined by the (somewhat irregular) rotation of the earth. Therefore JD is, strictly speaking, not a uniform count as compared to atomic clocks. Such clocks determine the 'Coordinated Universal Time' (UTC) which is broadcasted. Because of the secular terms in the change of the rotation of the earth, UT and UTC would differ more and more with time, but this discrepancy is avoided with the help of 'leap seconds' applied to UTC whenever the two time scales differ more than about 0.7 seconds. Another time scale, the 'International Atomic Time' (IAT) is physically the same as UTC but not 'disturbed' by leap seconds. Thus UTC and IAT differ by an integral number of seconds always. IAT is not uniform too because it is measured and every measurement involves uncertainty. However, it is the best time scale available. 'Ephemeris Time' (ET), on the other hand, is strictly uniform in a mathematical sense, thus an idealisation. It can be measured only indirectly by comparing the calculated position of a celestial object (fundamental time argument: ET) with its actual position (UT). The difference of these two scales represents the nonuniformity of the rotation of the earth. The fact that the difference between ET and IAT is not always the same suggests, however, that the gravitational theories of the planets (and especially those of Sun and Moon) are still poor, or, that there are nongravitational forces acting on the planets which are not part of the theories.

If an event is given in 'Greenwich Time' (GT), this is equal to UTC and this in principle must first be converted to UT (the shift is never more than plus or minus 0.7 seconds and may therefore be neglected). UT is then converted to ET in the usual manner. After having obtained JD_0 for the given date at midnight, the 'Julian Ephemeris Day Number' (JED) is then obtained by adding ET/24.

Whenever an event is given in 'Greenwich Mean Time' (GMT) one must be very careful. In the 'American Ephemeris' (AE) and in the 'Nautical Almanach' (NA) this means time counted from noon prior to 1925, whereas in the NA it means time counted from midnight after 1925. In the AE the term 'Greenwich Civil Time' (GCT) was adopted for dates from 1925 which counted time also from midnight. Therefore the astronomical date December 31.5, 1924 designated the same instant as January 1.0, 1925 (= January 1, 1925, 0 h UT). Today only UT is in use, fortunately, which counts time from midnight. If it is necessery to reckon time from noon in our times, the designation 'Greenwich Mean Astronomical Time' (GMAT) should be used.

The Julian Day Number at midnight JD_0 may be computed by one of the following formulas (D = Day, M = Month, Y = Year):

Egyptian Calendar (Ptolemy's System)

$$JD_0 = 1448241.5 + 365\cdot Y + 30\cdot M + D$$

Alexandrian Calendar

$$JD_0 = 1824633.5 + 365\cdot Y + 30\cdot M + D + \left[\frac{Y}{4}\right]$$

Muslim Calendar

$$JD_0 = 1948054.5 + 354\cdot Y + \sum_{i=1}^{11}\left[\frac{Y + 29 - R_i}{30}\right] + 29\cdot M + \left[\frac{M}{2}\right] + D$$

uncertainty: plus or minus one day, $R_1, \ldots R_{11}$: 2, 5, 7, 10, 13, 16, 18, 21, 24, 26, 29.

Persian Calendar

$$JD_0 = 1951666.5 + 365\cdot Y + 30\cdot M + D + 5\left[\frac{M}{9}\right]$$

The Greek Calendar is somewhat similar to the Egyptian Calendar and the procedure can be found in Robert R. Newton: 'Ancient planetary observations and the validity of ephemeris time', where I also have taken the other formulas from.

Julian and Gregorian Calendar

a) Danby's formula

$$J_0 = D + \left[\frac{367\cdot m + 5}{12}\right] + \left[365.25\cdot(y + 4712)\right] - 2.5 \quad \text{(Julian Calendar)}$$

$$J_0 = J_0(\text{Julian Calendar}) - \left[\frac{y}{100}\right] + \left[\frac{y}{400}\right] + 2 \quad \text{(Gregorian Calendar)}$$

where: $y = Y + \left[\frac{M - 14}{12}\right]$, $m = 13 + 12\left\{\frac{M - 14}{12}\right\}$

b) Singleton's formula

$$J_0 = D + \left[\frac{m}{48}\right] + \left[\frac{365\cdot m + 2\cdot y + 7}{12}\right] - 32083.5 \quad \text{(Julian Calendar)}$$

$$J_0 = J_0(\text{Julian Calendar}) + \left[\frac{m}{4800}\right] - \left[\frac{m}{1200}\right] + 38 \quad \text{(Gregorian Calendar)}$$

where: $m = 12\cdot(Y + 4800) + M - 3$, $y = m - \left[\frac{m}{12}\right]\cdot 12$

Gregorian Calendar (Formulas valid only in a limited time interval)

a) Isaacson's formula

$$JD_0 = D + \left[365.25\cdot y\right] + \left[30.6\cdot m\right] + 1720981.5$$

where: $y = Y + \left[\frac{M - 14}{12}\right]$, $m = 15 + 12\left\{\frac{M - 14}{12}\right\}$

validity: March 1, 1900 thru February 28, 2100

b) Seidelmann's formula (1)

$$JD_0 = D + 367\cdot Y - \left[\frac{7\cdot(Y + \left[(M + 9)/12\right])}{4}\right] + \left[\frac{275\ M}{9}\right] + 1721014 - 0.5\ \text{sign}(100\ Y + M - 190002.5)$$

validity: March 1, 1800 thru February 28, 2100

c) Seidelmann's formula (2)

$$JD_0 = D + \left[\frac{1461\cdot(Y + \left[(M-14)/12\right])}{4}\right] + \left[\frac{367\ (M - 2 - 12\left[(M-14)/12\right])}{12}\right] + \left[\frac{24002 - 12\cdot Y - M}{1200}\right] + 1721073.5$$

validity: March 1, 1600 thru February 28, 2100

The following abbreviations were used:

$[a]$ = integral part of a , $\{a\} = a - [a]$ = fractional part of a

Some BASIC's produce -2 out of INT(-1.5) which produces useless results when applied to the above formulas (Example: WANG-BASIC; however, WANG provides also a function called FIX which produces the required results, namely FIX(-1.5) = -1). Check this before using the calendar routines!

In some cases it may be required to convert the 'Julian Day Number' at midnight JD_0 to the corresponding date. I have found only one formula of this kind and modified it a little for our purposes. The formula is due to Isaacson and applies to the Gregorian Calendar.

First compute the following auxiliary constants:

$x = JD_0 - 1720981.5$ (Note that $\{JD_0\}$ must always be equal to 0.5)

$y = \left[\frac{x - 122.9}{365.25}\right]$, $m = \left[\frac{x - [365.25\cdot y]}{30.6001}\right]$

Then the day (D), month (M) and year (Y) are given by:

$D = x - [365.25\cdot y] - [30.6001\cdot m]$, $M = 1 + 12\left\{\frac{m - 2}{12}\right\}$, $Y = y + \left[\frac{m - 2}{12}\right]$

validity: JD 2415079.5 thru JD 2488127.5

This formula is very useful when generating planetary ephemerides by means of numerical integration whenever not only the 'Julian Day Number' but also the civil date should appear in the print out. It would be a nice job to extend its validity.

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E. Isaacson: Days to dates and dates to days, HP-65 Library, No. 00256A

Almanac for computers 1978, NA Office, US Naval Observatory, p. B2

Oesterwinter, C. and Cohen, C. J.: New orbital elements for moon and planets, Celestial Mechanics, 5 (1972), p. 327

A REVERSE JULIAN DAY NUMBER ROUTINE

The following FORTRAN subroutine was sent by James Neely to add to those of Alexander Borg. It is authored by Henry F. Fliegel of Georgetown University Observatory, Washington, D.C. and Thomas C. Van Flandern of the U.S. Naval Observatory in Washington, D.C. 20390

```
INVERSE JULIAN DAY NUMBER ROUTINE
FORTRAN SUBROUTINE

L=JD+68569
N=4*L/146097
L=L-(146097*N+3)/4
I=4000*(L+1)/1461001
L=L-1461*I/4+31
J=80*L/2447
K=L-2447*J/80
L=J/11
J=J+2-12*L
I=100*(N-49)+I+L
RETURN
END
```

BASIC TRANSLATION

(here it is in BASIC for micro fans)

```
 100 INPUT"JULIAN DAY NUMBER";JD
 110 L=JD+68569
 120 N=INT(4*L/146097)
 130 L=L-INT((146097*N+3)/4)
 140 I=INT(4000*(L+1)/1461001)
 145 L=L-INT(1461*I/4)+31
 150 J=INT(80*L/2447)
 160 K=L-INT(2447*J/80)
 170 L=INT(J/11)
 180 J=J+2-12*L
 190 I=100*(N-49)+I+L
 199 REM J=MONTH, K=DAY, I=YEAR
 200 PRINTJ;K;I
 210 RETURN
READY.
```

A note from Alexander Borg. " Note that the equations given in the paper enclosed cannot be read correctly without stating that these are FORTRAN statements involving integer arithmetic only. That means, the statements must be executed from left to right (with the usual priority rules) and after every division the part result is truncated as if there would be an IFIX function. For instance, K = L - 2447*IFIX(FLOAT(J)/80.), or, in our notation: K = L -[2447* J/80].

COSMECOLOGY BULLETIN

Special Double Issue (#8 & 9)

Published in early 1979 at $5 postpaid. Articles by Dr. Ralph Metzner, Dr. Marvin Layman, Thomas Shanks, Annette Rubin, Helen Ramsey, Charles Jayne (Editor), Michael Erlewine, Malcolm Dean. A long full account of the extraordinary repetition of the Vernon Clark Experiment by Dr. Joseph Vidmar and a Johndro reprint too.

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BASIC Translations of the Julian Day Number Routines
see Alexander Borg's (page 48) article

```
  1 REM BASIC TRANSLATIONS OF JULIAN DAY NUMBER ROUTINES
  3 REM
  4 REM FUNCTION FOR INTEGRAL PART
  5 DEFFNI(X)=SGN(X)*INT(ABS(X))
  6 REM FUNCTION FOR FRACTIONAL PART
  7 DEFFNF(X)=X-FNI(X)
  8 REM
 10 INPUT"M,D,YYYY";M,D,Y
 20 REM
 49 REM DANBY'S FORMULA
 50 YY=Y+FNI((M-14)/12):MM=13+12*FNF((M-14)/12)
100 JD=D+FNI((367*MM+5)/12)+FNI(365.25*(YY+4712))-2.5
115 PRINT"JULIAN=";JD
120 JD=JD-FNI(YY/100)+FNI(YY/400)+2
130 PRINT"GREGORIAN=";JD
140 REM
199 REM SINGLETON'S FORMULA
200 MM=12*(Y+4800)+M-3:YY=MM-FNI(MM/12)*12
210 JD=D+FNI(MM/48)+FNI((365*MM+2*YY+7)/12)-32083.5
220 PRINT"JULIAN=";JD
230 JD=JD+FNI(MM/4800)-FNI(MM/1200)+38
240 PRINT"GREGORIAN=";JD
250 REM
299 REM ISAACSON'S FORMULA (VALID MARCH 1, 1900 THRU FEB 28, 2100)
300 YY=Y+FNI((M-14)/12):MM=15+12*FNF((M-14)/12)
310 JD=D+FNI(365.25*YY)+FNI(30.6*MM)+1720981.5
320 PRINT"GREGORIAN=";JD
330 REM
398 REM SEIDELMANN'S FORMULA (1)
399 REM VALID MARCH 1, 1800 THRU FEB 28, 2100
400 JD=D+367*Y-FNI((7*(Y+FNI((M+9)/12)))/4)+FNI(275*M/9)+1721014
410 JD=JD-.5*SGN(100*Y+M-190002.5)
420 PRINT"GREGORIAN=";JD
430 REM
498 REM SEIDELMANN'S FORMULA (2)
499 REM VALID MARCH 1, 1600 THRU FEB 28, 2100
500 JD=D+FNI((1461*(Y+FNI((M-14)/12)))/4)
505 JD=JD+FNI((367*(M-2-12*FNI((M-14)/12)))/12)
510 JD=JD+FNI((24002-12*Y-M)/1200)+1721073.5
520 PRINT"GREGORIAN=";JD
530 REM
597 REM REVERSE JULIAN DAY NUMBER FORMULA
598 REM VALID MARCH 1, 1900 THRU FEB 28, 2100
599 INPUT"JD#=";JD
600 X=JD-1720981.5:Y=FNI((X-122.9)/365.25)
605 MM=FNI((X-FNI(365.25*Y))/30.6001)
610 D=X-FNI(365.25*Y)-FNI(30.6001*MM)
615 M=1+12*FNF((MM-2)/12)
620 Y=Y+FNI((MM-2)/12)
625 PRINT"DATE=";M;D;Y
630 END
READY.
```

Malcolm Dean says that the CHIRON EPHEMERIS is off the press and ready to ship.

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Your BASIC Astrology

This section of MATRIX is devoted to the techniques of programming astrology in the programming language BASIC. Readers are encouraged to share in this project. Send us your programming 'quickie' or valuable subroutine and share it with others through this column. The editors are working to assemble a large astrological programming manual to be made available to readers. Let us hear from you.

SORTING ROUTINES

One of the most important items in a programmers library of subroutines (particularly in astro-programming) is the SORT routine. Sorting may well be the slowest things that our lightning computers do. In all probability, more money has been spent in attempts to develop fast sorting routines than in any other area of program design. Here are two useful but different sorting routines of interest to astrologers. The first is the familiar 'Bubble' sort which is useful for sorting short lists of items such as planet's positions; the second is a Shell-Metzner sort that can be used for long lists such as midpoints.

The Shell sort requires more variable assignment and uses more program memory while the bubble sort is simple to use and takes little memory. Let's examine the Bubble sort first.

As mentioned, the bubble can be used for short sorts...of say...under 20 items. This sort is perfect for sorting planets into Zodiac order...or sorting parallels...harmonics and the like.

The listing on the right is in the PET Extended BASIC and should run on any of the modern BASICs with string handling. We have chosen to READ in the planet positions from data statements (line 600) but these values could be calculated elsewhere or input manually. The bubble sort is in lines 60-110. One of the problems astrologers face in sorting is that we not only want to sort things (planets)...we want to remember what each of these sorted values is. This is accomplished in lines 120-170 where each of the sorted values is compared to the planetary values in a known order..and the planet name derived and printed out along with the value.

360-degree/Decimal to Degree-Sign-Minutes

We have included a subroutine (lines 200-250) that converts a number from 360-degree/decimal to degrees-sign-minutes of Zodiac notation. This subroutine also displays the digits for numbers under ten with a preceding zero. Obviously, this Zodiac notation subroutine can be accessed for use in other parts of a program.

The subscripted variable X(I) is needed in the (unlikely) event that two or more planets should have identical values. If your memory space is tight, you might be able to get along without it. When you enter this code into your machine, you will want to throw out the REMARK statements and perhaps tighten up the lines (use multiple statements per line) to save space.

Bubble Sort and D-M-S Subroutines

```
 1 REM BUBBLE SORT/ DECIMAL > DEG-SIGN-MINUTES
 3 REM
 4 REM ROUNDS TO TWO PLACES
 5 DEFFNW(X)=INT(X*100+.5)/100
 8 REM DIMENSION VARIABLES: K=SORT C=PLANETS
 9 REM C$=PLANET NAMES, Z$=ZODIAC NAMES, X=PRINT CHECK
10 DIMK(11),C(11),C$(12),Z$(12),X(11)
19 REM NN=TOTAL NUMBER TO BE SORTED
20 NN=11
29 REM FILL PLANET NAME STRINGS
30 FORI=1TO12:READC$(I),Z$(I):NEXTI
34 REM READ IN PLANETS POSITIONS (CAN BE CALCULTED ELSEWHERE)
40 FORI=1TONN:READC(I):NEXTI
49 REM TRANSFER C(I) VARIABLES TO K(I)
50 FORI=1TONN:K(I)=C(I): X(I)=0:NEXTI
59 REM THIS IS THE BUBBLE SORT
60 FORI=1TONN-1
70 FORJ=I+1TONN
80 IFK(J)>=K(I)GOTO100
90 K1=K(I):K(I)=K(J):K(J)=K1
100 NEXTJ
110 NEXTI
115 REM END OF BUBBLE SORT
119 REM THIS SECTION COMPARES TO GET PLANET NAME
120 FORI=1TONN
130 FORJ=1TONN
140 IFK(I)=C(J)ANDX(J)=0THENX(J)=1:GOTO160
150 NEXTJ
159 REM D-M-S, THEN PRINT PLANET STRING AND VALUE
160 GOSUB200:PRINTC$(J);Z$
170 NEXTI
180 END
199 REM SUBROUTINE TO CONVERT 360/DECIMALS TO D-M-S
200 Z3=INT(K(I))
209 REM ZODIAC SIGN
210 Q=INT(Z3/30)+1
219 REM DEGREES IN SIGN
220 Z$=STR$(INT(FNW((Z3/30-INT(Z3/30))*30)))
225 IFVAL(Z$)<10THENZ$="0"+RIGHT$(Z$,1)
229 REM MINUTES IN DEGREE
230 T$=STR$(INT(INT(((K(I)-Z3)*60)*10+.5)/10))
235 IFVAL(T$)<10THENT$="0"+RIGHT$(T$,1)
239 REM ASSEMBLE STRING
240 Z$=" "+RIGHT$(Z$,2)+" "+Z$(Q)+" "+RIGHT$(T$,2)
250 RETURN
499 REM DATA TO FILL PLANET STRINGS
500 DATASUN,AR,MON,TA,MER,GE,VEN,CA,MAR,LE,JUP,VI,SAT,LI,URA,SC,NEP
510 DATA 6A,PLU,CP,NOD,AQ,0,PI
599 REM PLANETARY POSITIONS JULY 18,1941 21:03 GMT
600 DATA115.8,53.5,97.4,139.9,9.1,71.9,56.02,59.3,175.4,123.7,175.8
READY.
```

The Shell-Metzner Sort

To the right is a fast Shell sort coupled with a midpoint routine by Charles Hocking from MATRIX ONE. These are hooked together so that the 45 major midpoints are calculated, sorted and listed out in three columns. Some of you may want to make use of the subroutine (given above) for conversion of degrees/decimals to Zodiac notation of Deg-Sign-Min and have the midpoints printed out in Zodiac notation rather then the 360-degress notation used in this program.

The Shell sort is in lines 5570-5900, the midpoint routine in lines 5530-5570 and the midpoint string routine in lines 5580-5590. The PRINT routine starts at line 6089.

The planet positions are read in at line 5010 but these can be calculated elsewhere and brought to this program section. Line 7120 makes use of the string format of the Commodore PET and this will be different for different machines. It makes sure that the midpoints are listed below the legend... starting at five lines below screen top.

Some More BASIC Notes

Those of you who are looking for an entrance into astrological programming...or those of you now using programmables who want to share programming information had better consider learning the BASIC language. Altho we will see alternative languages appearing in the next year or so (other than BASIC) ...such as PASCAL, FORTRAN and the like...BASIC is here to stay. Instead of growing weaker, BASIC is becomming stronger and more versatile by borrowing useful features from other languages (such as FORTRAN). The new BASIC HANDBOOK by Dr. A. Lien (author of TRS-80 Level I manual) claims to cover up to 80 BASIC dialects! We have received this book and it is a useful reference tool for those of you trying to translate BASIC from one dialect to another (say from SWTP to Microsoft).

The Radio Shack TRS-80 Level I manual by Dr. Lien is now available as a paperback intended for teaching the language BASIC to beginners— regardless of what machine they have. The parts of the books that related exclusively to the TRS-80 have been removed and this book can be obtained at your nearest Radio Shack dealer.

Before I received my BASIC machine (PET), I attempted to learn from a pile of BASIC books...and while many happy hours can be passed pouring over such books...nothing beats hands-on experience for learning to program.

We are in the process of assembling a large collection of subroutines, algorithms and so forth (most of which will appear in various issues of MATRIX). We will try to link all of these routines together and create a beginning text for astrologers to learn the BASIC language. This book will not start from the absolute beginning level..but instead will be oriented toward the user who knows a little BASIC (loops, variables, etc.) and wants to begin to link various astrological subroutines together into full programs.

A SHELL-METZNER SORT FOR MIDPOINTS

```
4999 REM M$=MIDPOINTS, C$=PLANET NAMES, C=PLANETS
5000 DIMM$(46),C$(12),C(12)
5004 REM N=NUMBER OF POINTS TO BE SORTED
5005 N=45
5009 REM FILL PLANET & PLANET NAME STRINGS
5010 FORI=1TO11:READC(I),C$(I):NEXTI
5049 REM DETERMINE MIDPOINT
5050 NN=10:A=1:FORI=1TONN
5060 FORJ=I+1TONN
5530 W=0:Y=ABS(C(I)-C(J)):IFY<=180THENGOTO5570
5540 W=180
5550 IF(C(I)+C(J))/2<180GOTO5570
5560 W=-180
5570 Y=(C(I)+C(J))/2+W
5580 Y=INT(((Y*100)+.5)/100)
5589 REM FORM MIDPOINT STRING
5590 M$(A)=RIGHT$("   "+STR$(Y),3)+" "+LEFT$(C$(I),2)+"/"+LEFT$(C$(J),2)
5600 A=A+1:NEXTJ
5610 NEXTI
5769 REM BEGIN SHELL-METZNER SORT
5770 M=N:PRINT"WORKING ON MIDPOINTS"
5780 M=INT(M/2)
5790 IFM=0THEN
5800 J=1:K=N-M
5810 I=J
5820 L=I+M
5830 IFVAL(M$(I))<VAL(M$(L))THENGOTO5880
5840 M$=M$(I):M$(I)=M$(L):M$(L)=M$
5850 I=I-M
5860 IFI<1THEN5880
5870 GOTO5820
5880 J=J+1
5890 IFJ>KTHEN5780
5900 GOTO5810

6089 REM PRINT OUT MIDPOINTS IN THREE COLUMNS
7090 PRINT"********** MIDPOINT SORT **********":PRINT
7100 PRINT"DEG MIDPT    DEG MIDPT   DEG MIDPT"
7110 PRINT
7118 REM "SQQQQQ" IS A PET SCREEN FORMAT STRING AND
7119 REM STARTS PRINTING 5 ROWS DOWN FROM SCREEN TOP
7120 Y=0:A=1:FORI=1TO3:PRINT"SQQQQQ";
7130 FORJ=1TO15
7140 IFNN=9ANDA>36GOTO7160
7150 PRINTTAB(Y);M$(A):A=A+1
7160 NEXTJ
7170 Y=Y+12:NEXTI
7180 END
8000 DATA115.8,SU,53.5,MO,97.4,ME,139.9,VE,9.1,MA,71.9,JU,56.02,SA,59.3,UR
8010 DATA175.4,NE,123.7,PL,175.8,NO
READY.
```

HANDSHAKING DEPARTMENT

MATRIX TWO is really great. It is a valuable source of reliable information. Thank you very much for conveying it. Your introduction to the terms used in orbit determination is clear and easy to read. You should continue this way.

I have been very engaged in preparing the publication of RELATIONS BETWEEN THE SECULAR CYCLE OF SOLAR ACTIVITY AND THE SUN'S MOTION ABOUT THE CENTER OF MASS OF THE SOLAR SYSTEM. The astronomical institutes of the universities of Goettingen and Frankfurt advised a publication of the material which was the subject of several colloquium discussions....I think that these results are very important for astrology because this is a proof acknowledged by scientists showing clearly that just the outer planets including Pluto play a vital role in the solar system. I was in the position to show that there is a hidden structure behind the sun's motion around the center of mass which is resembling the information structure of DNA in cell nuclei. The structure can be traced back for thousands of years and is related to the secular cycle of solar activity which can be predicted with high precision now.

Best wishes

Theodor Landscheidt
Im Dorfe 14
2804 Lilienthal-Klostermoor
Fed. Republic of Germany

I'm sure you are aware of what your undertaking means for astrologers— and for astrology: it has to be the most useful thing to emerge in centuries. It may be because I have no math background but I'm still squeezing more out of MATRIX I and II and never cease to be amazed at how much I can squeeze into my TI-59!

One suggestion. I was a little perplexed at one issue aimed at HP users and the other at the TI persuasion; while I could use all the help I can get with the actual programming I'd appreciate even more both the formulae behind the programming as well as some clear examples. This is not offered as a criticism because if anything I got more out of your first issue than I did from MATRIX II which was more immediately intelligible to me.

And beyond that: keep it up!

Sincerely,

Ray Tetrault
269 Arch St.
Laguna Beach, CA 92651

I think MATRIX is great! However, I have some quibbles with your version of "terms used in orbit determination".

Eccentricity is not measured in radians. It is a dimensionaless number— a ration between two distances.

You reverse most and least inclined from the way of speaking I am familiar with— least meaning the smallest angle...Figure 1 is missing a label "E".

I also noticed a typo on page 33 where you say JED 2433280.5 is December 31, 1950 at 0 hr. It isn't.

Despite the above, I am very impressed by your magazine and the programs you are making available. Keep up the good work!

Mark Pottenger
838 5th Ave.
Los Angeles CA 90005

PS I will send you some of my own programs if/when I get them commented.

[Editor's note: Thanks for pointing out the errors and we can hardly wait for some programs from the computing Pottenger family!]

Dear Mr. Erlewine,

..My congratulations on your latest endeavors in astrology, especially MATRIX and your forthcoming textbook. I am especially appreciative of your graphics quality— if others were as clearly attentive to such things...

Yours Sincerely,

Geoffrey Dean
RECENT ADVANCES
64 Coghlan Road
Western Australia

..MATRIX ONE and MATRIX TWO are most important parts of my astrological reference library, and I am certainly most grateful for your initiative in making this material available.

Sincerely yours,

Mr. E. Schary
4608 Westmont Blvd.
Akron, Ohio 44321

Dear Michael,

I have the copies of MATRIX and I continue to be enormously impressed by what you have accomplished...and Neely is a marvel...I have included my KOCH program for the SR-52 despite my present conviction that calculators should be abandoned forever. You and I were brought up on them and they have a certain nostalgia for me just as the slide rule has but the cold truth is that they should be consigned to the garbage in favor of the small computers which cost no more and which do an immeasurably better job. I agree that it is much easier to program the computer than the calculator so there seems no real reason to encourage their use.

Astrology programs for calculators are marvels of ingenuity and quite entertaining by themselves but they are, in a practical sense, unweildy and I honestly doubt that they are put to much use...so there is the evaluation of calculators you requrest...get rid of them!

I agree with you that BASIC will probably be with us for a long time. This pleases me even though superior languages may be available. I prefer standardization to constantly changing optimization and, from the personal computing standpoint, one's initial investment in equipment may well be his last if he's lucky. I hate to think that we might have to turn our computers in each September as we do our cars in order to stay abreast of progress. We should remember, I think, that the computers are a means to an end rather than an end in themselves to be sweated over for their own sake. My last two years have been entirely dedicated to fooling with the damned things and I have enjoyed it but I have accomplished little of my own real work.

Cordially,

John McCormick
Box 1413
Bloomfield, NJ 07003

[editor— Thank you John for these thoughts. Readers might like to know that John is in the process of building his own ZITAN-GRAPHIC computer system and owns a TRS-80 micro as well. As regards his comment about time spent on computers...I like to tell myself that after so many centuries of neglect a few years of technical and even mechanical concern is no great sin.]

PHENOMENA

The News Journal of Cosmic Influence Research

PHENOMENA 2.3-2.4 May-August 1978

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Lunation records, from Africa c. 6500 BC. This issue, **PHENOMENA** begins a special series of articles covering the many recent discoveries of ancient astrologies, far beyond what was formerly held to be the early limits of civilization and science. Bones such as these may very well be the earliest attempts to record celestial influences in the environment.

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Contents

4 News
Moons detected for Pluto, asteroid; Sun signs linked to personality; Water signs correlated to Jungian sensing-intuition scale; Electrical mechanism for solar weather cycles; Sunspots linked to manufacturing production; Physical evidence for chakras; Chiron defies distinction between asteroids, comets.

8 Editorial
Brave New Astrology

Letters

14 Science Briefs
Theory links ice ages, galactic arms; Earthquakes linked to Sun, Moon; Only 1 in 3 females have menstrual, mood cycles linked; Human spleen can regenerate.

16 Asteroids
Chiron may be just the beginning; Minor Planet Center begins new life.

Articles

18 Lunar Evidence in Plant Growth: A Review of the Evidence
Simon Best

22 Memorandum on the Relation of Mars' Solar Proximity to Gauquelin's Mars-Sports Results & Claims
Dennis Rawlins

27 Who Invented the Horoscope? The Chaldaean Background of Horoscopic Astrology
Robert Powell

29 Deciphering the Phaistos Disc (1)
Ruth Hale Oliver

33 Fate and Archetype: Reflections on a Sacred Astrology
Anne Bevan

35 Aspects of Egyptian Astronomy
Daniel Kolos

36 Interview
Geof Dean and Arthur Mather, of *Recent Advances in Natal Astrology.*

38 Astronomy
The Jehovah Factor; Will the universe last forever?
Terence Dickinson

42 Books
C.G. Jung Speaking; Astrology and the Law; Unfinished Animal, The Aquarian Frontier and the Evolution of Consciousness; The Secret of Atlantis, etc.

44 Contents
Major articles and features of journals in related fields from around the world

MATRIX SOFTWARE

We are assembling a collection of programs for a variety of different programmable (and non-programmable) calculators. We are in the process of doing this and cannot give you a very definitive list at this point.

Here are the Hewlett-Packard HP-67/97 programs we have available written by James Neely. These are all very well documented and include relavent equations and notes so they could be adapted to fit other machines.

These programs are available as xerox reproductions of the originals at a price of $4 per program (postpaid). The programs can be obtained already recorded on magnetic cards (ready to run) for an additional fee of $1.50 once the program itself has been ordered. Some of these programs have been published in issues of MATRIX and this has been indicated. Some programs may appear in future issues of MATRIX. Many of you have asked for these programs to be made available now for your professional use. Here they are:

HP-67/97 PROGRAMS by JAMES NEELY

HOUSE CUSPS- ALCIBUTUS I (classical) METHOD

HOUSE CUSPS- CAMPANUS METHOD

HOUSE CUSPS- CLASSICAL LOCI METHOD (PTOLEMY PER NOONAN METHOD)

HOUSE CUSPS- EQUAL HOUSE A (PTOLEMAIC) & M (MIDHEAVEN) METHODS

HOUSE CUSPS- KOCH (GOH) METHOD

HOUSE CUSPS- MERIDIAN (AXIAL, OR ALCIBUTUS II) METHOD

HOUSE CUSPS- MORINUS METHOD

HOUSE CUSPS- PLACIDUS APPROXIMATION METHOD

HOUSE CUSPS- PLACIDUS METHOD (EXACT)

HOUSE CUSPS- PORPHYRY METHOD

HOUSE CUSPS- REGIOMONTANUS METHOD

HOUSE CUSPS- TOPOCENTRIC METHOD

ALMUCANTAR/ECLIPTIC INTERSECTION & NONAGESIMAL ALTITUDE

ASPECTS & MIDPOINTS

ASPECTS & MIDPOINTS II

ASPECTS WITHIN ORB

DISTANCE VALUES

TRUE LUNAR NODE

LUNAR PARALLAX

MUNDOSCOPE (CAMPANUS)

MUNDOSCOPE (REGIOMONTANUS)

PLANETARY COORDINATES (*MATRIX II)

PLANETARY COORDINATES 1900-2000 (WITH RETROGRADE MOTION)

RIGHT ASCENSION & LATITUDE FROM LONGITUDE & DECLINATION

RIGHT ASCENSION, LATITUDE, & LONGITUDE FROM MC & ASCENDANT

SOLSTICE POINTS

SPECULUM-SEMIARC, ASCENSIONAL DIFFERENCES, ETC.

ASTRO 1: MEAN OBLIQUITY & GREENWICH S.T.

ASTRO 2: LUNAR NODE, NUTATION AND SVP

ASTRO 3: L.S.T., MIDHEAVEN & ASCENDANT

MATRIX 2

BACK ISSUES OF MATRIX MAGAZINE

Back issues of our magazine will be kept available. Here is a list of contents of the first two issues:

MATRIX ONE

Editorial
Notes on the First Issue
The Work of James Neely
HP-67/97 Programs ASTRO 1,2,3 by James Neely
HP-67/97 HOROSCOPE PROGRAM by M. Erlewine
COSMIC ORGANISMS by Theodor Landscheidt
ANGLES: AN ALGORITHM FOR HOROSCOPE CONSTRUCTION by Robert Knight
PLANETARY HARMONICS/POSITIONAL DIFFERENCES HP-67/97 by John Van Zandt
NON-LINEAR INTERPOLATION USING THE 2nd DIFFERENCE by Stephen Erlewine
ASPECT CALCULATION HP-67/97 by Noel Tyl
HARMONIC ASTROLOGY GUIDE HP-67/97 by Buz Overbeck
ASTROLOGICAL DATA PROCESSING:MIDPOINTS by Luci Titunik & Charles C. Hocking
THE NEW $600 COMPUTERS by Rob Hand & Pat White
THE PET & THE TRS-80 ..Editors
DIGICOMP'S DR-70: THE FIRST ASTROLOGICAL COMPUTER by Tim Smith
..And News, reviews and what-not

MATRIX TWO

THE DETERMINATION OF PLANETARY VELOCITIES AND RETROGRADE MOTION by James Neely
AN INTRODUCTION TO ORBIT DETERMINATION..Editors
ASTROLOGICAL ROUTINES FOR THE TI-59 PROGRAMMABLE CALCULATOR (LUNAR & PLANETARY COORDINATES) by James Neely
MEAN ORBITAL ELEMENTS— A DISCUSSION by Neely & Editor
THE ORBITAL ELEMENTS FOR THE MAJOR ASTEROIDS by James Neely
THE ORBITAL ELEMENTS FOR CHIRON by J. Neely
PLANETARY & LUNAR COORDINATES ON THE HP-67/97 PROGRAMMABLE CALCULATOR by J. Neely
A BASIC PROGRAM FOR PLANETARY & LUNAR COORDINATES by Michael Erlewine
AN INTRODUCTION TO THE COMPUTER LANGUAGE BASIC FOR ASTROLOGERS..Editor
...And News, Notes, Letters, etc.

MATRIX ONE and TWO are $5 each (Postpaid)

CIRCLE BOOKS ASTROLOGICAL CALENDAR 1979

In our 11th year, the calendar contains an article reviewing pocket caclulators from the astrological-user's point of view. Included are a set of programs for doing astrology on a $5 4-function calculator (L.S.T, Solar Returns, etc)

Standard features on our calendar include Geocentric and Heliocentric Ephemerides of planets, asteroids and Chiron as well as daily times of moon transit, moon-sun angle, a complete aspectarian and much more.

put up by Michael & Margaret & Stephen Erlewine

POSTPAID 1979 is $3 to:

HEART CENTER/MATRIX
1041 N. Main St.
Ann Arbor, MI 48104

MATRIX SOFTWARE

We have a good number of programs for the PET and the TRS-80 (Level II) recorded on cassette and ready to ship out. We have 8K and 16K programs (and larger) as well as programs specifically formated for line printers. We are putting together a much more comprehensive catalog that will allow the user to choose from among many different options. Until then, this will give you an idea as to the kind of programs we will be making available.

All programs come with clear user-instructions and are sent by FIRST CLASS mail.

STANDARD NATAL PACKAGES

Most of our programs accept the standard birth or event data used by astrologers: birthdate, time and place along with the time zone. Programs are available in sidereal format too and many come with both options.

PET 8K NATAL CHART WHEEL. Output is an attractive wheel with planets in houses and birth data in wheel center. Your choice of one house system (Equal, Koch, Placidus, Campanus, etc.). Program lists major aspects for the planets, moon and lunar node too. A good place to start.

PET 8K GEO & HELIO PACKAGE. Geocentric and Heliocentric planetary positions plus your choice of houses systems. This program can be used with the Aspect Package and will pass the positions calculated to that program. Gives R.A.M.C and chart angles including Vertex.

PET 8K ADVANCED PACKAGE. Outputs Geo and Helio Longitude & Latitude; Right Ascension and Declination, Azimuth and Altitude and positions of planets along the Prime Vertical in Vertical Position and Amplitutde. Angles (including Vertex) are calculated but no house cusps. Does a variety of Locality options including shifting the angles and also the planets positons along the Horizon and Prime Vertical, plots any R.A. celestial object on natal or shifted horizon.

PET 8K ASPECT PACKAGE. Can be used with the GEO & Helio program above or planet positions can be input by user. Output is aspect & midpoint grid, midpoints sorted by Zodiac or 360-Notation, and Harmonic options including any series of harmonics (user-selects orb) or any single harmonic. Harmonic planets are sort in zodiac order and conjuntions (within set orb) are indicated.

PET 8K TRANSITS. Erects radix and transit chart with angles and displays aspects and midpoints between the two charts. Aspect display includes indication as to Separating or Applying as well as degrees and minutes out-of a perfect aspect.

PET 8K SOLAR RETURNS. Calculates date & time for solar return and displays both Geo and Helio planet positions for return as well as your choice of 1) house cusps for moment of return or 2) radix house cusps adjusted to whatever locale the return is cast for.

PET 8K ASTEROIDS. Displays Wheel-of-Houses with planets, moon, lunar node and four major asteroids.

Most of our PET programs are in the process of being translated into TRS-80 format. January of 1979 should see most of this material (and more) available for both machines. We are also working on programs for the APPLE II and the HEATH H-8 as well as a large collection of program LISTINGS for those of you with other machines that use the BASIC language.

We have a number of authors working on special programs: Statistical & Research programs from Charles Hocking, a comprehensive ASTRODYNE package from John Molfese, a large TRS program from Rob Hand and others.

8K PET SOLAR ARC DIRECTIONS. Using a perturbed sun routine, this program does two basic things: 1) Choice of a date will allow user to scan time period around that date for solar arc directions that are due within that time period. Aspects found are listed along with date. 2) User-direct aspects (such as direct Venus conjunct the Sun by solar arc, etc.) will give date when selected aspect is due. Program will give major or major & minor aspects as well as chart angles (where appropriate)

16K TRS-80 NATAL PACKAGE. This is a large program that accepts birth data and gives choice of four Dimensions of coordinates at any time (1) Geocentric, (2) Heliocentric, (3) Right Ascension & Declination and (4) Horizon System of Azimuth & Altitude. Within any one of these dimensions user may select to view planets on (1) Chart wheel, (2) Aspect Grid with major and minor aspects along with totals for hard & soft aspects, (3) Midpoints sorted by Zodiac or 360-Notation, (4) Parallels sorted, (5) Planets sorted in Zodiac or 360-Notation. House system of your choice as well as Angles including Vertex plus locality options. Also sensitive points Part of Fortune and East Point too.

PET or TRS-80 PRINT 16K PACKAGE. This program is designed to work with a line-printer and will fill an 8½x11 page as follows. Prints a small rectangular chart wheel with house cusps and planets (birth information and S.T. in wheel center). To the right of this wheel are the Longitude & Latitude and Declination of the planets, Moon and positions of the Vertex, Part of Fortune and East Point. Beneath this is a dual aspect/midpoint grid that list midpoints in deg-Sign-minutes and major aspects (applying/separating..degrees and minutes away from true aspect). Where no major aspect is present, the angle between the two planets is noted. $40

Note: for $5 additional fee, we will program the above to list "ASTROLOGICAL SERVICES BY"..with your name, address and phone number in the upper right-hand corner.

PRICES for the above programs are $20 for 8K programs and $40 for 16K programs regardless of what machine they are written for. The above programs authored by Michael Erlewine. Outer body elements by James Neely are used.

Orders to: MATRIX SOFTWARE
1041 N. Main St.
Ann Arbor, MI 48104
phone: (313) 663-6677



Spring 1979

Issue Four MATRIX

Neely Letters 3 THE MAKING OF THE NEW CHIRON EPHEMERIS

James Neely 6 ON VECTORS, MATRICES, AND COORDINATE TRANSFORMATIONS

A. Two Dimensional Coordinates

B. Three Dimensional Coordinates

C. A Comprehensive Example

Roger Elliot 46 THE BIRTH OF STARLIFE

Charles S. Hocking 50 ASTROLOGICAL DATA PROCESSING: SOLAR ARCS

Robert Hand 54 NINE HOUSE SYSTEMS IN EXTENDED BASIC

inside front cover HANDSHAKING

5 ERRATA

2 NEW HARDWARE

58 OUTPUT: VARIABLE TABLE

Editors: Michael & Margaret Erlewine

1041 North Main Street ✧ Ann Arbor, Michigan 48104

Dear Friends,

...I'd also like, at this time, to pass along a few comments and ideas, keyed in to the 3 issues of MATRIX which I have:

James Neely's work: Outstanding! Superb!
Midpoints Subroutine (by C. Hocking, L. Titunik): Subroutines of this type are vital fare for the astrological computing enthusiast.
Comments concerning the uncertain quality of Texas Instruments products (MATRIX 3, p.3)
Very true (based on much grief with T.I. SR-50, an SR-51A and an SR-52).
The question concerning the immediate accessibility of material in MATRIX to the general astrological public (MATRIX 3, p.3): It appears that the central matters at issue here are really economics and an appraisal of priorities. Costs, of course, set the ceiling on the size of the publication. If inclusion of tutorial material on astronomy and the mathematics of astrology required that material central to the main purpose and them of MATRIX be deleted, due to space limitations, then opposition to the inclusion of such tutorial material could be understood. It seems, however, that a certain amount of material of a nature which really amounts to tutorial material on hardware has been appearing in MATRIX. Just as a suggestion, might it not be possible to cut back on some of the material currently devoted to hardware (much of which is also available in publications such as BYTE, KILOBAUD, PERSONAL COMPUTING, INTERFACE AGE, etc., and in an ever-increasing flood of paperback texts on home computing) and devote the vacated available space in MATRIX to tutorial material on astronomy and the mathematics of astrology (which is not available elsewnere)? ...Besides, tutorial material of this nature is truly more in harmony with the central theme of MATRIX, and should therefore appear in MATRIX. A few pages devoted to tutorial material on astronomy and the mathematics of astrology, appearing from time to time in MATRIX (and which can later be assembled into a separate text) would be of immeasurable benefit to the rank beginner (and also to the not-so-rank, more "advanced" student, who might have some gaps in his command of these topics). I do hope that you will agree that the suggestion has merit, and that such material will appear in MATRIX,— the need is very definitely there, and MATRIX should be the vehicle for its publication...

Very sincerely yours,

Mr. E. Schary
4608 Westmont Blvd.
Akron, OH 44321

[EDITORS NOTE: We thank Mr. Schary for his detailed and fascinating letter which epitomizes the current response as to the future direction of our magazine.]

Dear Michael & Margaret,

...MATRIX 3 has arrived here and I'm delighted to have it though, to me without a micro, its greatest value shouldbe manifested in and through its future use as a reference and teaching aid. PLEASE keep MATRIX a highly technical journal and resist the plea for broad base popularity.

Am glad to see Neely getting the recognition due to him for the benefits he has brought to our people.

Respects & Best Wishes,

Arthur Blackwell
329 E. 5th St., Apt. B
NYC, N.Y. 10003

Dear Michael,

...Your idea for an "Algorithm Library" fascinates me. I only wish one was available when I began. I only hope that this doesn't restrict your readership to those who are algebraically inclined. If you are self taught, as I am, you are aware of the time and dedication it takes to overcome the "parenthesis phobia." (Know what I mean?) j; where j = joke.

Warmest regards,

Buz Overbeck
9470 Forest Springs, Suite 196
Dallas, Texas, 75243

Dear Michael,

...The PET computer is busy; it is working in the field of predictions of solar activity... What do you think of a node program including the interpretations of my node book? In my opinion the mean positions of the nodes are more important than the true nodes; I did not get good results with the moon's true node. Perhaps the mean positions, around which the true positions are osculating, have a center-function. I could write a program too yielding reliable primary directions not yet published...Cordially,

Theodor Landscheidt
2804 Lilienthal-Klostermoor
Im Dorfe 14
Federal Republic of Germany

[EDITOR'S NOTE: Dr. Landscheidt's reference to a node book is to his book on geocentric planetary nodes (GEOZENTRISCHE PLANETENKNOTEN) not yet published in English. We have his permission to publish portions of this book in a future edition of MATRIX but have need of a reader to finish up with the translation from German to English. Any takers? We also hope to report on Dr. Landscheidt's very important work on solar activity soon.]

Dear Michael,

Thank you for your prompt reply to my request. I would be pleased to receive issues 2 and 3 of your magazine plus information on succeeding issues...

These magazines and their contents seem to be just the thing we need, and I am looking forward to receiving them. Thank you for your assistance and best regards to you and yours...

David V. Smith
Computing Section
The Royal Astronomical
Society of New Zealand
23 Forfar St
Christchurch 1, New Zealand

MATRIX:

FEEDBACK: seems like a valuable mag: has already saved me many man-days of blind stumbling! and has given me access to equations that would take me months to figure out, and I would still end up with something quite unweildy...

Paul Galioni
130 Cement Hill Rd.
Nevada City, CA 95959

Dear Sir or Madam,

...Although I am a rank amateur, I liked very much MATRIX nos. one and two, and I think the magazine fills a real need of astrologers and would-be astrologers, like myself. The vast majority of your magazine is completely over my head; hopefully somewhere I will be able to find a decent bibliography suitable for beginners such as myself so that I might understand more of your publication. If you have any suggestions, I'd be pleased to hear them. Thank you,

Michael J. Gowen
1234 21st St.
Santa Monica, CA 90404

[EDITOR'S NOTES: We could use some annotated bibliographies from readers suggesting beginning reading in all of the areas covered by MATRIX. I would like to see some simple examples of BASIC programs that do some of the traditional astrological chores like the calculation of Local Sidereal Time and so forth. These should have extensive redundant remarks that show how very easy programming can be. I do agree with Buz Overbeck's remark on the other side of this page about "parenthesis phobia". I like to believe that programming is not in itself difficult at all..but it is time consuming. Programming... whether of astrology or games or anything takes about the same amount of time— A LOT.]

MATRIX

MATRIX is a periodical in the real sense of the word. About four issues a year can be expected with a single copy price of $5 each ($6 first-class) POSTPAID. MATRIX is produced and edited by Michael & Margaret Erlewine. phone (313) 663-6677

MATRIX PUBLICATIONS
1041 N. Main St.
Ann Arbor, Michigan 48104

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Here is MATRIX number FOUR. We hope you like it. Many of you have phoned or written about the format you would like to see in future issues of our magazine. Thanks for the response! The letters in the HANDSHAKING department will give you some idea as to the general consensus of opinion on this subject but I would like to sum it up and to outline some of the areas of disagreement among readers.

First of all, everyone agrees that they would like to keep MATRIX as un-dated as possible. What this means is that we will attempt to keep our news and advertising to a minimum. We have decided to cut out all advertising from the pages of MATRIX with the exception of exchange ads with other periodicals...and of course a few ads of our own.

There is fast and furious disagreement among the owners of the various programmables about the inclusion of too many programs devoted to the brand that they dont happen to own. Thus the Hewlett-Packard owners cry out at seeing so much space devoted to the Texas Instruments (TI) 59 and the TI-59 owners moan about so many programs in the HP code... and so on. Most programmable owners agree that all of the present machines will be dated in five years and that these portions of MATRIX will gradually become less and less useful.

There is almost total agreement that the prime factor in publishing an article in MATRIX should be the Algorithm or Equation first and the machine upon which the equation is implemented second.

Therefore, let it be known that what we would like from readers in terms of articles is a presentation of the algorithm or equation involved in any operation along with a clear and numerical example.

There were many letters similar to the note from Arthur Blackwell (see HANDSHAKING) to the effect that readers would prefer a small readership and a highly technical format as opposed to a wide readership and a more popular approach. The editors are in total agreement with the readers on this point and we will continue to insist upon material for MATRIX of a somewhat sophisticated nature. Keep in mind tho that this means that we will have to be content with our Xerox production and spiral bindings. Also we will continue to notify you when each issue is ready and wait for your money to roll in before we commit ourselves to our Xerox printer.

Another very important point is that aside from a few ...we have received almost no articles from our readers. This puts a heavy burden on people like James Neely, Robert Hand and so forth. I dont feel they mind..and I believe that the lack of articles reflects our general ignorance of this subject rather than a lack of interest. What this means in terms of future MATRIX format is that we will be taking a somewhat more tutorial approach than we have in the past. This will involve more diagrams and introductory material. Starting with MATRIX FIVE James Neely will be doing a regular column on House Systems and other spherical problems of astrology. The editors will be changing our BASIC ASTROLOGY subroutines..to include line-by-line variable printouts of a worked example. Again, the emphasis will be to see that MATRIX is a Library or depository of the equations and techniques essential to astrology with as little dated material— whether that be news or machine-code, etc— as possible.

Let me outline some of the problems involved in making MATRIX as non-dated as possible. First of all, we are going to lose the reader who pursues MATRIX in order to find specific programs ready to run on their particular machine but who is not interested in the rest of our subject matter. This brings me to another important matter (at least from the point of view of your editors)..that being: MATRIX the software company as separate from MATRIX the publication.

As most of you know, we are attempting to provide a variety of ready-to-run programs that do astrology for astrologers. This has grown in recent months from a very small operation to one involving all kinds of business experience we dont have. We are having fun learning about the business world and expanding this part of our operation. We want to keep MATRIX the company a distinct entity from the magazine. We feel that the software company is the appropriate place to offer ready-to-run programs for a variety of computers and programmable calculators. In fact we have been collecting all kinds of programs that do astrology and are putting together a catalogue that will be ready around summertime. We invite our readers to submit well-documented programs for the machine of your choice to be included in this catalog.

We feel that software authors should make something for their effort and we will pay a 50% of NET royalty on any program sold thru us. This means that after the expenses of producing your program (xerox, postage, labor, etc) are deducted we will split the remainder with the author. While you may not make a fortune it might be possible to at least pay for your subscription to MATRIX and make your programs available to others for use. In this way, those individuals who are interested in working programs only and not in programming can get what they want and the rest of us can have the more technical magazine that we desire.

We are going to advertise and promote our software company and we hope to have a wide selection of software available for almost every kind of calulator and computer by the fall. So if you have programs running on a machine and can stand the hassle of documenting them for others...please contact us. We have some fine programs by James Neely, Buz Overbeck and others. Charles Hocking is working on a statistical package in BASIC for astrologers, Robert Hand on a 32K program for the TRS-80 and so forth.

Now...on with some of the problems of MATRIX content. Some of you have complained about too much space being devoted to computer hardware news and the like. The complaint is that this is dated material and takes away from more "eternal" material. I feel that while this is a legitimate complaint it is not the case that all of this material is covered in computer magazines. The fact is that the astrologer has a very specific need and not every machine will suffice for astrological work. MATRIX THREE carried an introduction to some of these concerns and we will not need to repeat that. As an editor, I do insist on keeping the readers informed as to what equipment on the market will do the job..where to get it..what peripherals will work and so forth. Some of you with computer background have learned all of this long ago..but the majority of astrologers know nothing about computers or their peripherals. It will be a concern of MATRIX to provide at least minimum information on the current systems on the market. We want to facilitate the arming of astrologers with computers and this cannot be done only thru software and programming. We must include some sort of tutorial material about what kind of computer systems will do what kind of astrology. Which brings me to another point. We have received hundreds of letters asking for endless specific answers to what appear as thousands of questions about computers and programming. MATRIX was first formed to try to alleviate some of this work . We are just too far behind in answering many of these letters. What I suggest is the following: If you have a very specific series of questions, call us on the phone during working hours (EST 7:30 AM- 5:00 PM) and ask for Michael Erlewine (313-663-6677). I will be glad to attempt to answer the questions. If what you require is "all the information there is about computers and doing astrology on them"... send us $5 and I will

send you all of the information I can get together on prices, machines, specifications, interfaces and the like. This will eventually turn into our MATRIX SOFTWARE CATALOG but for now will include material on the most popular home computers as well as what software we have available for them. I cant think of any other solution to this need on the part of many of you for information. I feel it is important to look over what is available before making a decision..and spending a whole lot of money on a computer system. So.. to repeat myself..I will assemble in the next couple of weeks pictures of the PET, APPLE, TRS, OSI and the like along with my comments on what would be a minimum configuration for different levels of astrological work..plus all kinds of other information. I will take all of the material in my files and xerox the most useful data and get the whole batch xeroxed and spiral bind this together to form some kind of information package that you can send for..or .. which you can recommend to astrologers who are trying to make a choice of computer systems. This will save your doing what I have had to do...writing to the various manufacturers and so forth. So lets call it our Information Package at $5 ($6 firstclass).

So, to sum up: MATRIX will continue to be a small xerox produced journal with increased emphasis on the general equations used in astrology. MATRIX SOFTWARE will (we hope) grow and develop as the major outlet for astrological software. We hope our readers will continue to support our magazine with subscriptions and with articles. We would like to have your support as well for our software company. Now, lets move on to other news.

ASTROLOGY NOW: Special Computer Issue

In the last couple of months Noel Tyl the editor of ASTROLOGY NOW-which is the best all around general astrology magazine on the market— has purchased a Commodore PET computer and found it very much to his liking. Tyl has used the HP-67 programmable calculator for his chart work until now. He was quick to appreciate what the new home computers will mean for astrology and is devoting an entire issue of ASTROLOGY NOW (coming out around June) to this subject. The issue will contain articles by James Neely, Robert Hand, Charles Jayne, and others as well as something from your editors too. Everyone feels and Tyl as declared that 1979 will be the year of the computers in astrology. It sure looks like that is the case and that 1979 will see the home computer become a permanent part of modern astrology. I would go so far to say that the use of these home computers by astrologers will do more to raise the general level of astrological understanding than all of the books on astrology to date.

ASTROLOGICAL CONFERENCE ON TECHNIQUES

This title (A.C.T.) has been coined by Charles Jayne to describe the conference we are trying to get together. We will have to postpone the date for this event for several reasons. We had hoped to have it in late spring but there is too little time for publicizing the event...your editors are involved in changing their residence...and we dont have enough time to devote to the organizing of such a conference. Noel Tyl has promised to help us organize the conference in the fall and to promote it thru his magazine. We could use some suggestions as to what we would like to do at such a get together. Tyl has pointed out the need for beginning and advanced classes in programming both calculators and computers. Charles Jayne has suggested that we have a series of meetings headed by speakers and followed by smaller workshops. Some of the names suggested to date as principal speakers are James Neely, Charles Jayne, Robert Hand, Thomas Shanks of Astro-Computing, Arthur Blackwell, David Cochrane, Mark or Rique Pottenger..to name a few.

Both Malcolm Dean of PHENOMENA and Henry Weingarten of NASO have expressed interest in attending. What we need are some more ideas for seminars, workshops and the like..from our readers. We might be able to have the conference later in the fall (1979).

COMPUTER UPDATE

There is still no word from Texas Instruments concerning their entry into the home computer market. As might be expected, there are two opposing rumors: (1) that TI has decided not to enter the market just now and will wait a year or so...and (2) that the shortage of TI components on the market points to their being now in production of the new machines. Most recent rumor has it that they have decided to bring one out with their own color TV hook-up ..and this will raise the price to around $1000. We just dont know at this point. Before you rush out an buy one the moment they hit the market please be sure to check that the precision is at least 8-9 digits or better. Give us a call as we should have the pertinent information as to their use for astrological purposes.

TRS-80 RADIO SHACK

Radio Shack has come out with a number keypad alongside the regular TRS keyboard, a modem for computer-telephone communications and a voice synthesizer. They have dropped the price of extra memory a tad..but it is still much cheaper to get the memory from other sources. FORTRAN is now available for the TRS-80, Level II with disk. My local Radio Shack manager tells me that all of the different TRS options (except peripherals) will be available on-the-shelf within two months.

COMMODORE PET

Commodore is making a lot of moves fast..perhaps in anticipation of TI's new system or in response to Radio Shack. They are bringing out both a 16K and 32K machine with full standard typewriter-style keyboards. The 16K will sell at $995 and the 32K at $1195. They have also announced three 80-column printers (1) an electrostatic dot-matrix printer at $549, (2) a dot-matrix impact printer at $849 and (3) one with tractor-feed at $995. All printers print upper and lower-case and full PET graphics. They have two disks coming out too: (1) a single disk with 171.5K user storage at $595 and (2) a dual drive disk system with 343K at $1095. Both of these disk system use the BASIC in ROM and do not require RAM memory space. These machines (the 16K and 32K PETS) are available now and in fact MATRIX is selling them and giving free software for those who buy systems thru us. We get a commission and pass this on to you thru astrological software.

We have also tested the Dual-Drive COMPUTHINK disk system with 200K on line (400K in June with dual density option)and are very satisfied with it. It is much faster than Commodores disk and has FORTRAN, PLM and BASIC Compilers available this spring. That's right..there is a BASIC compiler available soon that will increase the running speed of most programs from 10 to 100%! The Commodore manual is now available and it is very well done.

THE APPLE II

The APPLE too is coming on strong! They have dropped their price in some regions and about $1400 will buy an APPLE II that will do some astrology. Keep in mind that a color TV and a cassette will be extra. The high-resolution graphics of the APPLE make it very attractive for astrological graphics— chart wheels and the like. There is a new computer...the EAGLE..to debut in June that will have resolution that is five times finer than the APPLE!!!

Here at MATRIX, we still feel that the COMMODORE PET is the best buy for the average astrologer at this time.

HOME COMPUTER SYSTEMS

Here are the most popular systems in use by astrologers (from your letters and phone calls): RADIO SHACK TRS-80, LEVEL II, 16K computer system preferably with at least one disk drive. (the cassette problems with the TRS continue to cause unnecessary hassles); The COMMODORE PET 8K or 16K and the APPLE II, with APPLESOFT and 24K (minimum) of memory.

It looks that the 16K program will be the average sized program for doing astrology altho the memory efficiency of the PET allows a whole lot of astrology to be done in even their 8K model (the 8K PET can be expanded). Enough.

IT NEVER RAINS, BUT IT POURS

There are two Heliocentric Ephemerides in the works after centuries of no daily listing of helio positions. One is the work of Malcolm Dean and PHENOMENA. This will be the more technical of the two. It will include articles by Dean, Robert Hand, your editor and perhaps by John Nelson. This ephemeris will include an aspectarian of the type used by Nelson in his famous short-wave radio investigations. The ephemeris will be published sometime this year by Samuel Weiser.

The second ephemeris will be published by Llewellyn and put together by David Lanier. It too will include daily listings as well as a helio chart drawn out on the 360 degree wheel for the first of each month. A reader will be able to scan thru the book and watch the patterns change on these wheels. This publication may also include an article by your editor.

As many of you may know, we have worked with heliocentrics (your editors) for many years. We are glad to see a real ephemeris finally be made available — even two of them! We wish both editions the very best.

FOREIGN MATRIX ORDERS

A more mundane concern is the billing problems for some MATRIX orders— in particular orders from overseas. As you know we notify readers when each issue is ready...you send in the payment...we print the issue and mail it to you. Altho combersome, this method insures that we do not over-commit ourselves at the printer and end up with a lot of money sitting in unsold MATRIX on the shelf. It is a fact that a great number of small journals fail because of the expense of initial printings. So we ask you U.S. readers not to pay ahead for future issues of MATRIX but to wait until notification. However, this is not good for foreign orders where AIR postage and what-not makes it hard to specify just how much an issue will cost. Many of our overseas readers have sent a lump sum (say $20) and we have kept track of the credit and notified you when that credit is gone. This has made our billing proceedure more complicated than we would like. We will continue to do this for foreign orders but ask that you let us know how much credit you believe you have with each letter to us. If these totals match with ours...it makes life appear less crazy. We will notify you when your credit amount falls below what is needed to mail you an issue...and you can respond with another sum. We are glad to see that MATRIX is read in all parts of the world and that some libraries are beginning to order copies for their files.

THE MAKING OF THE CHIRON EPHEMERIS

I am sure that by now many of you will have had a chance to see a copy of the new EPHEMERIS OF CHIRON 1890-2000 put out by PHENOMENA PUBLICATIONS-MONOGRAPH SERIES. The book is well put up with a lovely 4-color cover and all. I believe there may still be a few copies

CHIRON EPHEMERIS (continued)

left of the first numbered edition. The ephemeris has been produced by Malcolm Dean, Erik Tarkington, Michael Campbell with computations by the indefatigable James Neely. I wrote to Neely recently and asked some behind-the-scenes notes on how the Chiron project developed. I would like to share these notes with our readers. From letter of James Neely:

" I'm not exactly sure, but I think that the Chiron affair, or at least my involvement began with a telephone call from Malcolm for there is no obvious correspondance in which it was initiated. The time was apparently during the latter half of January 1978 and at that time I was working only with information that had appeared in SKY & TELESCOPE, such as preliminary orbital elements. My hope was that I could do some simpleminded curve fitting to the orbital elements so that I could generate some equations similar to those that you have published in MATRIX II for the other bodies. Early in February I received some data from Malcolm that he had in turn received from Brian Marsden of the Smithsonian Institute. The first data point that I tried was cause for elation, for the 1976 Oct. 22.48556 observation of Chiron gave a (1950.0 epoch) position of 1h 48m 44s.48 in RA and 11° 08' 31"! But this elation was short-lived, for I next found that I was off of the 1895 observation by 7m 42s in RA and 26' 04" in declination; as I told Malcolm, this wasn't even good enough to point binoculars. What has happened, of course, was that Marsden's published osculating elements were quite close in time to the 1976 observation, and so the fit was bound to be good: but the perturbations acting on Chiron were such that the 1895 retro-calculation was no good at all.

" During February and March I received some more information from Malcolm, such as search ephemerides that were printed by Marsden, but even with additional information I was not able to acheive more than a slight increase in accuracy in the computations. So I relayed this to Malcolm at just about the time that he had found someone from a local observatory who promised to deliver ± 1' of accuracy from 1890-2000. Needless to say, Malcolm was delighted and so was I. And at this point in time I had no working mechanism for performing detailed perturbation computations of any kind. What I did have was a program that could take the Chebyshev coefficients that Lloyd Carpenter had published and from them compute positions of the outer bodies that are apparently good to about 0".001 of arc (according to Carpenter), that is, for I have no way of checking this sort of claim). You wrote some of my comments regarding this in MATRIX I (pg.5)

" I had also programmed Carpenter's perturbation routine and had tried to run it once or twice, but I got garbage out, and being out of time with other things to do, I put it on the shelf. As I recall, I was fighting with the harmonic analysis on the outer body elements to see if I couldn't come at all close to the accuracy that I thought was achievable and which you published in MATRIX I.

" All proceeded quietly until Werner Popp of Gettorf, Germany, introduced me by mail to Alexander Borg of Forch, Switzerland. I met Alex in late July and discovered that he too had been working with Carpenter's Chebyshev method and the perturbation program, but he too was having problems getting the program to work properly. Sometime in August, Alex and I got our versions of Carpenter's programming working by trading experiences and sample problems by mail. We still don't know if our programs reproduce exactly what Carpenter had intended, but at least we were agreeing with each other, so I thought that a good test of the program would be to try it out on Chiron. Fortunately Chiron's orbit is such that it is mainly between the orbits of Saturn and Uranus and so was an ideal test subject. My first trials using Marsden's IAU circular 3151 orbital elements and Carpenter's perturbation program were quite successful and so I began to think that it would be possible to meet the ± 1' that Malcolm

wanted for the Chiron Ephemeris. The computations were still not tracking Marsden's Search Ephemerides quite as closely as I would have liked, but I surmised that the Search Ephemerides were computed from earlier and more provisional orbital elements and so maybe I shouldn't be expecting perfect agreement anyway; what I should be trying to do was to get agreement with the published observational positions of Chiron . In the meantime I had been hearing from Malcolm that their programming effort was proceeding well and he thought everything was under control even though the publication date had slipped by a number of months.

" I told Malcolm of my successes with Carpenter's program and indicated that I might have a backup program in case theirs ran into any unexpected difficulties. In late August Malcolm acknowledged my offer to help but said that their program seemed to be in good shape, that the perturbations of Jupiter, Saturn, and Uranus had been incorporated into their program, and even though things had been slowing down a bit there appeared to be no problems. By mid-September Malcolm said that they had reached an impasse and the computations had gotten worse when they went to double precision instead of better and that the "senior astronomer" was going to look the problem over and see what might be going wrong. I'm not sure what they ever found out about that program, for by the end of September (or perhaps the first week in October) I received the last letter that I was going to get from Malcolm for some time. for communications moved from the pony express to Ma Bell. We discussed the status of my efforts and the results that I was obtaining. Apparently it seemed anomalous to them (Malcolm Dean and Erik Tarkington) that I was generating heliocentric equatorial coordinates of Chiron for epoch 1950.0 and then was converting to geocentric coordinates using the AENA AP Vol. XIV Solar Coordinates and an HP-67 programmable calculator; and then continuing to use the HP-67 for precession and rotation computations to obtain geocentric spherical ecliptic coordinates of date. (no reflection on either Malcolm or Eric, but many people still cannot realize that the HP-67's and TI-59's are very powerful computational devices and are NOT toys. In fact the handhelds are very often much faster in debug and turnaround time than the big full-blown computers— and I didn't have need of the big computer for the last phases of the computations yet, for I wasn't generating an ephemeris but only spot check computations). Thus it was that in October Malcolm was in need of my Chiron methodology but I could not yet generate a geocentric ephemeris directly for I did not have the Chiron routine wedded to a Solar routine so that all of the computations could be automated. Fortunately I had an excellent solar routine, so it wasn't too difficult to patch the two programs together and generate decent geocentric positions directly.

" I made a run of a Chiron ephemeris for my own use that was printed down to the second of arc, plus I could input the times of observation of Chiron directly to cross check the reported positions of Chiron. The final results were most satisfying for all observations since 1941, the observed and calculated Right Ascensions are within 2^s of time and the declinations are within 8" of arc. The worst agreement is in the 1895 observation where my RA is off (high) by 8^s and my declination is low by 37" of arc. One of my next projects will be to learn how to fine tune the elements that go into the Carpenter program so that I can eliminate things like the 1895 discrepancy.

" I sent my results to Malcolm, and then we had several weeks of frantic long-distance debugging to do, for Malcolm's crew could not get the program to reproduce the sample computations that I sent. It was undoubtedly the climax to a frustrating experience for Malcolm, for it turned out that they suppressed the information in columns 73-80 of the punched cards; this is normal proceedure for FORTRAN does not use any information in these columns, which are for decksequencing only. But FORTRAN can read all 80 columns of data decks, and of the six perturbation coefficients that are on each data card, the last coefficient is in colums 73-80. Thus one sixth of all of the perturbation terms were inadvertantly turned into zeros. This too is no reflection on anyone involved with the project, it is just one of those unfortunate things that can happen when people attempt to communicate with computers. But when telephone calls from Malcolm and Erik ceased by late October, I was sure that a Chiron Ephemeris must be in the final stages of editing and setup.

" That is essentially the history of the Chiron Ephemeris from my side of the fence. It doesn't indicate at all any of the myriads of details that went into the generation of the Chebyshev coefficients by Carpenter's program. The biggest of the hurdles is probably worth documenting because no one except Alexander Borg knows what I mean when I've said that the orbital elements had to be "boot-strapped" in order to produce perturbations to cover the period from 1890 to 2000. By the nature of the way in which Carpenter's program was written, it is necessary to generate the perturbations around a central epoch of time. The perturbations of the outer bodies that Carpenter generated were around the central epoch of Julian Day (JD) 2415200.5 (30 June 1900) and are for a total time span of 73600 days about the central date. That is, over the period of 2415200.5 ± (73600/2) or 2378400.5 to 2452000.5 (27 Sept 1799 to 1 April 2000). Now, one can generate perturbations for other bodies using the outer body elements of Carpenter, but the entire span of time must be a subset of the 2378400.5 to 2452000.5 time frame and must be equally spaced about some central epoch. Perhaps this will become clearer as I proceed. The final orbital elements (osculating elements of date) published by Brian Marsden are for epoch 2443400.5 (14 Sept 1977). This MUST be the CENTRAL epoch that I can use, and I am limited in how far forward in time I can go by how far forward in time Carpenter's elements go, and that is JD 2452000.5. From 2443400.5 to 2452000.5 is 8600 days; thus I can go back 8600 days from 2443400.5 to JD 2434800.5 or 27 Feb 1954 but I can go no further back in time with the limitation of the central starting epoch of Marsden's. But what I can do is to generate perturbations of Chiron for the period of 2434800.5 to 2452000.5 as accurately as I can and then determine Chiron's position and velocity at some time within this period, for example, for JD 2435000.5. This was done (I could have chosen 2434800.5 as well, but I felt more comfortable with a new central epoch within the old time span). Now with the position and velocity of Chiron at 2435000.5, I can compute osculating orbital elements for Chiron at 2435000.5 using other programs and other (well known) methods. This is the first boot-strap for I've now got good osculating elements for an epoch other than the one that Marsden has given us. Using 2435000.5 as a central epoch, I can now go forward in time by 17000 days to 2418000.5, which is Feb 29, 1908. This latter date doesn't make it to 1980, so we have to go thru the entire process once more. It is worrysome if you think about what kinds of computational errors are accruing, but at least there are some check points that one can use, for example, the perturbations for the period of 2418000.5 to 2452000.5 must be generated before we can proceed further.

With these new perturbations we can calculate the position and velocity of Chiron at epoch 2443400.5 which, if you remember, was where we started with Marsden's elements and these we can convert into orbital elements. Now we can compare these to Marsden's values and see how much accuracy we have lost in the process. If it looks too bad we go back to the drawing board; if it looks not unreasonable we take a deep breath and continue to pray. By now you've gotten the idea. A third central epoch of JD 2431600.5 was chosen so that the time span covered was from JD 2411200.5 (17 July 1889) to JD 2452000.5 (1 April 2000). It is true that we could have taken a time nearer to 2418000.5 and obtained coverage back to about 1816, but the goal was 1980, which would include the 1895 observation, and by this time I felt that I had stretched my luck and roundoff about as far as I dare stretch it; and there was no need to be greedy since the goal was accomplished. It is probable that the error quoted above between the 1895 observation and the 1895 retrocalculation is due to gyrations needed to extend the coverage, but that is not a certainty. What is desirable is to fine-tune the 2431600.5 epoch elements to improve the total fit, but that is a chapter for a story which is yet to be written. "

EDITOR'S NOTE: What an effort!!! is all that I can say. In our next issue we will continue the saga of Neely's conquest of the Mean Orbital Elements begun in MATRIX I..and which he has now brought to a good conclusion. If you will remember, in that issue Neely had brought the Mean Elements for the outer planets from around some 45' of arc...where the scientists had left them when they moved into the huge mainframe computers..to about 2-4 minutes of arc..decent for a lot of astrological work. In MATRIX I, James Neely predicted that he might be able to further tune these elements until outer body positions of better than one minute of arc would be possible. What this means for the user of the programmable calculator and in particular the small home computer should be obvious— instant planets. Dont't miss the next action packed episode of James Neely Astro-computer!

VISIT FROM IAN McKINNON

Ian McKinnon from the Toronto Islands and author of the section on the General Equations for the terrestrial planets in our last issue of MATRIX spent a day with us recently. McKinnon had been chasing the eclipse of February 26 and was returning from a more western part of Canada where he had been able to witness the total eclipse when he stopped by. Aside from a nice exchange Ian tells us that he is working with Malcolm Dean on their upcoming heliocentric ephemeris. McKinnon plans to contribute some material to MATRIX on eclipses. Speaking of Mckinnon and I getting together..between the two of us we threw another bunch of ERRATA at you in the last MATRIX...so we had better detail these. Some were copying errors and others were changes that should be made..discovered after we had gone to press.

ERRATA IN MATRIX THREE

Page 5, line 5 reads "+ (30.6 [M+1]) INT for March, April, etc.; for Jan and Feb, use +(30.6[M+13])INT"
Page 5, last paragraph " Nutation in obliquity..", line 5a (a= text on right hand side of page) reads " + .27692«..."
Page 7, line 15, "+ .0010344 cos(2V-1A-160.692)"; line 30, "Values for J,V,Ep are defined on P. 8"
Page 8, line 3, "Mean Sun + (1.9194603 - 1.31113 x10^{-7} Ep)sin 1E"
Page 9, line 1a, "relevant"; line 35a, "-(.00296214- 5.676x10^{-10}Ep) cos 1 V"; line 20a "M= 319.5294250 + .524020767 Ep + .0001808(Ep/36525)^2" (above from page 10)

ERRATA MATRIX THREE (continued)

Page 11, line 6, "-(.0002481+2x10^{-11}Ep)cos 2M"
Page 12, opposite step 20 read "Converts longitude and latitude to decimal"; step 56; "X-Y -41"; step 112 read "STO Ø 35 00"; step 168 read "STO D 35 14"; step 224 read "GTO 0 22 00"
Page 13, opposite step 50 read"t^2 term in mean Mars and Mean anomaly"; step 195 read " 4 04"
Page 14, step 202 is "TAN 43"
Page 17, step 30 "STO 5 35 05"
Page 18, step 56 "STO 4 35 04"; opposite step 150 read "Perturbations J_{42}, -1"
Page 19, step 70 "D>R 16 45 "; step 72, "P>R 44"; opposite step 143 " Sum nutation to λ".
Page 20, opposite step 41 read " Mean anomaly of Venus"

FLAG STATUS: L.S.T., CARD ONE: all off; TRIG:DEG; DISP: FIX 4
MARS CARDS 1 & 2, Flags off, TRIG:DEG; DISP:FIX 0
MARS CARD 3, Flag Ø is on, TRIG: DEG; DISP:FIX 4
SUN CARD ONE, Flags off; TRIG:DEG; DISP:FIX 4
SUN CARD TWO, Flags off; TRIG:DEG;DISP:FIX 0
MERCURY CARD ONE, Flags off;TRIG:DEG;FIX 0
MERCURY CARD TWO, flags off,TRIG:DEG: DISP:FIX 4
VENUS CARD ONE, flags off, TRIG:DEG; DISP:FIX 0
VENUS CARD TWO, flag Ø is on;TRIG:DEG; DISP:FIX 4

Page 36, right hand side of page, 3rd line from top, "Dan " should read "Dane Rudhyar"

ERRATA IN MATRIX TWO

Page 53, 7th line from top, "45 minutes" should read "18 minutes"
Page 55, line 830 should read "RUN 10"
Page 57, line 2000, "358.4748445" should read "358.4758445"...and line 2160..the term ".0041875" should read ".00041875" which is why my Uranus values were so far out!!! Mea Culpa...

SUCCESS FOR ROGER ELLIOT'S NEW BUSINESS

Roger Elliot describes how he set-up a computer based horoscope interpretation service in his article elsewhere in this issue. He was kind enough to send us a sample copy. He has done a real bang-up job...particularly in the package department. His little booklet has an impressive full color cover and the way he varies the type faces thru the booklet gives a greater sense of depth than with other computer generated interpretations I have seen.

Roger writes that in the first month of operation he has been so deluged with requests that he has had to purchase an entire second computer system— printer and all! He literally cannot keep up with the incoming orders.

It seems that Great Britain is now awakening to the new home computers. The Commodore PET is available there...at about twice the price and we have heard from several astrologers who are either setting up computer horoscope services or thinking about doing so.

LOCAL CHART SERVICES— THE COMING THING.

We have been in touch with many individuals around the country who have purchased a small micro-computer system and are servicing the astrologers in their area. Many offer a wide range of services including INSTANT CHART POSITIONS over the phone...or same day pick-up and so forth. Many dont have a printer yet and they are copying their positions right off the video display screen unto chart blanks. While these smaller systems cannot yet compete with the large systems such as ASTRO-COMPUTING and ASTRO-NUMERIC in the range of their services.. they can offer fast service and custom calculations.

That's about it for the news coverage. Hope you like this issue and best wishes,

Michael & Margaret Erlewine
Editors

ON VECTORS, MATRICES, AND COORDINATE TRANSFORMATIONS

JAMES NEELY

Coordinate systems are used to describe where one or more places, things, or points are with respect to some other place, thing, or point. In astronomy there are several different coordinate systems that are useful. One uses the coordinate system that is easiest or most descriptive for the purpose at hand. Complications arise when a position is given in one system and you would like to know how to describe the location of the same position but in one of the other frames of reference. Before describing the transformations that are used in space (3 - dimensional coordinates), it will be informative to examine two types of coordinate systems that are used in the plane (2 - dimensional coordinates).

TWO DIMENSIONAL COORDINATES

The most commonly used rectangular coordinate system is depicted in Figure 1. There are two coordinate axes, the x-axis which is positive to the right of the origin and negative to the left of the origin, and the y-axis which is positive in the upward direction and negative in the downward direction from the origin. The unit of measurement in both the x- and y-directions is the same (inches, feet, blocks, astronomical units) and the two coordinate axes meet at right angles (90°); for this reason the system is called rectangular.

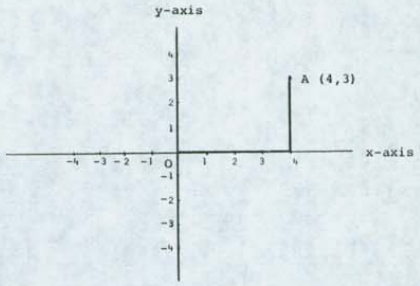


Figure 1. Rectangular Coordinates

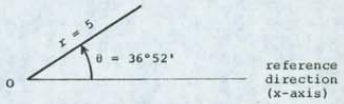


Figure 2. Polar Coordinates

Observe that the coordinate axes divide the plane (commonly called the x,y-plane) into four pieces, called quadrants. For points in the 1st quadrant both the x and y coordinates are positive; in the 2nd quadrant x is negative and y is positive; in the 3rd quadrant both x and y are negative; and in the 4th quadrant x in positive and y is negative.

In Figure 1 the point A has coordinates (4,3), which is shorthand for saying that the way to get from the origin to point A is to go four units in the positive x-direction (right) and then three units in the positive y-direction (up). By convention the x-coordinate is specified first and the y-coordinate is specified second, that is, (x,y). Sometimes we will know the values of x and y and sometimes the values of x and y will be unknown and we will want to find what they are (solve for x and y, we say).

The second commonly used polar coordinate system is depicted in Figure 2. In this system the position of a point is specified by the distance of the point from the origin and the direction of the point from the origin measured as an angle from some reference direction. Navigators and surveyors use North as the reference direction; for now we shall use the direction of the positive x-axis as the reference direction and later we shall use the Vernal Equinox or the First Point of Aries as the positive x-direction.

In the polar coordinate system it is conventional to measure the polar angle (usually designated by a Greek letter such as theta θ) as positive in the counterclockwise direction from the reference direction and negative in the clockwise direction. In Figure 2 point A (point A in Figure 2 is at the same location with respect to the origin and the x-axis as point A in Figure 1) has polar coordinates (5,36°52'). By convention the distance from the origin r is specified first and the polar angle θ is specified second, that is, (r,θ).

Coordinate Conversion in Two Dimensions

The first coordinate conversion problem is how to transform from rectangular coordinates to polar coordinates, and vice versa. In these conversions it is important that the position of the origin and the x-direction remain fixed. To transform from rectangular coordinates to polar coordinates, the necessary formula are

$$r = \sqrt{x^2 + y^2} \qquad (1a)$$

and

$$\theta = \tan^{-1}(y/x). \qquad (1b)$$

Equation (1a) shows how to obtain the polar r coordinate from the rectangular x and y coordinates and equation (1b) shows that the polar angle θ is the arctangent of y divided by x. The numerical computations which follow may be performed on a variety of handheld calculators which have scientific functions. To convert the point A whose rectangular coordinates are (4,3) to polar coordinates we first use equation (1a) to find r. We see that

$$r = \sqrt{4^2 + 3^2}$$

or $r = \sqrt{16 + 9}$

$= \sqrt{25}$

$= 5.$

In polar coordinates, the r-component is always positive. To find the polar angle θ equation (1b) gives us

$\theta = \tan^{-1}(3/4)$

$= \tan^{-1}(0.75)$

$= 36°.87$

$= 36°52'.$

There are no pitfalls in computing r, but we must be wary in the computation of θ. To illustrate this, convert the point B in Figure 3 whose rectangular coordinates are (-4,-3) to polar coordinates. The r-component is

$r = \sqrt{(-4)^2 + (-3)^2}$

$= \sqrt{16 + 9}$

$= \sqrt{25}$

$= 5,$

and the θ-coordinate is

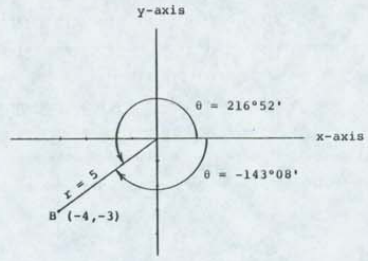


Figure 3. A Point in the 3rd Quadrant

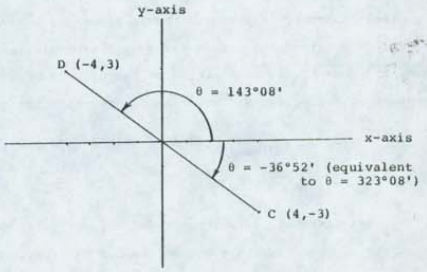


Figure 4. Points in the 2nd and 4th Quadrants

$\theta = \tan^{-1}(-3/-4)$

$= \tan^{-1}(0.75)$

$= 36°.87$

$= 36°52'.$

But now look again at Figure 3. The value for r is correct but θ should be 216°52' instead of 36°52'. The problem lies in the arctangent formula for θ, for the so-called principal angle of the arctangent function lies in the range of -90° to + 90°, which is not a full circle. The reason for this is that when the value of y is divided by the value of x information is lost. The information that is lost is the information that determines in which quadrant the angle θ should lie. For point A, y divided by x is +3 divided by +4 or +0.75; and for point B, y divided by x is -3 divided by -4 or +0.75 again. We cannot blame the arctangent function for not being able to tell the difference between +0.75 and +0.75.

Before showing how to resolve this dilema let us look at the pair of problems shown in Figure 4. Point C has rectangular coordinates (4,-3) or polar coordinates (5,-36°52') which is equivalent to (5,323°08'). Point D has rectangular coordinates (-4,3) or polar coordinates (5,143°08'). We can anticipate problems with the arctangent function again for in both cases y divided by x is -0.75. In fact, the result of using equation (1b) is correct for point C but in not correct for point D. Note also that for point C the handheld calculator gives -36°52'; the equivalent but preferred polar angle is -36°52' + 360° or 323°08'.

All of the problems may be resolved using the following procedure or algorithm to compute the polar angle:

1. If x is exactly zero, then θ = 90° if y is positive, or θ = 270° if y is negative. Stop.
2. If x is not zero then compute $\theta = \tan^{-1}(y/x)$.
   a. Then if θ is negative, add 180° to θ.
   b. Finally, if y is negative, then add 180° to θ.

Let us illustrate this algorithm with points A, B, C, and D. Since x is nonzero in all cases, we need use only the second part of the algorithm.

Point A: $\theta = \tan^{-1}(3/4) = 36°52'$. Steps a and b are not used.

Point B: $\theta = \tan^{-1}(-3/-4) = 36°52'$. Since y = -3 is negative, add 180° to θ to obtain θ = 216°52' in step b.

Point C: $\theta = \tan^{-1}(-3/4) = -36°52'$. Since θ is negative, add 180° to θ to obtain θ = 143°08' in step a. Then, since y = -3 is negative, add 180° to θ again in step b to obtain θ = 323°08'.

Point D: $\theta = \tan^{-1}(3/-4) = -36°52'$. Since θ is negative, add 180° to θ to obtain θ = 143°08' in step a. Since y = +3 is positive, step b is not used, so the result is θ = 143°08.

This algorithm may seem long or cumbersome but it is actually quite straightforward and easy to use. In fact it is a commonly used digital computer algorithm. Handheld calculators that have the rectangular-to-polar conversion function are much easier to use for they contain the algorithm that checks the y-value and returns a polar angle that lies between -180° and +180° (some machines return -90° to + 270°); for the 0° to 360° range all that is needed is to add 360° to negative polar angles. Interested users should consult their owner's manual for their calculators to determine precisely what storage registers and function keys are used. In all cases the value of y is stored in one register and the value of x is stored in a second register. The rectangular-to-polar function key(s) is (are) depressed and then the value of r will be returned in one of the two registers and the value of θ will be in the other register (and if θ is negative, add 360°).

The inverse transformation, or polar-to-rectangular transformation must also be performed. Fortunately these transformation formulas are straightforward and unambiguous. They are

$$x = r \cos \theta \qquad (2a)$$

and

$$y = r \sin \theta. \qquad (2b)$$

On the handheld calculator one may either use the sine and cosine transformations according to the above formulas or may use, if available, the polar-to-rectangular conversion may be used; in either case the results are identical.

Coordinate Translation in Two Dimensions

Coordinate translations are used to move coordinates from one origin to another origin. In astronomical work the equations of planetary motion are solved with the Sun at the origin (heliocentric coordinates). For terrestrial observations we are not interested in where the planets are from the Sun but rather where they are from the Earth (geocentric coordinates), and so we must know how to make the coordinate change.

There are two cardinal rules regarding the mathematics of coordinate translations:

1. The translations are always performed in rectangular coordinates.
2. The new coordinate axes are parallel to the old coordinate axes. That is, the new x-axis is parallel to the old x-axis and the new y-axis is parallel to the old y-axis.

One implication of these rules is that if the original and final coordinates are in the polar system then the original polar coordinates must be transformed to rectangular coordinates, then the translation is performed, and then the final rectangular coordinates are converted to polar coordinates.

Often one sees the equations of relationships between points and/or coordinate systems written in vector notation. Vector notation is not required to perform the task at hand, but it is a very convenient way to view relationships between points in two or three

dimensions (and mathematicians do not limit the number of coordinates to three). When we deal with points and want to know how to get from one point to another then we need to do computations on each coordinate of the point; instead of having to write a separate equation for each coordinate we represent the point by a vector and then we write just one vector equation. Thus vector notation can be considered to be just a form of shorthand, but when we finally do computations we still have to do the computations one component at a time. Symbolically we represent a vector by a letter of some kind with an arrow above it. For example, $\vec{a}$ and $\vec{r}$ would represent two vectors. If we need to write the components of vectors we write the x-component first, then the y-component is written below the x-component, and if we have a third or z-component, it is written below the y-component. For example, we might write

$$\vec{A} = \begin{bmatrix} x_A \\ y_A \end{bmatrix} = \begin{bmatrix} 4 \\ 3 \end{bmatrix}$$

to represent the point A in Figure 1.

Geometrically we use arrows to designate vectors. The "tail" of the arrow is placed at the origin or some other "starting place" and the "head" of the arrow is placed at some point or place that we are interested in. The components of the vector tell us how much of the vector points in the x-direction and how much of the vector points in the y-direction. For example, point A in Figure 1 can be represented by a vector with its tail at the origin (0,0) and its head at point A (4,3), the arrow then points +4 units in the x-direction and +3 units in the y-direction.

To add two vectors we add the corresponding components of each vector. The result is a new vector, called the resultant vector. In Figure 5 the two vectors

$$\vec{a} = \begin{bmatrix} 1 \\ 3 \end{bmatrix} \qquad \text{and} \qquad \vec{b} = \begin{bmatrix} 3 \\ 2 \end{bmatrix}$$

are added. The resultant vector is

$$\vec{r} = \vec{a} + \vec{b} = \begin{bmatrix} 1 \\ 3 \end{bmatrix} + \begin{bmatrix} 3 \\ 2 \end{bmatrix} = \begin{bmatrix} 1 + 3 \\ 3 + 2 \end{bmatrix} = \begin{bmatrix} 4 \\ 5 \end{bmatrix}.$$

In Figure 5 observe that the vectors $\vec{a}$ and $\vec{b}$ form two sides of a parallelogram and that the resultant $\vec{r}$ is the diagonal of the parallelogram.

When a vector has its tail at the origin then the x- and y-coordinates of the head of the vector are numerically equal to the x- and y-components of the vector. Often it is convenient to think of vectors as starting at some point other than the origin. For example, in Figure 6 there are two vectors with

$$\vec{a} = \begin{bmatrix} 7 \\ 4 \end{bmatrix} \qquad \text{and} \qquad \vec{b} = \begin{bmatrix} -12 \\ 4 \end{bmatrix}.$$

Suppose we start a journey at the origin and travel along the vector $\vec{a}$ to the point E, that is 7 units in the x-direction and 4 units in

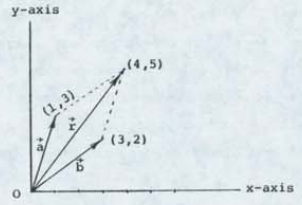


Figure 5. Addition of Two Vectors (First Representation)

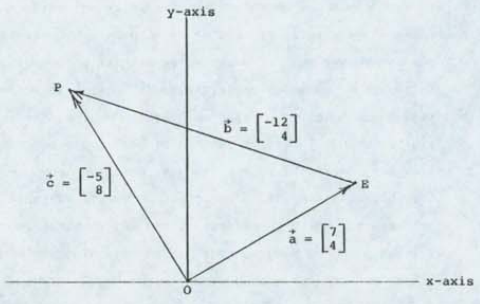


Figure 6. Addition of Two Vectors (Second Representation)

the y-direction. Then, from point E we travel along vector $\vec{b}$ to point P; to do this we travel from point E -12 units in the x-direction and 4 units in the y-direction to get to point P. The resultant vector $\vec{c}$ shows us that we could have gotten directly from point O to point P by traveling -5 units in the x-direction and 8 units in the y-direction. Note that since point O is the origin the components of $\vec{c}$ are numerically equal to the coordinates of point P.

We can subtract vectors as well as add vectors. For example, as in Figure 6 we saw that $\vec{a} + \vec{b} = \vec{c}$. If we knew $\vec{a}$ and $\vec{c}$ we could find $\vec{b}$ by the vector equation

$$\vec{b} = \vec{c} - \vec{a} = \begin{bmatrix} -5 \\ 8 \end{bmatrix} - \begin{bmatrix} 7 \\ 4 \end{bmatrix} = \begin{bmatrix} -5 - 7 \\ 8 - 4 \end{bmatrix} = \begin{bmatrix} -12 \\ 4 \end{bmatrix}.$$

Suppose now that point O represents the Sun, point E represents the Earth, and point P represents some planet. Then the vectors $\vec{a}$ and $\vec{c}$ would represent the heliocentric positions of the Earth and the planet respectively. Since the Sun at O is the origin, the components of the vectors $\vec{a}$ and $\vec{c}$ are numerically equal to the heliocentric coordinates of the Earth at E and the planet at P. Now, when we subtract the heliocentric coordinates of the Earth at E from the heliocentric coordinates of the planet at P the resultant $\vec{b} = \vec{c} - \vec{a}$ is the position of the planet P with respect to the point E. In otherwords the components of $\vec{b}$ are numerically equal to the coordinates of P with respect to the point E, and so the components of the vector $\vec{b}$ are equal to the geocentric coordinate of point P.

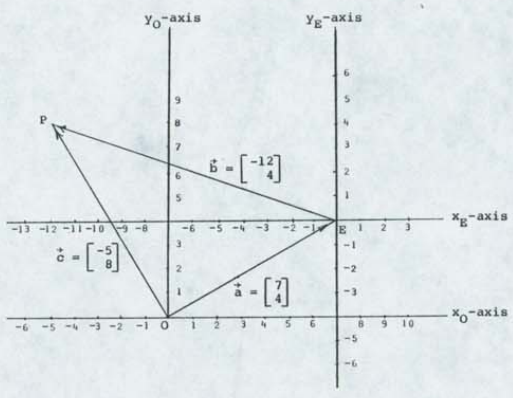


Figure 7. Translation of Coordinates

In summary, vector subtraction can be viewed as a translation of one coordinate system to another. Figure 7 is the same as Figure 6 but with a second set of coordinate axes drawn. Observe the following points: The x_E-axis is parallel to the x_O-axis, and the y_E-axis is parallel to the y_O-axis. Vectors $\vec{a}$ and $\vec{c}$ originate at the point O; thus the components of $\vec{a}$ and $\vec{c}$ are the coordinates of E and P, respectively, with respect to the origin O. Vector $\vec{b}$ is the difference of vectors $\vec{c}$ and $\vec{a}$. Vector $\vec{b}$ originates at the point E and so the components of $\vec{b}$ are numerically equal to the coordinates of P with respect to the origin E. Finally, the vector operations were performed in rectangular coordinates.

Coordinate Conversion and Translation - An Example

Before proceeding to the next topic it seems advisable to work through an example that combines the features of the previous sections. We will consider a snapshot of a stylized flat solar system in which the "heliocentric" polar coordinates of the Earth and planet are known and we wish to find the "geocentric" polar coordinates of the planet.

Let the heliocentric polar coordinates of the planet P be (5.20,290°) and the heliocentric polar coordinates of the Earth be (1.00,10°). The first step is to convert the heliocentric polar coordinates of P and E to heliocentric rectangular coordinates. To do this we use equations (2a) and (2b). Let

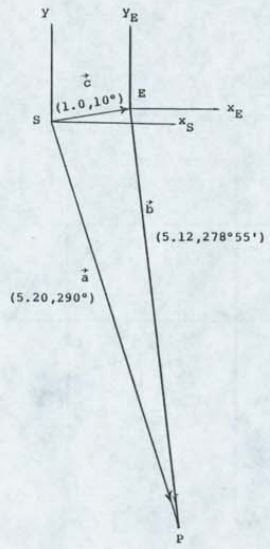


Figure 8. Example of Polar Conversion and Translation

$$\vec{c} = \begin{bmatrix} x_P \\ y_P \end{bmatrix} = \begin{bmatrix} r_P \cos \theta_P \\ r_P \sin \theta_P \end{bmatrix} = \begin{bmatrix} 5.20 \cos 290° \\ 5.20 \sin 290° \end{bmatrix}$$

$$= \begin{bmatrix} 5.20(0.34202) \\ 5.20(-0.93960) \end{bmatrix} = \begin{bmatrix} 1.77850 \\ -4.88640 \end{bmatrix}$$

and let

$$\vec{a} = \begin{bmatrix} x_E \\ y_E \end{bmatrix} = \begin{bmatrix} r_E \cos \theta_E \\ r_E \sin \theta_E \end{bmatrix} = \begin{bmatrix} 1.00 \cos 10° \\ 1.00 \sin 10° \end{bmatrix}$$

$$= \begin{bmatrix} 0.98481 \\ 0.17365 \end{bmatrix}.$$

Thus the heliocentric rectangular coordinates of the planet are (0.98481,0.17365). These heliocentric rectangular of P and E are also equal to the components of the heliocentric position vectors $\vec{c}$ and $\vec{a}$ of P and E, respectively.

The geocentric position vector $\vec{b}$ of P is, by vector subtraction,

$$\vec{b} = \vec{c} - \vec{a} = \begin{bmatrix} 1.77850 \\ -4.88640 \end{bmatrix} - \begin{bmatrix} 0.98481 \\ 0.17365 \end{bmatrix}$$

$$= \begin{bmatrix} 1.77850 - 0.98481 \\ -4.88640 - 0.17365 \end{bmatrix} = \begin{bmatrix} 0.79369 \\ -5.06005 \end{bmatrix}.$$

The geocentric rectangular coordinates of P are equal to the components of the position vector $\vec{b}$ and are (0.79369,-5.06005). Using equations (1a) and (1b) we find the geocentric polar coordinates fo P to be

$$r = \sqrt{(0.79369)^2 + (-5.06005)^2}$$

$$= \sqrt{26.23405}$$

$$= 5.12,$$

and

$$\theta = \tan^{-1}(-5.06005/0.79369)$$

$$= \tan^{-1}(-6.37535)$$

$$= -81°05'.$$

But we have to get θ into the proper quadrant, so since θ is negative we add 180°, and since y is negative we add another 180°. The result is θ = -81°05' + 180° + 180° = 278°55'. Thus the geocentric polar coordinates of P are (5.12,278°55').

To illustrate the power of the handheld calculators this same problem is solved on the HP-67 (Figure 9) and on the TI-59 (Figure 10).

RCL Σ+ h Σ-	Clear registers S4 and S6
290 ↑ 5.20	Enter heliocentric polar coordinates of P
f R↔	Convert to rectangular coordinates ($\vec{c}$)
Σ+	Store components of $\vec{c}$ in R4 and R6
10 ↑ 1.0	Enter heliocentric polar coordinates of E
f R↔	Convert to rectangular coordinates ($\vec{a}$)
h Σ-	Subtract $\vec{a}$ from $\vec{c}$ in registers S4 and S6
RCL Σ+	Recall $\vec{b}$ from registers S4 and S6
g →P	Convert $\vec{b}$ to polar. r = 5.12 is in the display
h x↔y	Exchange registers. θ = -81°.09 is in the display
360 +	Since θ is negative, add 360°
g →H.MS	Convert θ to degrees and minutes. θ = 278°55'.

Figure 9. HP-67 Program (Coordinate Translation)

0 STO 01 STO 04	Clear registers 01 and 04
5.20 x↔t 290	Enter heliocentric polar coordinates of P
2nd P→R	Convert to rectangular coordinates ($\vec{c}$)
2nd Σ+	Store components of $\vec{c}$ in registers 04 and 01
1 x↔t 10	Enter heliocentric polar coordinates of E
2nd P→R	Convert to rectangular coordinates ($\vec{a}$)
INV 2nd Σ+	Subtract $\vec{a}$ from $\vec{c}$ in registers 04 and 01
RCL 04 x↔t RCL 01	Recall the components of $\vec{b}$ from reg. 04 and 01
INV 2nd P→R	Convert $\vec{b}$ to polar. θ = -81.09 in the display
+ 360 =	Since θ is negative, add 360°
INV 2nd D.MS	Convert θ to degrees and minutes. θ = 278°55'.
x↔t	Exchange registers. r = 5.12

Figure 10. TI-59 Program (Coordinate Translation)

Coordinate Rotation in Two Dimensions

Coordinate rotations are used to change from one coordinate system to one of another orientation. One example is the change from a system with true North as the primary reference direction to a system with magnetic North as the primary reference direction. In astronomy two commonly used coordinate systems are the equatorial system and the ecliptic system. The relationship between these two systems is a single rotation from celestial North to ecliptic North through the angle, the obliquity of the ecliptic, between these two directions. The form of the coordinate rotation formulas in three dimensions appears to be quite complicated. In two dimensions the formulas are considerably less involved, especially for polar coordinates.

The only cardinal rule of coordinate rotation is that the position of the origin remains unchanged during the rotation.

In Figure 11 the point P has rectangular coordinates (x,y) or polar coordinates (r,θ). In the rotated system the point P has rectangular coordinates (x',y') or polar coordinates (r',θ').

We are interested in how to express the coordinates of the point P in both the unprimed and the primed (') coordinate systems. In polar coordinates the situation is quite simple. The distance from the origin to P is r in the unprimed system and r' in the primed system; but this distance is the same in both systems so that r = r'.

As usual we will measure angles as positive in the counter-clockwise direction and negative in the clockwise direction. The rotation angle φ (phi) is the angle between the x-reference direction and the x'-reference direction. In Figure 11, the angle from the x-reference direction to the x'-reference direction is +φ, whereas the angle from the x'-reference direction to the x-reference direction is -φ. In Figure 11 we see that θ = θ' + φ or, likewise, θ' = θ - φ.

Rotation in polar coordinates thus has a very simple form:

$$r' = r \,, \tag{3}$$

and

$$\theta' = \theta - \phi \,,$$

or

$$r = r' \,, \tag{4}$$

and

$$\theta = \theta' + \phi \,.$$

In otherwords, the distance remains unchanged and you either add or subtract the rotation angle from the polar angle depending upon the direction of the rotation.

To transform the rectangular coordinates we have two choices: One choice is to transform the rectangular coordinates to polar coordinates, add or subtract the rotation angle to/from the polar angle and then convert back to rectangular coordinates. Usually this method is too cumbersome and indirect, but the availability of the rectangular-to-polar and polar-to-rectangular conversion function on the handheld calculators makes the task extremely simple. The other choice is to develop a method which involves x, y, x', y', and φ only and thus avoids the intermediate polar coordinate systems. It will be informative to develop these formulas in detail.

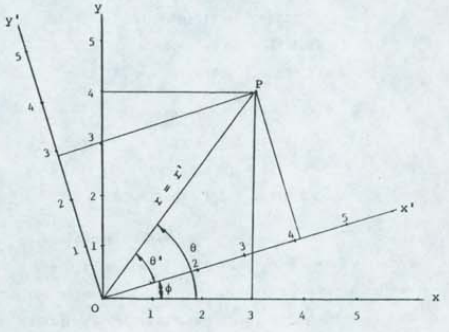


Figure 11. Coordinate Rotation

From equations (1a) and (1b) we can write

$$x' = r' \cos \theta' \tag{5}$$

and $$y' = r' \sin \theta'.$$

Now substitute equations (3) into equations (5) to obtain

$$x' = r \cos(\theta - \phi) \tag{6}$$

and $$y' = r \sin(\theta - \phi).$$

Using well known trigonometric formulas we may write equations (6) as

$$x' = r(\cos \theta \cos \phi + \sin \theta \sin \phi)$$

and $$y' = r(\sin \theta \cos \phi - \cos \theta \sin \phi),$$

or

$$x' = (r \cos \theta)\cos \phi + (r \sin \theta)\sin \phi \tag{7}$$

$$y' = -(r \cos \theta)\sin \phi + (r \sin \theta)\cos \phi .$$

Now substitute equations (2a) and (2b) into equations (7) to get

$$x' = x \cos \phi + y \sin \phi \tag{8}$$

$$y' = -x \sin \phi + y \cos \phi.$$

Equations (8) are the required formulas for converting from the unprimed rectangular coordinate system to the primed rectangular coordinate system. The inverse transformations are

$$x = x' \cos \phi - y' \sin \phi \tag{9}$$

and $$y = x' \sin \phi + y' \cos \phi .$$

On a computer it is generally easiest to perform the rotation of rectangular coordinate systems using either equations (8) or equations (9), but as mentioned earlier it is much simpler to use the rectangular/polar feature on a handheld calculator. This method is illustrated using the HP-67 (Figure 12) and the TI-59 (Figure 13) calculators on the following sample problem: x = 3, y = 4, and ϕ = 17°. Find x' and y'.

To use equations (8) we have

$$\begin{aligned} x' &= 3 \cos 17° + 4 \sin 17° \\ &= 3(0.95630) + 4(0.29237) \\ &= 2.86891 + 1.16949 \\ &= 4.03840 \end{aligned}$$

and

$$\begin{aligned} y' &= -3 \sin 17° + 4 \cos 17° \\ &= -3(0.29237) + 4(0.95630) \\ &= -0.87712 + 3.82522 \\ &= 2.94810 . \end{aligned}$$

In an earlier section we showed how rectangular coordinates could be written as components of a vector. Often the rotation formulas given by equations (8) and (9) are written in the form of a matrix equation. By convention, equations (8) are written in the form

4 ↑ 3	Enter the y and x coordinates
g →P	Convert to polar. r = 5.00000
h x↔y	Exchange. θ = 53°13010
17 −	Subtract to rotation angle ϕ = 17° θ' = 36°.13010 is in the display
h x↔y	Exchange. r' = 5.00000 is in the display
f R→	Convert to rectangular. x' = 4.03840
h x↔y	Exchange. y' = 2.94810 is in the display.

Figure 12. HP-67 Program (Coordinate Rotation)

3 x↔t 4	Enter the x and y coordinates
INV 2nd P→R	Convert to polar. θ = 53°.13010
− 17 =	Subtract to rotation angle ϕ = 17° θ' = 36°.13010 is in the display
2nd P→R	Convert to rectangular. y' = 2.94810
x↔t	Exchange. x' = 4.03840 is in the display

Figure 13. TI-59 Program (Coordinate Rotation)

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos \phi & \sin \phi \\ -\sin \phi & \cos \phi \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} \tag{10}$$

and the inverse equations (9) are written as

$$\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} \cos \phi & -\sin \phi \\ \sin \phi & \cos \phi \end{bmatrix} \begin{bmatrix} x' \\ y' \end{bmatrix} . \tag{11}$$

The quantity

$$\begin{bmatrix} \cos \phi & \sin \phi \\ -\sin \phi & \cos \phi \end{bmatrix}$$

is called a matrix, and in this particular case it in called a a rotation matrix. In equations (10) the primed vector is obtained by multiplying the unprimed vector by the rotation matrix. For our two dimensional problems there is no more advantage of expressing the equations in form (10) than there is in using form (8); both forms contain exactly the same information. However in three dimensions we will need to express composite rotations and often the matrix form is more convenient. We will have more to say about matrices at that time.

THREE DIMENSIONAL COORDINATES

The most commonly used rectangular coordinate system is depicted in Figure 14. There are three coordinate axes: the x-axis, the y-axis, and the z-axis; the positive directions only are shown in Figure 14. Although any figure drawn in a plane is necessarily two dimensional, Figure 14 is drawn so that the y-axis and the z-axis are in the plane of the page; the x-axis is to be thought of as being perpendicular to the plane of the page, or perpendicular to the plane of the y- and z-axes and extending above the page in the positive x-direction. As in two dimensional rectangular coordinates, the unit of measurement in the x-, the y- and the z-directions is the same (inches, feet, astronomical units).

In Figure 14 the point A has coordinates (4,6,7), which means that the way to get from the origin O of the coordinate system to point A is to go four units in the positive x-direction (out of the page and toward the reader), then six units in the positive y-direction (right) and then seven units in the positive z-direction (up). By convention the x-coordinate is specified first, the y-coordinate is specified second, and the z-coordinate is specified third, that is, (x,y,z). Sometimes we will know the values of x, y and z and sometimes the values of x, y and z will be unknown and we will want to find what they are, or solve for them.

The second commonly used spherical coordinate system is

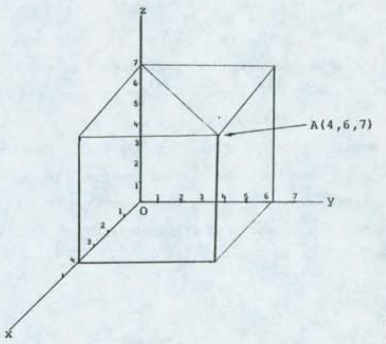


Figure 14. Rectangular Coordinates.

depicted in Figure 15. In this system the position of a point is specified by the distance of the point from the origin, the direction of the projection of the point in some reference plane from some reference direction in the reference plane, and the direction of the point itself from its projection in the reference plane. In astronomical work there are several commonly used coordinate systems, two of these are the ecliptic system and the equatorial system. In both of these systems the reference direction is the direction of the Vernal Equinox or the First Point of Aries (to be defined precisely later). In the ecliptic system the reference plane is the plane of the ecliptic, or the plane in which the Earth moves as it revolves around the Sun. In the equatorial system the reference plane is the plane of the Earth's equator, or the plane in which all points of the Earth's equator lie.

Before we proceed with a spherical coordinate system it should be pointed out that, as in the two dimensional case, a spherical coordinate system is invariably associated with a corresponding rectangular coordinate system. In the spherical system, the direction of the positive x-axis is taken as the reference direction and the plane containing the x-axis and the y-axis, called the x-y plane, is taken as the reference plane. When the x-y plane is viewed from the direction of the positive z-axis then the x-y plane has the same properties that were discussed in the two dimensional case.

The spherical coordinates of the point A (see Figure 15)

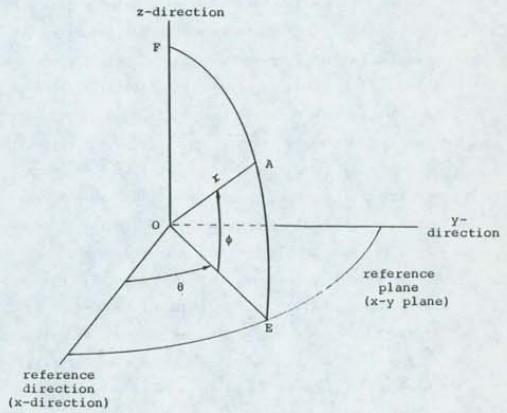


Figure 15. Spherical Coordinates

are determined in the following way. Pass a plane through the point A and the z-axis; in Figure 15 this plane contains the points O, E, A and F. The distance OA is the distance of A from the origin O and is designated by the letter r. The line OE lies in the reference plane; the angle from the reference direction (positive x-axis) to the line OE is denoted by θ. The angle θ in the x-y plane is measured using exactly the same conventions as were discussed in the section on the polar coordinate system. The angle measured from OE to OA is denoted by the Greek letter phi, ϕ. If OA lies in the positive z-direction from OE, then ϕ is a positive angle and has a maximum value of +90°. If OA lies in the negative z-direction from OE, then ϕ is a negative angle and has a minimum value of -90°. If the point A in Figure 15 has rectangular coordinates (4,6,7) as in Figure 14, then we shall show in the next section that the spherical coordinates of point A are r = 10.05, θ = 56°18' and ϕ = 44°09'. It is common to denote the spherical coordinates by (r,θ,ϕ).

Coordinate Conversion in Three Dimensions

The coordinate conversion problem is how to transform from rectangular coordinates to polar coordinates and vice versa. In these conversions it is important that the positions of the origin, the x-direction and the reference plane remain fixed. To transform from rectangular coordinates to polar coordinates, the necessary formula are

$$r = \sqrt{x^2 + y^2 + z^2}, \tag{12a}$$

$$\theta = \tan^{-1}(y/x), \tag{12b}$$

and

$$\phi = \tan^{-1}(z/\sqrt{x^2 + y^2}) = \sin^{-1}(z/r). \tag{12c}$$

Equation (12a) shows how to obtain the spherical r coordinate from the rectangular x, y and z coordinates. Equation (12b) shows that the spherical angle θ is the arctangent of y divided by x. It is important to note that equation (12b) is exactly the same as equation (1b). The same polar algorithm that was used to find θ from equation (1b) is required to find θ from equation (12b). Recall that the arctangent function will only give the principal angle and that the sign of y must also be examined so that the proper value of θ can be computed in the range of -180° to +180° or, more commonly, in the range of 0° to 360°. The determination of ϕ from either formula in equation (12c) is quite straightforward. The range of ϕ is from -90° to +90°; since this range is identical to the principal value of both the arctangent function and the arcsine function no further adjustments must be made. The arctangent formula is readily implemented on handheld calculators with the rectangular/polar function whereas the arcsine formula is usually easier to implement on a computer.

To convert the point A whose rectangular coordinates are (4,6,7) to spherical coordinates we first use equation (12a) to find r. We see that

$$r = \sqrt{4^2 + 6^2 + 7^2}$$
$$= \sqrt{16 + 36 + 49}$$
$$= \sqrt{101}$$
$$= 10.05.$$

To find the angle θ equation (12b) gives us

$$\theta = \tan^{-1}(6/4)$$
$$= \tan^{-1}(1.50)$$
$$= 56°.31$$
$$= 56°18'.$$

The rules for determining the proper value of θ do not change the result, so we have θ = 56°18'. To find the angle ϕ, equation (12c) gives us

$$\phi = \sin^{-1}(7/10.05)$$
$$= \sin^{-1}(0.69652)$$
$$= 44°.15$$
$$= 44°09'.$$

As an exercise in rectangular-to-spherical conversion, the following results may be checked.

(x, y, z)	(r, θ, ϕ)
(4, 6, 7)	(10.05, 56°18', 44°09')
(-4, 6, 7)	(10.05, 123°41', 44°09')
(4,-6, 7)	(10.05, 303°41', 44°09')
(-4,-6, 7)	(10.05, 236°18', 44°09')
(4, 6,-7)	(10.05, 56°18', -44°09')
(-4, 6,-7)	(10.05, 123°41', -44°09')
(4,-6,-7)	(10.05, 303°41', -44°09')
(-4,-6,-7)	(10.05, 236°41', -44°09')

The spherical-to-rectangular transformation formulas are straightforward and unambiguous. They are

$$x = r \cos\phi \cos\theta, \tag{13a}$$

$$y = r \cos\phi \sin\theta, \tag{13b}$$

and

$$z = r \sin\phi. \tag{13c}$$

A method of implementing equations (12) and equations (13) on the HP-67 and TI-59 calculators is given in Figures 16, 17, 18 and 19.

-6 ↑	Enter y-component
4	Enter x-component
g →P	Convert to polar coordinates. See $(x^2+y^2)^{1/2}$.
h x↔y	Exchange registers. See θ = -56°.31.
360 +	Since θ is negative, add 360°.
g →H.MS	Convert to degrees and minutes. θ = 303°41'.
CLx	Clear x-register & disable stack.
-7	Enter z-component.
h x↔y	Exchange. See $(x^2+y^2)^{1/2}$ in the display.
g →P	Convert to polar. See r = 10.05. See comment below.
h x↔y	Exchange. See ϕ = -44°.15.
g →H.MS	Convert to degrees and minutes. ϕ = -44°09'.

Comment: The HP-67 evaluates ϕ using the $\tan^{-1}$ function in equation (12c).

Figure 16. HP-67 Program (Rectangular to Spherical)

4	Enter x.
x↔t	Exchange.
-6	Enter y.
INV 2nd P→R	Convert to polar. See θ = -56°.31.
+ 360 =	Since θ is negative, add 360°.
INV 2nd D.MS	Convert to degrees and minutes. See θ = 303°41'.
-7	Enter z.
INV 2nd P→R	Convert to polar. See ϕ = -44°.15.
INV 2nd D.MS	Convert to degrees and minutes. See ϕ = -44°09'.
x↔t	Exchange. See r = 10.05.

Figure 17. TI-59 Program. Rectangular to Spherical.

75 ↑	Enter ϕ.
20	Enter r.
f R←	Convert to rectangular. See r cos ϕ.
h x↔y	Exchange. See z = r sin ϕ.
CLx	Clear x-register and disable stack.
30	Enter θ.
h x↔y	Exchange. See r cos ϕ.
f R←	Convert to rectangular. See x = (r cos ϕ)cos θ.
h x↔y	Exchange. See y = (r cos ϕ)sin θ.

Figure 18. HP-67 Program (Spherical to Rectangular)

20	Enter r.
x↔t	Exchange.
75	Enter ϕ.
2nd P→R	Convert to rectangular. See z = r cos ϕ.
30	Enter θ.
2nd P→R	Convert to rectangular. See y = (r cos ϕ)sin θ.
x↔t	Exchange. See x = (r cos ϕ)cos θ.

Figure 19. TI-59 Program. Spherical to Rectangular.

Coordinate Translation in Three Dimensions

Coordinate translations are used to move coordinates from one origin to another. The major difference between three dimensional translations and two dimensional translations is that in three dimensions we have a third coordinate with which to deal and the translations are not restricted to the x-y plane.

There are two cardinal rules regarding the mathematics of coordinate translations:

1. The translations are always performed in rectangular coordinates.
2. The new coordinate axes are parallel to the old coordinate axes. That is, the new x-axis is parallel to the old x-axis, the new y-axis is parallel to the old y-axis and the new z-axis if parallel to the old z-axis.

One implication of these rules is that if the original and final coordinates are in the spherical system then the original spherical coordinates must be transformed to rectangular coordinates, then the translation is performed, and then the final rectangular coordinates are converted to spherical coordinates.

The details of coordinate translation in three dimensions are no different than they are in two dimensions. The third, or z-, coordinate is handled in exactly the same way as the x-coordinate and the y-coordinate. Two vectors, say,

$$\vec{a} = \begin{bmatrix} 1 \\ 3 \\ -2 \end{bmatrix} \quad \text{and} \quad \vec{b} = \begin{bmatrix} 3 \\ -4 \\ 5 \end{bmatrix}$$

can be added to obtain a resultant vector

$$\vec{r} = \vec{a} + \vec{b} = \begin{bmatrix} 1 \\ 3 \\ -2 \end{bmatrix} + \begin{bmatrix} 3 \\ -4 \\ 5 \end{bmatrix} = \begin{bmatrix} 1+3 \\ 3-4 \\ -2+5 \end{bmatrix} = \begin{bmatrix} 4 \\ -1 \\ 3 \end{bmatrix}$$

Now, suppose that the heliocentric coordinates of the Earth and Venus, respectively, are

$$\vec{e} = \begin{bmatrix} 0.9372 \\ -0.3745 \\ 0. \end{bmatrix} \quad \text{and} \quad \vec{v} = \begin{bmatrix} 0.3328 \\ -0.6470 \\ -0.0282 \end{bmatrix}$$

These heliocentric coordinates are represented in Figure 20. Using the principles of vector addition, $\vec{v} = \vec{e} + \vec{p}$ where p is the vector from Earth to Venus. We can find then that $\vec{p} = \vec{v} - \vec{e}$, or

$$\vec{p} = \begin{bmatrix} 0.3328 \\ -0.6470 \\ -0.0282 \end{bmatrix} - \begin{bmatrix} 0.9372 \\ -0.3745 \\ 0. \end{bmatrix}$$

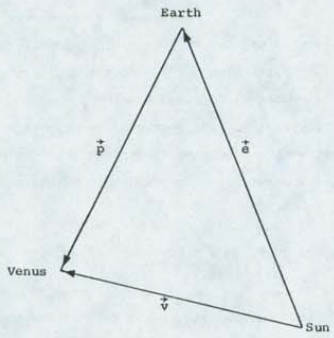


Figure 20. Coordinate Translation.

Thus,

$$\vec{p} = \begin{bmatrix} 0.3328 - 0.9372 \\ -0.6470 + 0.3745 \\ -0.0282 + 0. \end{bmatrix} = \begin{bmatrix} -0.6044 \\ -0.2725 \\ -0.0282 \end{bmatrix}.$$

The components of the vector $\vec{p}$ are the geocentric coordinates of Venus.

Coordinate Rotation in Three Dimensions

Coordinate rotation in three dimensions appears to be considerably more complicated than rotation in two dimensions for there are many more "directions" in which one can perform a rotation. In practice, all rotations in three dimensions can be written as a sequence of rotations about the x-axis, about the y-axis and about the z-axis. The conversion from ecliptic to equatorial coordinates, for example, requires only a single rotation about the x-axis whereas the conversion of "orbital coordinates" to ecliptic coordinates requires three separate rotations which involve the argument of perigee ω, the orbital inclination i and the longitude of the ascending node Ω.

In the section on two dimensional rotations we showed how a rotation could be performed in either polar or rectangular coordinates in the x-y plane. It should be noted that there are two ways in which a single species of rotation can be specified.

For example, a rotation in the x-y plane and a rotation about the z-axis mean exactly the same thing. Similiarly, a rotation in the x-z plane and a rotation about the y-axis are identical. Finally, a rotation in the y-z plane and a rotation about the about the x-axis are identical.

One might state the following as the cardinal rules of rotation:

1. The position of the origin remains unchanged during the rotation.

2. A rotation is performed about one of the three coordinate axes only.

Notice that our discussion of the three rotational axes refer to rectangular coordinate axes and that implicit in this is that we will discuss rotations in a rectangular coordinate system and not in a spherical coordinate system. A rotation from one spherical system to another to another requires that an intermediate transformation must be made to rectangular form so that the rotation can be performed.

Let us designate the rotation angle by ϕ (not to be confused with the use of ϕ in Figure 15). To perform a rotation in the x-y plane about the z-axis, the values of the x and y components change whereas the value of the z component remains unchanged. The equations for this rotation are

$$x' = x \cos \phi + y \sin \phi,$$

$$y' = -x \sin \phi + y \cos \phi, \qquad (14)$$

and

$$z' = z.$$

Equations (14) are the required formulas for converting from the unprimed rectangular coordinate system to the primed rectangular coordinate system. Compare these equations to equations (8) and note that they are identical except for the introduction of the z component. The inverse transformations are

$$x = x' \cos \phi - y' \sin \phi,$$

$$y = x' \sin \phi + y' \cos \phi, \qquad (15)$$

and

$$z = z'.$$

Compare equations (15) to equations (9). Also compare Figures 11 and 14 and observe that the orientation of the x and y axes in Figure 11 is the same orientation as the x and y axes in Figure 14 when the x-y plane is observed from the direction of the positive z-axis. Now, if a rotation is to be performed about the y-axis or in the x-z plane, view the x-z plane from the direction of the positive y-axis. If we orient these axes in the same manner as the x and y axes in Figure 11, we find that the z-axis is to the right and that the x-axis is is up (see Figure 21). The point is that Figure 11 can be converted into Figure 21 by replacing x by z and

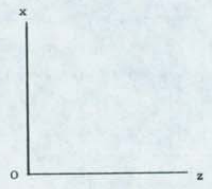


Figure 21. x-z plane as viewed from the positive y-direction.

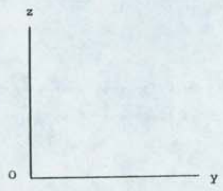


Figure 22. y-z plane as viewed from the positive x-direction.

y by x. This can be done in equations (14) to obtain the rotation formulas about the y-axis; the value of y remains unchanged. The formulas are

$$z' = z \cos \phi + x \sin \phi,$$

$$x' = -z \sin \phi + x \cos \phi, \qquad (16)$$

and

$$y' = y.$$

The inverse transformation equations are

$$z = z' \cos \phi - x' \sin \phi,$$

$$x = z' \sin \phi + x' \cos \phi, \qquad (17)$$

and

$$y = y'.$$

The rotation formulas about the x-axis (see Figure 22) can be obtained in a similiar manner. They are

$$y' = y \cos \phi + z \sin \phi,$$

$$z' = -y \sin \phi + z \cos \phi, \qquad (18)$$

and

$$x' = x.$$

The inverse transformation equations are

$$y = y' \cos \phi - z' \sin \phi,$$

$$z = y' \sin \phi + z' \cos \phi, \qquad (19)$$

and

$$x = x'.$$

By now this must all appear to be quite confusing and complex, so let us take time out and work through a practical example of converting from equatorial spherical coordinates to ecliptic spherical coordinates.

Equatorial to Ecliptic Coordinate Transformation

Earlier it was stated that two commonly used coordinate systems are the ecliptic system and the equatorial system. In the ecliptic system the reference plane is the plane of the ecliptic, or the plane in which the Earth moves around the Sun. In the equatorial system the reference plane is the plane of the Earth's equator. As the Earth moves about the Sun, the apparent motion of the Sun is from the South in the winter months (First Point of Capricorn) towards the North in the summer months (Last Point of Gemini) and then to the South again. There is a point at which the apparent path of the Sun crosses the equator from South to North. The actual position of this crossing is known as the Vernal Equinox or the First Point of Aries; the time of crossing is on the 21st or 22nd of March of each year. The direction of the First Point of Aries is chosen as the reference direction in both the equatorial and ecliptic coordinate systems. This direction is the same in both the heliocentric and geocentric systems. The relationship between the ecliptic and equatorial coordinate systems is depicted in Figure 23.

In the rectangular system the positive x-axis always points in the direction of the Vernal Equinox and the z-axis always points North. In the equatorial system North is called celestial North and is close to the direction of the Pole Star, Polaris. In the ecliptic system North is called ecliptic North and is in a direction of about 23°.5 from Polaris and is in the constellation of Draco.

In both of these systems the direction of the x-axis and the z-axis have been well defined; the y-axis is taken to be in the reference plane and at right angles (90°) to the x-axis. The positive y-direction is 90° counterclockwise from the x-axis as viewed by looking at the reference plane from the positive z-direction.

In the ecliptic spherical coordinate system it is conventional to measure the angle in the reference plane (plane of the x'-axis and y'-axis, or x'-y' plane) as positive from the positive x'-direction (reference direction) toward the positive y'-direction. This angle is called the ecliptic longitude (or just longitude) and is usually designated by the Greek letter lambda, λ. The second direction is measured from the reference plane and is positive in the direction of the positive z'-axis. This angle is called the ecliptic latitude (or just latitude) and is usually designated by the Greek letter beta, β.

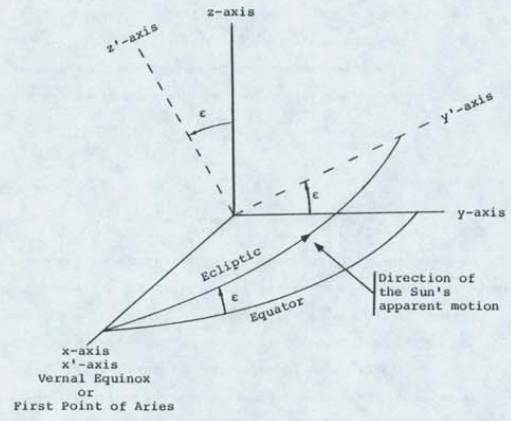


Figure 23. Ecliptic and Equatorial Coordinate Systems

In the equatorial spherical coordinate system the measurements are similiar to the measurements in the ecliptic system. In both systems the x-axes coincide but the z-axes are about 23°.5 apart (and thus the y-axes are about 23°.5 apart). The equatorial angle which is measured in the reference plane (x-y plane) is called the right ascension (instead of longitude) and is denoted by the Greek letter alpha, α. The second angle which is measured from the reference plane toward (or away from) the z-axis is called the declination (instead of latitude) and is denoted by the Greek letter delta, δ.

The relationship between the equatorial and the ecliptic coordinate systems are depicted in Figure 23. The angle between the y-axes, and which is the angle between the ecliptic plane and the equatorial plane is called the obliquity of the ecliptic (or simply, obliquity) and is denoted by the Greek letter epsilon, ε.

Since the x'-axis of the ecliptic system coincides with the x-axis of the equatorial system, it is apparent from Figure 23 that the transformation between these two coordinate systems involves a rotation about the x-axis, or in the y-z plane, through the angle ε, and in particular the transformation from the equatorial system (unprimed) to the ecliptic system (primed) is given by rotation equations (18). That equations (18) rather than equations (19) should be used can be seen by reviewing the two dimensional discussion, comparing Figure 11 with Figure 23, and comparing equations (8) and (9) with equations (18) and (19).

For ease in reference, equations (18) are

$$x' = x,$$

$$y' = y \cos \varepsilon + z \sin \varepsilon, \qquad (20)$$

and $$z' = -y \sin \varepsilon + z \cos \varepsilon.$$

Let us follow through a specific example. Suppose we wish to convert the equatorial coordinates of epoch 1950.0 of Arcturus to ecliptic coordinates. The equatorial coordinates are right ascension $\alpha = 213°20'45"$ and declination $\delta = 19°26'31"$. First, we must transform the equatorial spherical coordinates to equatorial rectangular coordinates using equations (13), which are

$$x = r \cos \delta \cos \alpha,$$

$$y = r \cos \delta \sin \alpha, \qquad (21)$$

and $$z = r \sin \delta.$$

Since r is the same in both the equatorial and ecliptic systems, and since a precise value of r is not required, it is customary to let r = 1 in equations (21); actually the value of r cancels out in the computations and so in these equations it does not matter what choice is made for r (other than zero). Thus we obtain

$$x = \cos 19°26'31" \cos 213°20'45" = -0.787735,$$

$$y = \cos 19°26'31" \sin 213°20'45" = -0.518347,$$

and

$$z = \sin 19°26'31" = 0.332852$$

as the equatorial rectangular coordinates of Arcturus.

Now we convert the equatorial rectangular coordinates to ecliptic rectangular coordinates using the rotation equations (20) with $\varepsilon = 23°26'45"$. The results are

$$x' = -0.787735,$$

$$y' = -0.518347 \cos 23°26'45" + 0.332852 \sin 23°26'45",$$

and

$$z' = 0.518347 \sin 23°26'45" + 0.332852 \cos 23°26'45"$$

or

$$x' = -0.787735,$$

$$y' = -0.343115,$$

and $$z' = 0.511611.$$

Finally, these ecliptic rectangular coordinates are converted to ecliptic spherical coordinates using equations (12b) and (12c) which we write as

$$\lambda = \tan^{-1}(y'/x'),$$

and $$\beta = \sin^{-1}(z'/r').$$

We know that we have chosen $r = r' = 1$, but we can use equation (12a) as a check on our arithmetic to see that

$$r' = \sqrt{(-0.787735)^2 + (-0.343115)^2 + (0.511611)^2}$$

$$= 1.000000.$$

Now,

$$\lambda = \tan^{-1}(-0.343115/-0.787735) = 203°32'12",$$

and $$\beta = \sin^{-1}(0.511611/1.000000) = 30°46'16".$$

The inverse problem of converting ecliptic spherical coordinates to equatorial spherical coordinates is accomplished in exactly the same way as the foregoing with the one exception that rotation equations (19) are used instead of equations (18).

Rotation Matrices

All coordinate rotations may be performed without any knowledge of the material that is presented in this section. Equations (8) and (9) are sufficient to perform rotations in two dimensions. In three dimensions, rotations about the z-axis are performed with equations (14) and (15), rotations about the y-axis are performed with equations (16) and (17), and rotations about the x-axis are performed with equations (18) and (19). Nothing more is needed. However, mathematicians and astronomers often use a shorthand notation to represent the equations of rotation; this representation is called matrix notation. An excellent reference in which this notation is used is the text, "Spherical and Practical Astronomy as Applied to Geodesy", by Ivan I. Mueller, Frederick Ungar Publishing Co., Inc., 1969.

Before delving into the rotation matrices it would be best to first illustrate how a system of equations can be represented in matrix form. A typical example is the system

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}. \qquad (22)$$

To convert this matrix system to the usual form, we must multiply the 3x1 vector (read "3 by 1", and means 3 rows and 1 column)

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

by the 3x3 matrix (3 rows and 3 columns)

$$\begin{bmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{bmatrix}.$$

The result of the multiplication is

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} a_1x + a_2y + a_3z \\ b_1x + b_2y + b_3z \\ c_1x + c_2y + c_3z \end{bmatrix}.$$

Observe that we have a 3x1 vector on the left and a 3x1 vector on the right. For these two vectors to be equal, each component of the vector on the right must be equal to the corresponding component of the vector on the left. That is,

$$x' = a_1x + a_2y + a_3z,$$

$$y' = b_1x + b_2y + b_3z, \qquad (23)$$

and

$$z' = c_1x + c_2y + c_3z.$$

We say that the matrix system (22) is shorthand for the algebraic system (23). To evaluate the system (22), the computations that are performed are given by equations (23). Note that the matrix multiplication indicated in equation (22) is performed by first multiplying each consecutive element of the first row of the matrix by each consecutive element of the right hand column vector, that is a_1x, a_2y and a_3z; these products are then added together to obtain $a_1x + a_2y + a_3z$; then this result is equal to the first element, x', of the left hand column vector. Next the second row of the matrix is "multiplied" onto the right hand column vector, and finally the third row of the matrix is "multiplied" onto the right hand column vector in the same way.

As an example, consider the following numeric system

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} 5 & 3 & 2 \\ -6 & 4 & 7 \\ 3 & -1 & 2 \end{bmatrix} \begin{bmatrix} 3 \\ 2 \\ 4 \end{bmatrix}$$

Proceeding as outlined above, we have

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} (5)(3) + (3)(2) + (2)(4) \\ (-6)(3) + (4)(2) + (7)(4) \\ (3)(3) + (-1)(2) + (2)(4) \end{bmatrix} = \begin{bmatrix} 29 \\ 18 \\ 15 \end{bmatrix}$$

or x' = 29, y' = 18 and z' = 15.

All of this may seem unnecessary, and in fact it is unnecessary; but in complex systems there is a certain economy that makes it all worth while for the professional. For one thing, it is an easier way to convey concepts without having to be burdened with writing out lengthy equations.

We now define the three fundamental rotation matrices:

$$R_1(\phi) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\phi & \sin\phi \\ 0 & -\sin\phi & \cos\phi \end{bmatrix},$$

$$R_2(\phi) = \begin{bmatrix} \cos\phi & 0 & -\sin\phi \\ 0 & 1 & 0 \\ \sin\phi & 0 & \cos\phi \end{bmatrix},$$

and

$$R_3(\phi) = \begin{bmatrix} \cos\phi & \sin\phi & 0 \\ -\sin\phi & \cos\phi & 0 \\ 0 & 0 & 1 \end{bmatrix}.$$

These three matrices are denoted by $R_1(\phi)$, $R_2(\phi)$ and $R_3(\phi)$. The symbol R_1 means that the rotation is about the first coordinate axis, or the x-axis; R_2 means that the rotation is about the second coordinate axis, or y-axis; and finally R_3 means that the rotation is about the third coordinate axis, or z-axis. The argument of the rotation ϕ designates the angle through which the rotation is to be performed.

To carry our notational simplification even further, let

$$\vec{X} = \begin{bmatrix} x \\ y \\ z \end{bmatrix} \quad \text{and} \quad \vec{X}' = \begin{bmatrix} x' \\ y' \\ z' \end{bmatrix}.$$

Now, we can write equations (14), (16), and (18) as

$$\vec{X}' = R_3(\phi)\vec{X},$$

$$\vec{X}' = R_2(\phi)\vec{X},$$

and

$$\vec{X}' = R_1(\phi)\vec{X},$$

respectively.

Usually the computation of an inverse transformation matrix is quite involved. Fortunately the inverse rotation matrices are formed very easily. The inverse of $R_3(\phi)$ is found by replacing ϕ by $-\phi$, which is equivalent to replacing $\sin\phi$ by $-\sin\phi$ in the matrices. Thus the inverse $R_3(\phi)$ is $R_3(-\phi)$ and is

$$R_3(-\phi) = \begin{bmatrix} \cos(-\phi) & \sin(-\phi) & 0 \\ -\sin(-\phi) & \cos(-\phi) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

or

$$R_3(-\phi) = \begin{bmatrix} \cos\phi & -\sin\phi & 0 \\ \sin\phi & \cos\phi & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Similiarly $R_2(-\phi)$ and $R_1(-\phi)$ are the inverse matrices of $R_2(\phi)$ and $R_1(\phi)$, respectively.

The inverse transformation equations (15), (17) and (19) can now be written as

$$\vec{X} = R_3(-\phi)\vec{X}',$$

$$\vec{X} = R_2(-\phi)\vec{X}' ,$$

and

$$\vec{X} = R_1(-\phi)\vec{X}' ,$$

respectively.

By way of illustration, equation (20) in the earlier example will be evaluated in matrix form. Write equation (20) as

$$\vec{X}' = R_1(\varepsilon)\vec{X} .$$

Then

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\varepsilon & \sin\varepsilon \\ 0 & -\sin\varepsilon & \cos\varepsilon \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} ,$$

or

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.917437 & 0.397882 \\ 0 & -0.397882 & 0.917437 \end{bmatrix} \begin{bmatrix} -0.787735 \\ -0.518347 \\ 0.332852 \end{bmatrix} ,$$

$$= \begin{bmatrix} (1)(-0.787735)+(0)(-0.518347)+(0)(0.332852) \\ (0)(-0.787735)+(0.917437)(-0.518347)+(0.397882)(0.332852) \\ (0)(-0.787735)+(-0.397882)(-0.518347)+(0.917437)(0.332852) \end{bmatrix} ,$$

or

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} -0.787735 \\ -0.343115 \\ 0.511612 \end{bmatrix} .$$

These techniques will be illustrated further in the next section.

A Comprehensive Illustration

To illustrate some of the major facets of planetary coordinate transformation we will find the position and motion of Mercury for 1 April 1979 at 0h00m E.T. (Ephemeris Time) using equations presented in the previous issues of MATRIX. For reference, M1 and M2 will denote issue 1 and issue 2 of MATRIX, respectively; page numbers such as p60 will be appended so that M1p60 will denote page 60 of issue 1.

From M1p60 we find that the Julian Day Number for Greenwich Noon on 1 April 1979 is 2443965; 0h00m is 0.5 days earlier, so the Julian Day Number for the date and time of interest is JD = 2443964.5. The fundamental time unit in planetary computations is the number of Julian Centuries elapsed from 0.5 January 1900, and is denoted by T. For 0.5 January 1900 we find that JD1900 = 2415020. Thus the number of days elapsed is t = JD - JD1900 = 28944.5. Since there are 36525 days in a Julian Century, T = 28944.5/36526 = 0.792457221l. This value of T will be used in many of the following computations.

The next step is to compute the mean orbital elements for Mercury (M2p31) using the value of T just obtained. Compute the mean longitude

$$L = 178°10'44".68 + 538106654".8T + 1".084T^2$$

$$= 427067949".7 = 118629°.9860 = 189°.9860 ,$$

the longitude of perihelion

$$\tilde{\omega} = 75°53'58".91 + 5599".76T + 1".061T^2$$

$$= 277677".15 = 77°.1325 ,$$

the longitude of the ascending node

$$\Omega = 47°08'45".40 + 4266".75T + 0".626T^2$$

$$= 173107".01 = 48°.0853 ,$$

the eccentricity

$$e = 0.20561421 + 0.00002046T - 0.0000000301T^2$$

$$= 0.20563040 ,$$

the orbital inclination

$$i = 7°00'10".37 + 6".699T - 0".066T^2$$

$$= 25217".017 = 7°.0047 ,$$

and the semimajor axis

$$a = 0.3870984 .$$

Then compute the mean anomaly

$$M = L - \tilde{\omega} = 112°.8535 ,$$

and the argument of perihelion

$$\omega = \tilde{\omega} - \Omega = 29°.0472 .$$

All of these quantities will be used in our computation before we are finished.

The next step is to solve Kepler's equation

$$M = E - e \sin E$$

for the eccentric anomaly E. There are many ways in which this can be done efficiently, however we will use the most direct but least elegant method and rewrite the equation as

$$E = M + e \sin E \ .$$

Then we will guess a value of E, and in particular use the guess that E = M. We will substitute this value into the right-hand side of the equation and thus compute an improved value for E. We will continue improving our value of E until no further improvement is possible.

One very important caution is required. We must be very careful of our units of measurement and not accidently attempt to add "apples" to "oranges". In Kepler's equation sin E is a pure number and so has no units. Also e is a pure number, but we have M = 112°.8535 and degrees is not a pure number in angular measurement. In mathematics the pure unit of angular measurement is the radian. The number of radians in a full circle is the ratio of the circumference of a circle, $2\pi r$, to its radius, r. This ratio is $2\pi = 6.283185$. Thus a full circle consists of 6.283185 radians; it also consist of 360°. Consequently there are $360°/2\pi = 57.295780$ degrees per radian. Then M = 112°.8535/57.295780 = 1.969665 radians. We will now proceed to solve Kepler's equation with

$$E = 1.969665 + 0.20563040 \sin E \ .$$

"Guess"	sin E	Improved value
1.969665	0.921501	2.159154
2.159154	0.831854	2.140719
2.140719	0.841943	2.142794
2.142794	0.840821	2.142563
2.142563	0.840946	2.142589
2.142589	0.840932	2.142586
2.142586	0.840934	2.142587
2.142587	0.840934	2.142587

We have now found that E = 2.142587 radians or E = 2.142587 x 57.295780 = 122°.7612. For the most part we can continue our computations using the more familiar "degree" measurement, but later we will need to use E in radians when we perform the motion computations.

Next we will perform the position computations which are found in M2p37. The perifocal coordinates of Mercury are

$$X_\omega = a(\cos E - e) = -0.289073 \text{ a.u.},$$

$$Y_\omega = a\sqrt{1 - e^2} \sin E = 0.318568 \text{ a.u.},$$

and $$Z_\omega = 0.$$

These perifocal coordinates must be "reduced to the ecliptic" to obtain the heliocentric ecliptic rectangular coordinates of Mercury. This reduction is accomplished by three rotations. Using our matrix notation the equations of the reduction are denoted by

$$\vec{X}_H = R_3(-\Omega) R_1(-i) R_3(-\omega) \vec{X}_\omega \qquad (24)$$

where

$$\vec{X}_\omega = \begin{bmatrix} X_\omega \\ Y_\omega \\ Z_\omega \end{bmatrix} = \begin{bmatrix} -0.289073 \\ 0.318568 \\ 0. \end{bmatrix}$$

and

$$\vec{X}_H = \begin{bmatrix} X_H \\ Y_H \\ Z_H \end{bmatrix}$$

are the desired heliocentric ecliptic rectangular coordinates of Mercury.

The reduction to the ecliptic is amazingly easy to implement using the polar/rectangular function of most handheld calculators since the transformations given by equations (1) and (2) are carried out by two or three simple keystrokes. But since we wish to illustrate the classical use of the rotation matrices we shall continue with the tedium of the evaluation of the so-called Euler matrix

$$E = R_3(-\Omega) R_1(-i) R_3(-\omega) \ .$$

Although there are several ways in which the evaluation of equations (24) can be performed, we will compute the Euler matrix since the same matrix will be needed to reduce the velocity components of Mercury to the ecliptic.

In the section on rotation matrices we showed how to multiply a vector by a matrix. To multiply a matrix by a matrix we think of the second matrix as a collection of three vectors. The result of multiplying the first matrix onto each of three vectors results in three new vectors. By placing these three vectors side by side we have a new matrix. In detail, we evaluate the following:

$$R_3(-\Omega) R_1(-i) = \begin{bmatrix} \cos\Omega & -\sin\Omega & 0 \\ \sin\Omega & \cos\Omega & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos i & -\sin i \\ 0 & \sin i & \cos i \end{bmatrix}$$

Multiply the first column (vector) of $R_1(-i)$ by $R_3(-\Omega)$. The result is

$$R_3(-\Omega) \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} (1)(\cos\Omega) + (0)(-\sin\Omega) + (0)(0) \\ (1)(\sin\Omega) + (0)(\cos\Omega) + (0)(0) \\ (0)(\ 1\ ) + (0)(\ 0\ ) + (1)(0) \end{bmatrix}$$

or

$$R_3(-\Omega)\begin{bmatrix}1\\0\\0\end{bmatrix} = \begin{bmatrix}\cos\Omega\\ \sin\Omega\\ 0\end{bmatrix}.$$

This vector is the first column of the matrix which results when $R_3(-\Omega)$ multiplies $R_1(-i)$. The second column is

$$R_3(-\Omega)\begin{bmatrix}0\\ \cos i\\ \sin i\end{bmatrix} = \begin{bmatrix}-\sin\Omega\cos i\\ \cos\Omega\cos i\\ \sin i\end{bmatrix}$$

and the third column is

$$R_3(-\Omega)\begin{bmatrix}0\\ -\sin i\\ \cos i\end{bmatrix} = \begin{bmatrix}\sin\Omega\sin i\\ -\cos\Omega\sin i\\ \cos i\end{bmatrix}.$$

The result is

$$R_3(-\Omega)R_1(-i) = \begin{bmatrix}\cos\Omega & -\sin\Omega\cos i & \sin\Omega\sin i\\ \sin\Omega & \cos\Omega\cos i & -\cos\Omega\sin i\\ 0 & \sin i & \cos i\end{bmatrix}.$$

Unfortunately we are not done, for we must multiply the $R_3(-\Omega)R_1(-i)$ matrix onto the $R_3(-\omega)$ matrix to arrive at the final Euler matrix. The symbolic details are much too involved, so we will return to our numerical example. We have

$$R_3(-\Omega)R_1(-i) = R_3(-48°.0853)R_1(-7°.0047)$$

$$= \begin{bmatrix}0.668023 & -0.744140 & 0\\ 0.744140 & 0.668023 & 0\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}1 & 0. & 0.\\ 0 & 0.992536 & -0.121951\\ 0 & 0.121951 & 0.992536\end{bmatrix}$$

$$= \begin{bmatrix}0.668023 & -0.738586 & 0.090749\\ 0.744140 & 0.663037 & -0.081466\\ 0 & 0.121951 & 0.992536\end{bmatrix}.$$

Next we multiply this matrix onto the matrix $R_3(-\omega)$ so that

$$\mathcal{E} = [R_3(-\Omega)R_1(-i)]R_3(-29°.0472)$$

$$= \begin{bmatrix}0.668023 & -0.738586 & 0.090749\\ 0.744140 & 0.663037 & -0.081466\\ 0 & 0.121951 & 0.992536\end{bmatrix}\begin{bmatrix}0.874220 & -0.485530 & 0\\ 0.485530 & 0.874220 & 0\\ 0 & 0 & 1\end{bmatrix}$$

or

$$\mathcal{E} = \begin{bmatrix}0.225393 & -0.970032 & 0.090749\\ 0.972466 & 0.218338 & -0.081466\\ 0.059211 & 0.106612 & 0.992536\end{bmatrix}. \qquad (25)$$

With the Euler matrix we can now return to equation (24) and complete the reduction to the ecliptic. From equation (24 we have

$$\vec{X}_H = \mathcal{E}\vec{X}_\omega$$

or

$$\begin{bmatrix}X_H\\ Y_H\\ Z_H\end{bmatrix} = \begin{bmatrix}0.225393 & -0.970032 & 0.090749\\ 0.972466 & 0.218338 & -0.081466\\ 0.059211 & 0.106612 & 0.992536\end{bmatrix}\begin{bmatrix}-0.289073\\ 0.318568\\ 0\end{bmatrix}$$

$$= \begin{bmatrix}-0.374176\\ -0.211558\\ 0.016847\end{bmatrix}.$$

These are the heliocentric ecliptic rectangular coordinates of Mercury. If desired, the heliocentric spherical coordinates may be computed using equations (12). These coordinates are

$$r_H = 0.430172 \text{ a.u.},$$

$$\lambda_H = \tan^{-1}(Y_H/X_H) = 209°.4837,$$

$$\beta_H = \sin^{-1}(Z_H/r_H) = 2°.2445 .$$

Using a similiar series of computations we find that the heliocentric ecliptic rectangular coordinates of the Sun are

$$\begin{bmatrix}X_{SUN}\\ Y_{SUN}\\ Z_{SUN}\end{bmatrix} = \begin{bmatrix}0.981858\\ 0.185168\\ 0\end{bmatrix}.$$

To obtain the geocentric ecliptic rectangular coordinates of Mercury we must translate the coordinate system using methods discussed earlier; add the heliocentric coordinates of the Sun to the heliocentric coordinates of Mercury.

$$\vec{X}_G = \begin{bmatrix}X_G\\ Y_G\\ Z_G\end{bmatrix} = \begin{bmatrix}X_H\\ Y_H\\ Z_H\end{bmatrix} + \begin{bmatrix}X_{SUN}\\ Y_{SUN}\\ Z_{SUN}\end{bmatrix}$$

$$= \begin{bmatrix}-0.374176\\ -0.211558\\ 0.016847\end{bmatrix} + \begin{bmatrix}0.981858\\ 0.185168\\ 0\end{bmatrix}$$

or

$$\begin{bmatrix} X_G \\ Y_G \\ Z_G \end{bmatrix} = \begin{bmatrix} 0.607682 \\ -0.026390 \\ 0.016847 \end{bmatrix}.$$

The geocentric ecliptic spherical coordinates of Mercury are then obtained using equations (12). They are

$$r_G = 0.608488 \text{ a.u.},$$

$$\lambda_G = 357°.5134 = 357°31',$$

and $$\beta_G = 1°.5865 = 1°35'.$$

The longitude and latitude are shown only to the nearest minute because of the inaccuracies involved with two-body Kepler orbits.

If the right ascension and declination are required, we must find the obliquity of the ecliptic for 1 April 1977. The mean obliquity (uncorrected for nutation) is given by

$$\epsilon_0 = 23°27'08".26 - 46".845T - 0".0058T^2 + 0".00181T^3$$

$$= 84391".13 = 23°.4420.$$

If we ignore the small nutation correction, then the geocentric equatorial rectangular components of Mercury are

$$\vec{X}_{EQ} = R_1(-\epsilon_0)\vec{X}_G$$

or

$$\begin{bmatrix} X_{EQ} \\ Y_{EQ} \\ Z_{EQ} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.917463 & -0.397820 \\ 0 & 0.397820 & 0.917463 \end{bmatrix} \begin{bmatrix} 0.607682 \\ -0.026390 \\ 0.016847 \end{bmatrix}$$

$$= \begin{bmatrix} 0.607682 \\ -0.030914 \\ 0.004958 \end{bmatrix}.$$

Again using equations (12) the geocentric equatorial coordinates of Mercury are

$$r_G = 0.608488 \text{ a.u.},$$

$$\alpha_G = 357°.0878 = 357°05' = 23^h48^m,$$

and $$\delta_G = 0°.4669 = 0°28'.$$

This completes the position computations. The motion (velocity) computation will be performed next.

The motion computations are described in M2p2-4. Once more the eccentric anomaly in radian measure is required. The time rate-of-change of the eccentric anomaly is

$$E' = \frac{k\sqrt{\mu}}{a^{3/2}(1 - e \cos E)}$$

or

$$E' = \frac{(0.01720209895)(1)}{(0.3870984)^{3/2}[1 - (0.20563040)(-0.541139)]}$$

$$= 0.064273 \text{ radians/day}.$$

The perifocal velocity components are

$$X_\omega' = -aE' \sin E$$

$$= -0.020922 \text{ a.u./day},$$

$$Y_\omega' = aE'\sqrt{1 - e^2} \cos E$$

$$= -0.013176 \text{ a.u./day},$$

and $$Z_\omega' = 0.$$

The daily motion in orbit for Mercury is

$$(X_\omega Y_\omega' - Y_\omega X_\omega')/(X_\omega^2 + Y_\omega^2)$$

$$= 0.056600 \text{ radians/day}$$

$$= 3°.2430/day.$$

The value given by the *American Ephemeris and Nautical Almanac* for this motion is 3°.2431/day.

The perifocal velocity components can now be reduced to the ecliptic using the transformation

$$\vec{X}_H' = E\vec{X}_\omega'$$

where E is the Euler matrix in equation (25). We have

$$\begin{bmatrix} X_H' \\ Y_H' \\ Z_H' \end{bmatrix} = \begin{bmatrix} 0.225393 & -0.970032 & 0.090749 \\ 0.972466 & 0.218338 & -0.081466 \\ 0.059211 & 0.106612 & 0.992536 \end{bmatrix} \begin{bmatrix} -0.020922 \\ -0.013176 \\ 0 \end{bmatrix}$$

$$= \begin{bmatrix} 0.008065 \\ -0.023223 \\ -0.002644 \end{bmatrix}.$$

Using similiar computations, the heliocentric ecliptic velocity vector of the Sun is

$$= \begin{bmatrix} -0.002907 \\ 0.016967 \\ 0 \end{bmatrix}.$$

The geocentric ecliptic motion of Mercury is

$$\vec{X}_G' = \begin{bmatrix} X_G' \\ Y_G' \\ Z_G' \end{bmatrix} = \begin{bmatrix} X_{SUN}' \\ Y_{SUN}' \\ Z_{SUN}' \end{bmatrix} + \begin{bmatrix} X_H' \\ Y_H' \\ Z_H' \end{bmatrix}$$

or

$$\begin{bmatrix} X_G' \\ Y_G' \\ Z_G' \end{bmatrix} = \begin{bmatrix} 0.005158 \\ -0.006256 \\ -0.002644 \end{bmatrix}.$$

The motion of Mercury in geocentric longitude is

$$\lambda' = (X_G Y_G' - Y_G X_G')/(X_G^2 + Y_G^2)$$

$$= -0.009908 \text{ radians/day}$$

$$= -0°.5677/\text{day} = -0°34'/\text{day}.$$

The negative sign means that the motion is retrograde in longitude.

The motion in geocentric latitude is

$$\beta' = \frac{X_G(X_G Z_G' - Z_G X_G') + Y_G(Y_G Z_G' - Z_G Y_G')}{(X_G^2 + Y_G^2 + Z_G^2)(X_G^2 + Y_G^2)^{1/2}}$$

$$= -0.004589 \text{ radians/day}$$

$$= -0°.2629/\text{day} = -0°15'/\text{day}.$$

The negative sign here means that the latitude is decreasing.

If desired, the geocentric equatorial motion of Mercury can also be computed. First, the equatorial rectangular motion is

$$\vec{X}_{EQ}' = R_1(-\varepsilon_0)\vec{X}_G'$$

or

$$\begin{bmatrix} X_{EQ}' \\ Y_{EQ}' \\ Z_{EQ}' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.917463 & -0.397820 \\ 0 & 0.397820 & 0.917463 \end{bmatrix} \begin{bmatrix} 0.005158 \\ -0.006256 \\ -0.002644 \end{bmatrix}$$

$$= \begin{bmatrix} 0.005158 \\ -0.004688 \\ -0.004915 \end{bmatrix}$$

is required. Then

$$\alpha' = (X_{EQ} Y_{EQ}' - Y_{EQ} X_{EQ}')/(X_{EQ}^2 + Y_{EQ}^2)$$

$$= -0.007264 \text{ radians/day}$$

$$= -0°.4162/\text{day} = -0°25'.$$

The negative sign means that the motion is retrograde in right ascension.

Finally, using the form of the equation that was used to calculate β', we have

$$\delta' = -0.008149 \text{ radians/day}$$

$$= -0°.4669/\text{day} = -0°28'.$$

The negative sign means that the declination is decreasing or that the motion is from North to South.

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Date	Long.	Lat.	R.A.	Dec.	HLong.	HLat.
1/ 7	5TA 5	1S 7	33 10	12N10	8TA 8	1S 5
1/17	5TA 3	1S 7	33 8	12N 9	8TA14	1S 6
1/27	5TA 7	1S 7	33 12	12N11	8TA21	1S 7
2/ 6	5TA17	1S 7	33 22	12N14	8TA28	1S 8
2/16	5TA32	1S 7	33 37	12N19	8TA34	1S 8
2/26	5TA53	1S 7	33 57	12N26	8TA41	1S 9
3/ 8	6TA18	1S 8	34 22	12N34	8TA48	1S10
3/18	6TA48	1S 8	34 50	12N43	8TA54	1S11
3/28	7TA20	1S 8	35 22	12N53	9TA 1	1S12
4/ 7	7TA56	1S 9	35 56	13N 4	9TA 8	1S12
4/17	8TA32	1S 9	36 33	13N15	9TA14	1S13
4/27	9TA10	1S10	37 10	13N27	9TA21	1S14
5/ 7	9TA49	1S11	37 47	13N38	9TA28	1S15
5/17	10TA27	1S12	38 25	13N49	9TA34	1S16
5/27	11TA 3	1S13	39 1	14N 0	9TA41	1S16
6/ 6	11TA38	1S14	39 35	14N 9	9TA48	1S17
6/16	12TA10	1S15	40 7	14N18	9TA55	1S18
6/26	12TA39	1S16	40 36	14N26	10TA 1	1S19
7/ 6	13TA 4	1S17	41 1	14N32	10TA 8	1S20
7/16	13TA24	1S19	41 22	14N37	10TA15	1S20
7/26	13TA40	1S20	41 38	14N40	10TA22	1S21
8/ 5	13TA51	1S22	41 48	14N41	10TA28	1S22
8/15	13TA55	1S24	41 54	14N41	10TA35	1S23
8/25	13TA55	1S25	41 53	14N40	10TA42	1S24
9/ 4	13TA48	1S27	41 47	14N36	10TA49	1S24
9/14	13TA36	1S28	41 36	14N31	10TA55	1S25
9/24	13TA19	1S30	41 20	14N24	11TA 2	1S26
10/ 4	12TA57	1S31	40 59	14N17	11TA 9	1S27
10/14	12TA32	1S33	40 35	14N 8	11TA16	1S28
10/24	12TA 4	1S34	40 8	13N58	11TA23	1S28
11/ 3	11TA35	1S35	39 39	13N48	11TA30	1S29
11/13	11TA 6	1S36	39 10	13N39	11TA36	1S30
11/23	10TA37	1S36	38 43	13N29	11TA43	1S31
12/ 3	10TA11	1S37	38 17	13N21	11TA50	1S32
12/13	9TA48	1S37	37 55	13N13	11TA57	1S32
12/23	9TA30	1S37	37 38	13N 8	12TA 4	1S33

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Stations	Date	Long.	Lat.
DIRECT	1/15.11	5TA 3	1S 7
RETROGRADE	8/18.54	13TA56	1S24

THE BIRTH OF STARLIFE

by ROGER ELLIOT

The Manor Cossington BRIDGWATER Somerset UK

Eighteen months ago, I bought my first calculator. Nine months ago, I ordered my PET computer. Now, at the start of 1979, I have launched my own computerised horoscope service, named Starlife. This is the story of its birth - from its ecstatic conception in the United States last year to its triumphant delivery to the British public this year.

I knew from the start that I'd bitten off more than I could chew. It was madness to think that I could instal a computer system, learn programing, write the necessary programs and input all the text within nine months. But that was the deadline. As the astrologer of *TV Times* - the largest-circulation magazine in the whole of Europe - I'd been running a personal horoscope service of sorts for several years. It was pretty inadequate - an ephemeris that calculated Sun, Moon and planets to the nearest 1½ *degrees* and then a very simple analysis of major transits for the twelve months ahead. I had thought of the idea and written the various paragraphs, but a professional programmer had done all the technical work (on an IBM 360) and a marketing company had dealt with all the data input, collating, mailing and other administrative tasks. All that remained for me to do was to bank the (small) royalty check that arrived infrequently.

Then, in the summer of 1977, I met Michael Erlewine and became enthused with the technical side of astrology. On his recommendation I bought an HP-67 and, later, one of the first PETs to be imported into Britain. But it was last spring, on a visit to the Erlewines, that the Starlife concept was born.

Suddenly I realised that, with the price of micro-computers rocketing downwards, I could do the whole *TV Times* horoscope service myself. I could devise a far superior program. I could manufacture a more graceful product than any standard upper-case high-speed line printer could do. And, not least, I could make more money - money that would pay for bigger and better computer equipment that would enable me to do bigger and better astrological research in the future.

So I spent a frantic few weeks, in the midst of an American lecture tour, trying to understand what equipment was available; what it would do; and what all this new-fangled jargon about bits and bytes, RAMS and ROMS, GOTOs and GOSUBs actually meant. I encountered the American Computer Salesman, who comes into two varieties: elegant and scruffy. The elegant version *nearly* got a $10,000 check out of me, but was kindly and helpful. The scruffy version - and there are many currently on show - was disinterested in money itself; he was far more concerned that I *didn't* buy from Mr Elegant and proved a fine constructive critic of all equipment not in his own store. Another lure was the girl advertising the Imsai VTR-80 in all the home-computing magazines. Her brown Californian limbs sent me on expensive wild-goose telephone chase all over the United States in search for a machine that, in reality, had not yet been manufactured.

Eventually, on my return to deepest rural Somerset, I discovered a guy in the nearby market town who had just opened his own computer store - the first in England's West Country. Together we agreed that my best buy would be the newly available Cromemco System Three computer: a Z2-based processor with an integral four-drive floppy-disc system. This provided me with 48K of core memory (later boosted to 64K) and about 1MB of store memory - roughly what I needed and could afford.

For my printer I picked the Tally 1612, a dot-matrix machine working at the comfortable speed of 120 characters/second. Its great virtue is its flexibility of type-faces. No less than six different faces, in upper and lower-case, can be created by varying the width and density of characters, so that a print-out can range from tiny footnotes to broad headlines - very desirable in a product being sold to the general public.

For my VDU, I was fobbed off with a pre-production model from a British company operating, so I learned later, out of a bed-sitting-room in North London. Luckily I hadn't paid for it - and after numerous heartaches I settled for an elaborate Newbury 7009 from a British-based company with government funds behind it.

Let me stress how vital it is that service engineers should be quickly available to sort out hardware faults. Maybe I've had more than my fair share of problems in the last six months, with interface difficulties, dreadful static on the printer itself and one suspect card in the processor that is still giving me crazy little nightmares. (Its latest trick, at a certain level of memory, is to lose track of the decimal point.) I am convinced that it pays to buy sturdy equipment from well-organised companies. There are going to be terrible problems in the next few years for the astrologers who have bought gimcrack peripherals at knock-down prices.

By the time the equipment arrived, in August, I had blocked out the main shape of my programs. The Starlife program itself, running at 38K at the latest count, is quite a complex affair. It's based on an elaborate analysis of the solar return. First it calculates the exact position of the Sun (to the nearest *second* - eat your heart out, Bob Hand!) at the time of your birth, and then calculates when in 1979 it returns to this position again. Then it works out the solar return chart, which is then converted to a harmonic year chart. (If you're 38 next birthday, for instance, your solar return chart is made to vibrate to the 38th harmonic.)

Then all aspects to the Sun - it is a *solar* chart, after all - from every planet, angle and midpoint is measured and analysed for its harmonic content. Thus a square between Mars and Sun means that Mars is on the 4th harmonic, according to this analysis. So the computer produces 92 aspects to the Sun and their corresponding harmonics.

The first part of the written report, dealing with overall trends for the coming year, is composed of a lengthy series of paragraphs, each one devoted to a particular topic and associated with an appropriate planet or midpoint. Thus the Moon-Saturn midpoint deals with relatives older than oneself: parents, grandparents and the like. The Mercury-Midheaven midpoint relates to training in connection with your work. The Venus-Mars midpoint relates to - well, you can guess.

The second half of the report, labelled Key Dates In The Coming Year, is an intriguing method of forecasting events, moods or circumstances. The computer calculates the distance between the Sun and every planet and midpoint in the original solar return chart, and then converts this distance into the time taken by the Sun to move round the Zodiac to form a conjoining transit.. In other words, the solar return chart is assumed to be a symbol for one's year ahead - an alarm clock triggering differing effects into action at the appropriate moment. So a total of 91 dates can be given a meaning. Some are shared by us all, for whenever your birthday and whatever your solar return chart, the Sun will still transit Pluto in the second week of October and Uranus a month later. But other factors, such as the midpoints involving Moon or angles, are intensely personal. Certainly I am pleased by the early results of this predictive technique. It's possible for you to receive an identical report to that of someone else only if you were born within 20 seconds on each other and still live within five miles or each other (for the solar return chart is based on your current locality, not original birth-place.)

Along with this main program I had to devise a series of lesser programs to support it. There's an 18K input program, for instance, which organises all the data being fed in - names and addresses, sex, birth details, money paid, etc. In some ways this was more complex than the astrological program. I had to think of all the possible reasons why a file might be opened - to place an order, or change a mistake, or refund money to a dissatisfied client, or issue a free report, or note who is giving a report to someone else.

There's the filing system for all members of Starlife, with room for 50,000 altogether on a total of 36 floppy discs arranged in alphabetical order. This will enable me to keep track of clients year after year, sending them birthday and Christmas cards and offering them other services by mail order.

There are files of all towns and villages in the British Isles with their latitudes and longitudes, so they do not have to be found and input each time by the operator. And British Summer Time, too, can be automatically calculated by the computer. And there are various financial files, including one - for straight cash transactions - with a special code (automatically changed daily) to guard against the prying eyes of the Inland Revenue.

I mention this at length because it's the sort of system that some other astrologers might hope to set up in the years ahead. Clearly I'm lucky to have the *TV Times* connection. (It's a 90-page, full-format weekly magazine, a cross, I suppose, between the American *TV Guide* and *Saturday Evening Post*.) I had a full-colour double-spread to launch the service in January, with a mention every week and a special feature every month.

But other astrologers, as I say, will be setting up broadly similar ventures, and perhaps you can learn from my trials and errors.

- It's tempting, with a VDU staring you in the face, to start programming straight into memory. It's a mistake, especially if you're dealing with a computer with few editing facilities in the software. It's vital with a large program to use pen and paper first, and to anticipate problems before they arise.

- With a commercial operation like my own, time is the key factor. A second saved here or there becomes a minute saved if, like me, you're producing 60 reports a day. So you search for short cuts. You discover that it's quicker to use a dozen IF...THEN statements that to search a file on disc. Expensive on memory, but quicker in time. You try to pace your program efficiently, for the computer is working much faster than the printer. So you feed a large chunk of text to the printer buffer, and while that's being printed you're already halfway through the planetary calculations.

- You must use the skill of the computer as much as possible. People receiving a computerised horoscope are rightly suspicious that it's a standard product sent to everyone. So my Starlife reports are liberally sprinkled with personal data in the midst of admittedly standard paragraphs. People are reassured to see their Christian name, or age, or birthplace, or home town or Sun-sign mentioned through the text.

- The tone of voice is very important. At one stage, I was thinking of taking out a British franchise on the Para-Research products written by Bob Hand. Now these are excellent in their own way, but they're indubitably *American*, written by an American for his fellow-citizens. Similarly the Astro-Flash product, on sale in London, is indubitably a poor English translation of a French text. Both these products do not ring true to the British ear, although the actual content may be perfectly valid.

- I find that the British do not want to buy a *computerised* horoscope. The more that they feel that they're getting a personal report from an individual astrologer, the happier they are. That's why I've pitched Starlife as a kind of family of like-minded people. If you buy a Starlife horoscope, you're joining a group of friends. (It's noticeable that Michael Erlewine, a fellow-Cancerian, automatically conveys a similarly maternal warmth through Matrix!)

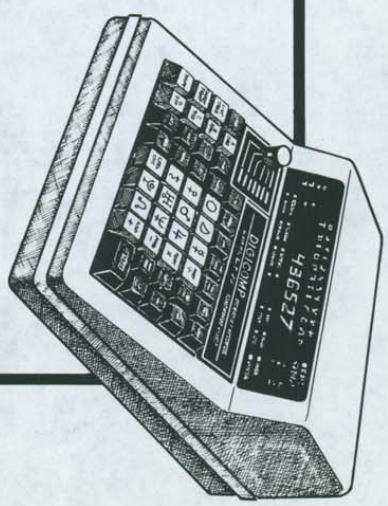
- Never buy equipment that cannot be enlarged or used in conjunction with other machines. Already I'm dreaming of a hard-disc system, a faster printer and multi-user BASIC. And keep planning ahead. In Britain we lead the world in TV information systems. The whole country is capable of receiving three separate services - Ceefax, Oracle and the largest of all, Viewdata, which turns your TV screen into a computer terminal, providing access to a vast and growing library of knowledge covering everything from company reports to - astrology? Well, not yet - but it would be comparatively easy to set up my Starlife program in the mainframe memory. Then anyone could phone the computer, input the relevant birth details, and within seconds receive their individual report in living colour on their TV set.

Finally I want to thank Michael and Margaret Erlewine for all their help in encouraging me to take this entrepreneurial leap, and also Chester Kemp for valuable help on the technical side. I also have one word of warning. If you ever visit the Erlewine's in winter, make sure that you sit next to the hot-air inlet and stick your legs in front. Otherwise their pair of vast white dogs slump together in front of the air-vent, effectively blocking all warmth from the human occupants. It's impossible to move these dogs, or reprimand them, for the leader of the pack is named, appropriately, Mother - and Mother, to all Cancerians, is sacrosanct.

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ASTROLOGICAL DATA PROCESSING: SOLAR ARC DIRECTIONS

by Charles S. Hocking
2727 Antietam Court
Ann Arbor, MI 48105

This subroutine provides a condensed program for examining the Solar Arc Direction between two points in a chart.

This program was developed in support of activities directed by Luci Titunic. The investigation centered around Uranian Astrology when all chartpoints of interest are mapped into the first quadrant resulting in a chart on a " 90-degree dial". Of special interest were the solar arcs, double solar arcs and one-half solar arcs between a planet or a special chart point on the 90-degree dial to a point of concern in the chart.

The mapping of chart points into a 90-degree dial may not be of interest to all readers. There is a set of notes at the end of the article which lists the changes to delete the 90-degree mapping operation.

Also the reader may not require the multiple solar arc comparison provided in this program. It is included because it provides an example of how multiple arc problems could be handled.

The program is in two parts, first is the generation of the arc table and second is the process of comparing the arc between two points in question to the arc values in the table.

As an example, assume that for a chart, the time represented by a Solar Arc Direction of 30 degrees is of special interest. The question is raised, "What points are hit in the natal chart by progressing all points, one at a time, thru an arc of 30 degrees?". First a planet/point is selected and the Arc Table is computed for this planet/point progressed 30 degrees. Points of interest, i.e. midpoints, T-Squares, etc. are just as important in some investigations as are the planets. Next, each planet-point in the chart is compared with the Arc Table and if it is found to be within the table limits, the point is considered hit by the original point progressed by 30 degrees. Normally this hit would be printed out at the operator's terminal. After a point's arc table is compared with all other points, the arc table is computed for the next planet/point and the searching process is repeated. After this is complete for all planet/points, the terminal will contain a detailed listing of all "hits" for this value of Arc and Orb. Next step is to set up the program to cover a range of arcs using increments equal to the orb as the stop value.

At this time we will only concern ourselves with computing the Arc Table and making the comparisons.

THE ARC TABLE

For this example we will compute the areas under investigation for ½ Solar Arc, double Solar Arc and 1 Solar Arc. Including an orb for each point, the table is as follows:

THE ARC TABLE

IPLT = the initial planet/point

```
L(1) = IPLT + 2*SA + orb
L(2) = IPLT + 2*SA - orb
L(3) = IPLT - 2*SA + orb
L(4) = IPLT - 2*SA - orb
L(5) = IPLT + SA + orb
L(6) = IPLT + SA - orb
L(7) = IPLT - SA + orb
L(8) = IPLT - SA - orb
L(9) = IPLT + .5*SA + orb
L(10)= IPLT + .5*SA - orb
L(11)= IPLT - .5*SA + orb
L(12)= IPLT - .5*SA - orb
```

SPLT= Planets or points brought into Arc Table to see if within solar arc orb. If within orb, that point is then SPLT.

If the point under investigation is SPLT, then the test is:

```
IS " L(1)>=SPLT>=L(2)
       OR
     L(3)>=SPLT>=L(4)
       OR
     L(5)>=SPLT>=L(6)
       OR
     L(7)>=SPLT>=L(8)
       OR
     L(9)>=SPLT>=L(10)
       OR
    L(11)>=SPLT>=L(12)"  True?
```

If "yes" then the point SPLT is considered "hit" by IPLT progressed by the solar arc direction.

The table and test are simple to make but they require more analysis if the test is to be done by a computer. As an example if IPLT is 10 degrees, and SA is 7 degrees with an orb of one degree, then:

L(3)= 10 - 2*7 +1 = -3 degrees
L(4)= 10 - 2*7 -1 = -5 degrees

To correct for the negative angle, 90 degrees is added (360 degrees is added if you are not doing a 90 degree dial):

L(3) = -3 + 90 = 87
L(4) = -5 + 90 = 85

and the second step of the test,

L(3)>=SPLT>=L(4),

will be processed correctly.

Also there is a similar problem if the limits straddle zero degrees. If IPLT is 25 degrees and SA = 12 degrees and the orb is 2 degrees, then:

L(3) = 25 - 2*12 +2 = 3 degrees
L(4) = 25 - 2*12 -2 = - 1 degrees

and adding 90 degrees to L(4) yields:L(3)=3 degrees, L(4)= 89°

We know that there is a zero degree point between L(3) and L(4) and when we run the test we really are saying:

IS 3 degrees>= SPLT>= 0 degrees
OR
90 degrees>= SPLT>= 89 degrees

So if a set of limits straddles the zero degree point, you must break up the limits into two sets of limits, one on either side of zero degrees. This is done by adding a set of limits to the end of the Arc Table. For the example of IPLT = 25 degrees, SA = 12 degrees, Orb = 2 degrees then:

L(1) = 51 degrees
L(2) = 47 degrees
L(3) = 3 degrees
L(4) = 0 degrees
.
.
.
L(13)= 90 degrees
L(14)= 89 degrees

At the other end of the chart is a similar problem, straddling the 90 degree point (360 degree point for the standard 360 degree chart) and it is handled the same, by adding a second set of limits at the end of the Arc Table.

Considering both ends of the chart there will be a maximum of two sets of extra limits at the end of the table.

L(1)
↓
L(12)
L(13)
L(14) } To provide for points that straddle
L(15) } 0° or 90°
L(16)

To compute the table ss illustrated requires consideration of the + and - pattern in the table.

```
L(1) = I + M*S +Q
L(2) = I + M*S -Q          I = IPLT
L(3) = I - M*S +Q          M = 2 or 1 or .5
L(4) = I - M*S -Q          S = SA
L(5) = I + M*S +Q          Q = orb
L(6) = I + M*S -Q
L(7) = I - M*S +Q
L(8) = I - M*S -Q
L(9) = I + M*S +Q
L(10)= I + M*S -Q
L(11)= I - M*S +Q
L(12)= I - M*S -Q
```

Where M = 2 for L(1) to L(4), M= 1 for L(5) to L(8) and M = 0.5 for L(9) to L(12)

If N is 1 thru 12 for L(N) i.e. L(1) to L(12) then the sign in front of M is expressed by

(-1)↑INT((N+3)/2)

For N = 1 the sign is +
2 the sign is +
3 the sign is -
4 the sign is -, etc.

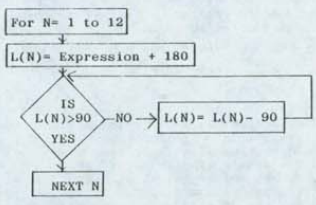
and the sign in front of Q is (-1)↑(N+1)

Therefore the expression for L(N) is:

For N = 1 to 12
L(N)= I +((-1)↑INT((N+3)/2))*M*S+((-1)↑(N+1))*Q

with M = 2 for N= 1 to 4
M = 1 for N= 5 to 8
M =.5 for N= 9 to 12

The flow diagram that computes and adjusts L(N) is



The values for L(1) to L(12) have been computed. Next the values for L(13) to L(16) are set to 999. This value is a flag to the program that there are no limits in L(13) to L(16). As the limits from 1 to 12 are examined if a set of limits are found straddling 0 or 90 degrees then L(13), L(14) or L(15),L(16) are used to hold the extra set of limits required.

This testing proceedure to determine if limits straddle zero degrees is simply a matter of comparing each pair of limits for the first greater than the second, i.e.

L(1)> L(2), L(3)> L(4)...etc. L(11)> L(12)

If any pair of limits do not follow this test then that pair of points is bridging the 90 degree point. For example let

L(5) = 5 degrees and L(6) = 85 degrees

(NOTE that L(5) > L(6) is not true)

Therefore L(5) and L(6) straddle the 90 degree point and must be separated as follows:

L(5) = 90° , L(6) = 85°

L(13) = 5°, L(14) = 0°

If there were a second set of limits that also bridge the 90 degree point, they would use the second set of extra limits, L(15), L(16).

The following is a program listing that computes the Arc Table;

```
8200 REM
8210 DIM L(16)
8220 FOR N=1 to 12
8230 LET M=2
8240 IFN<5 THEN 8280
8250 LET M=1
8260 IF N<9 THEN 8280
8270 LET M=.5
8280 LET L(N)=I+((-1)↑INT((N+3)/2))*M*S+((-1)↑INT(N+1))*Q+180
8290 IF L(N)<90 THEN 8320
8300 LET L(N)=L(N)-90
8310 GOTO 8290
8320 NEXT N
8330 FOR N=13 to 16
8340 LET L(N)=999
8250 NEXT N
8360 LET P=12
8370 FOR N=1 to 11 STEP 2
8380 IF L(N)>L(N+1) THEN 8430
8390 LET L(P+1)=L(N)
8400 LET L(P+2)=0
8410 LET L(N)=90
8420 LET P=P+2
8430 NEXT N
8432 RETURN
```

Note: To use the program for 0 to 360 degree charts, the following changes are made:

8280 change 180 to 360
8290 change 90 to 360

To use the table requires a small subroutine. The point to be examined is entered as J. The subroutine uses Z as its output. If Z=999 the search did not find a "hit". If Z is not equal to 999 then Z= the arc between the points under consideration. (note that I is the initial angle in both the subroutines and the Arc Table computation. It must not be changed until its search is completed).

```
8450 FOR  N=1 to 15 STEP 2
8452 LET Z=999
8455 IF L(N)=999 or L(N+1)=999 THEN 8496
8460 IF J>L(N) OR J<L(N+1) THEN 8496
8470 LET Z= ABS(I-J)
8480 GOTO 8500
8496 NEXT N
8500 RETURN
9999END
```

POSTSCRIPT

Some readers are aware of the trick to get around limits that bridge the zero degree point by offsetting all points such that no point is less than zero. This technique will be outlined in the next MATRIX article.

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NINE HOUSE SYSTEMS in Extended BASIC

by Robert Hand

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Orleans, Mass 02653

```
10 'Function definitions; may have to be converted to subroutines for
20 'some dialects of BASIC.
30 PI=4*ATN(1):'Definition of PI
40 DEF FNSI(D)=SIN(D*PI/180):'Sine with argument in degrees.
50 DEF FNCO(D)=COS(D*PI/180):'Cosine with argument in degrees.
60 DEF FNTA(D)=TAN(D*PI/180):'Tangent with argument in degrees.
70 DEF FNAS(D)=ATN(D/SQR(1-D*D))*180/PI:'Arcsine with argument in degrees
80 DEF FNAC(D)=ATN(SQR(1-D*D)/D)*180/PI:'Arccos with argument in degrees.
90 DEF FNAT(D)=ATN(D)*180/PI:'Arctan with argument in degrees.
100 DEF FNMO(X)=(X/MODUS-INT(X/MODUS))*MODUS:'Modulus function with MO as
110 'the modulus
120 DEF FNAR(X,Y):'Returns arctan with quadrant check*************
130 AR=ATN(Y/X)*180/PI
140 IF AR<0 THEN AR=AR+180
150 IF Y<0 THEN AR=AR+180
160 FNEND AR
165 '
170 'Test input routine**********************************
180 INPUT "Rt. Asc. of MC";RA
190 INPUT "Geographic Latitude: format DD,N or S,MM";DG,N$,MM
200 LA=DG+MM/60:IF N$="S"THEN LA=LA*(-1)
210 OB=23.45
220 PRINT"Which house system?"
221 PRINT"Placidus=1       ","Koch=2            ","Campanus=3"
222 PRINT"Regiomontanus=4","Topocentric=5      ","Morinus=6"
223 PRINT"Alcabitius=7       ","Porphyry=8       ","Meridian=9""
228 INPUT HH
230 ON HH GOSUB 1500,1900,2100,2400,2700,3000,3200,3400,3600
240 FOR I=1TO6:X=HC(I):GOSUB1100:PRINT DG;INT(MI+.5),
250 NEXT
255 PRINT
260 GOTO 180
270 'In all of the house system routines that follow HC(1)=MC, HC(2)=11th,
280 'HC(3)=12th, HC(4)=Ascendant, HC(5)=2nd, HC(6)=3rd.
290 '
1000 'RAMC to long. of Midheaven routine also used in Placidus *********
1010 X=FNCO(OB):Y=FNTA(RA)
1020 MC=FNAT(Y/X)
1030 IF MC<0 THEN MC=MC+180
1040 IF RA>180 THEN MC=MC+180
1050 RETURN
1060 'Directory of variables-X and Y are temporary storage variable.
1070 'OB=Obliquity;RA=Rt. Ascension of MC; MC=long. of Midheaven
1080 '
1100 'Degrees to D.M.S Routine ****************************
1110 DG=INT(X)
1120 MI=X-DG:MI=MI*60
1130 MN=INT(MI)
1140 SE=MI-MN:SE=SE*60
1150 'Directory of variables- X=the angles in decimal degrees;DG=the whole
1160 'number of degrees;MI=the mixed decimal number of minutes;MN=the
1170 'whole number of minutes;SE=the seconds.
1180 RETURN
1185 '
1190 'D.M.S. to dec. degrees ***************************
1200 X=DG+MN/60+SE/3600
1210 RETURN
1220 'Directory of variables- variables as in previous routine.
1230 '
1300 'Ascendant Routine *********************************
1310 Y=FNCO(RA)
1320 X=-((FNTA(LA)*FNSI(OB))+FNSI(RA)*FNCO(OB))
1330 AC=FNAT(Y/X)
1340 IF AC<0 THEN AC=AC+180
1350 IF Y<0 THEN AC=AC+180
1360 RETURN
1370 'Directory of variables- Y and X are temporary storage variables.
1380 'RA=Rt. Asc. of MC; LA=Geographic latitude of birth;OB=Obliquity
1390 'of ecliptic; AC=Ascendant
1395 '
1400 'Oblique Ascension to Longitude Routine ***************************
1410 X=FNAT(FNTA(LA)/FNCO(OA))
1420 Y=X+OB
1430 LO=FNAT(FNCO(X)*FNTA(OA)/FNCO(Y))
1440 IF LO<0 THEN LO=LO+180
1450 IF FNSI(OA)<0 THEN LO=LO+180
1460 RETURN
1470 'Directory of variables-X and Y are temporary storage variables.
1480 'LA=Geographic latitude of birth;OA=oblique Ascension;OB=Obliquity
1490 'of ecliptic; LO=Longitude on ecliptic.
1495 '
1500 'Placidus Function using Newton-Raphson Approach ******************
1510 'First routine inititializes the variables and calls the second
1520 'which calculates the RA then the long. of the cusps.
1530 GOSUB 1000:HC(1)=MC:'Calculation of Midheaven
1540 GOSUB 1300:HC(4)=AC:'Calling Ascendant routine
1550 RR=-FNTA(LA)*FNTA(OB)
1560 RM=RA:'RA is affected by the routines that follow, therefore its
1570 'value is temporarily stored in RM so that it can be converted
1580 'back later on.
1590 T1=1/3:GOSUB 1670:HC(2)=LC
1600 T1=2/3:GOSUB1670:HC(3)=LC
1610 T1=-2/3:GOSUB1670:HC(5)=FNMO(LC+180)
1620 T1=-1/3:GOSUB1670:HC(6)=FNMO(LC+180)
1630 RETURN
1640 'Subroutine which calculate RA of cusps and then calls the
1650 'routine which converts the RA to long.  This routine is the same
1660 'as that which converts the RAMC to long.
1670 X(0)=.000000001:X(1)=180.0000001
1680 Y(0)=RR*FNSI(RA+T1*X(0))-FNCO(X(0))
1690 Y(1)=RR*FNSI(RA+T1*X(1))-FNCO(X(1))
1700 I=2
1710 X(I)=X(I-1)-((X(I-1)-X(I-2))/(Y(I-1)-Y(I-2)))*Y(I-1)
1720 Y(I)=RR*FNSI(RA+T1*X(I))-FNCO(X(I))
1730 IF ABS(X(I)-X(I-1))>.001 THEN I=I+1:GOTO1710
1740 RC=RA+X(I)*T1
1750 IF RC<0 THEN RC=RC+360
1760 MO=360:RC=FNMO(RC)
1780 RA=RC:GOSUB1000:LC=MC
1790 MO=360:LC=FNMO(LC)
1800 RA=RM:'The restoration of RA as RAMC as mentioned above.
1810 RETURN
1820 'Directory of variables-T1,RR,X(I),Y(I) are the initial and
1830 'intermediate variables used in the iteration of the Newton-Raphson
1840 'approach; LC=long. of a single intermediate cusp; RA=RAMC and at
1850 'various points the RA of cusp for the call of GOSUB1000; RC=
1860 'RA of house cusp; MC=Midheaven;OA=Obl. Asc. of Ascendant
1870 '
1900 'Koch House routine *********************************
1910 AD=FNAS(FNSI(RA)*FNTA(OB)*FNTA(LA))
1920 OA=RA-AD
1930 SA=90+AD
1940 ARC=SA/3
1950 FOR I=1TO6
1960 GOSUB1400:'Calling of O.A. to Long. routine.
1970 OA=OA+ARC
1980 HC(I)=LO
1990 NEXT
2000 RETURN
2010 'Directory of variables- AD=Ascensional difference of MC;RA=Rt. Asc.
2020 'of the MC;OB=Obliquity of Ecliptic;LA=Latitude of birth;OA=Oblique
2030 'Ascension of a house cusp;SA=Semi-arc of MC;Arc=1/3 of the Semi-arc
2040 '
2100 'Campanus Routine ****************************************
2110 'This is new method that does not use poles.  It runs faster.
2120 X1=FNAC(FNSI(OB)*FNCO(RA))
2130 IF X1<0 THEN X1=X1+180
2140 IF X1>180THEN X1=X1-180
2150 D=FNAT(1/(FNTA(OB)*FNSI(RA)))
2160 IF D<0 THEN D=D+180
2170 GOSUB 1000:'RAMC to MC routine
2180 HC(1)=MC
2190 DL=D+LA
2200 FOR I=2TO6
2210 B=(I-1)*30:'Calculates the angle from meridian to house circle.
2220 CB=1/FNTA(B)
2230 EI=FNAT(FNSI(DL)/(FNCO(DL)*FNCO(X1)+FNSI(X1)*CB))
2240 IF EI<0THEN EI=EI+180
2250 HC(I)=MC+EI
2260 MO=360:HC(I)=FNMO(HC(I))
2270 NEXT
2280 RETURN
2290 'Directory of variables- X1=Angle of meridian to ecliptic clockwise
2300 'from zenith;D is decl. of MC but must always be positive; DL=sum
2310 'of decl. and lat.; B=angle between meridian and house circle
2320 'measured along prime vertical; CB=temp. storage variable;
2330 'EI=interval along ecliptic from MC to house.
2340 '
2400 'Regiomontanus House Routine ****************************
2410 SA=FNSI(30)
2420 PO(1)=FNAT(FNTA(LA)*SA):'Poles of 11 and 3
2430 SA=FNSI(60)
2440 PO(2)=FNAT(FNTA(LA)*SA):'Poles of 12 and 2.
2450 GOSUB 1000:HC(1)=MC:'Calculation of Midheaven
2460 LT=LA:'In the GOSUB 1400 LA is redefined so that LT is used as a
2470 'temporary storage variable for LA which will be restored later
2480 'in the routine.
2490 LA=PO(1)
2500 OA=RA+30:MO=360:OA=FNMO(OA):GOSUB 1400:HC(2)=LO
2510 LA=PO(2)
2520 OA=OA+30:OA=FNMO(OA):GOSUB1400:HC(3)=LO
2530 LA=LT
2540 OA=OA+30:OA=FNMO(OA):GOSUB 1400:HC(4)=LO
2550 LA=PO(2)
2560 OA=OA+30:OA=FNMO(OA):GOSUB1400:HC(5)=LO
2570 LA=PO(1)
2580 OA=OA+30:OA=FNMO(OA):GOSUB1400:HC(6)=LO
2590 LA=LT
2600 RETURN
2610 'Directory of variables- PO(1) and PO(2) are the house poles;
2620 'LA= latitude of birth and for the subroutine call the house
2630 'pole; LT is the temporary storage of the latitude during the
2640 'times when LA is a house pole; OA is the Obl. Asc. of the
2650 'house cusps; SA= is the sin of the distances of the house
2660 'circles from the meridian measured along the equator.
2670 '
2700 'Topocentric House Routine ****************************
2710 TL=FNTA(LA)
2720 PO(1)=FNAT(TL/3):'Poles for houses 11 and 3
2730 PO(2)=FNAT((TL/3)*2):'Pole for houses 12 and 2
2740 GOSUB 1000:HC(1)=MC:'Calculation of Midheaven
2750 LT=LA:'In the GOSUB 1400 LA is redefined so that LT is used as a
2760 'temporary storage variable for LA which will be restored later
2770 'in the routine.
2780 LA=PO(1)
2790 OA=RA+30:MO=360:OA=FNMO(OA):GOSUB 1400:HC(2)=LO
2800 LA=PO(2)
2810 OA=OA+30:OA=FNMO(OA):GOSUB1400:HC(3)=LO
2820 LA=LT
2830 OA=OA+30:OA=FNMO(OA):GOSUB 1400:HC(4)=LO
2840 LA=PO(2)
2850 OA=OA+30:OA=FNMO(OA):GOSUB1400:HC(5)=LO
2860 LA=PO(1)
2870 OA=OA+30:OA=FNMO(OA):GOSUB1400:HC(6)=LO
```

```
2880 LA=LT
2890 RETURN
2900 'Directory of variables- PO(1) and PO(2) are the house poles;
2910 'LA= latitude of birth and for the subroutine call the house
2920 'pole; LT is the temporary storage of the latitude during the
2930 'times when LA is a house pole; OA is the Obli. Asc. of the
2940 'house coups; SA= is the sin of the distances of the house
2950 'circles from the meridian measured along the equator.
2960 '
3000 'Morinus system according to Lyndoe **************************
3010 CB=FNCO(OB):'Cosine oblIquity
3020 FOR I=0TO5
3030 RM=RA+(3041)-MO-360:RM=FNRO(RM):GOSUB3060:HC(I+1)=C
3040 NEXT
3050 RETURN
3060 C=FNAT(FNTA(RM)*CB)
3070 IF C<0 THEN C=C+180
3080 IF RM>180THEN C=C+180
3090 RETURN
3100 'Directory of variables-- RM=the Rt. Asc. of the cusp; C=the long.
3110 'of the Indivldual cusp; OB=oblIquity; CB=Cosine oblIquity.
3120 '
3200 'Alcabitius house routine **************************
3210 GOSUB 1300:HC(4)=AC:'Find long. Ascendant
3220 DE=FNAS(FNSI(AC)*FNSI(OB)):'Find the declination of Asc.
3230 AD=FNAS(FNTA(DE)*FNTA(LA)):'Find Asc. Diff. of Ascendant.
3240 DS=90+AD:NS=90-AD:XD=DS/3:YM=NS/3:'Find 1/3 of the diurnal and
3250 'nocturnal semi-arcs.
3260 GOSUB 1000:HC(1)=MC:'Find MC
3270 RM=RA:'RAMC gets modified in this routine so we store in RM
3280 'temporarily.
3290 RA=RA+XD:RO=360:RA=FNRO(RA):GOSUB1000:HC(2)=MC:'Eleventh house
3300 RA=RA+XD:RA=FNRO(RA):GOSUB1000:HC(3)=MC:'Twelfth house
3310 RA=RA+XD+YN:RA=FNRO(RA):GOSUB1000:HC(5)=MC:'Second house
3320 RA=RA+YM:RA=FNRO(RA):GOSUB1000:HC(6)=MC:'Third house
3330 RA=RM
3340 RETURN
3350 'Directory of Variables-- AC=Ascendant; DE=Decl. of Asc.; OB=
3360 'Obliquity of ecliptic; AD=Ascensional Difference of Ascendant;
3370 'LA=Latitude of birth; DS=Diurnal Semi-Arc of Asc.; NS=Nocturnal
3380 'Semi-Arc of Asc.; XD=1/3 Diurnal Semi-Arc of Asc.; YM=1/3
3390 'Nocturnal Semi-Arc of Asc.; RM=is temporary storage of RAMC.
3395 '
3400 'Porphyry house routine **************************
3410 GOSUB 1000:HC(1)=MC:'Midheaven
3420 GOSUB1300:HC(4)=AC:'Ascendant
3430 ARC=AC-MC:IF ARC<0 THEN ARC=ARC+360:'Distance between MC and Asc.
3440 AX=ARC/3:'Distance from MC to 11, 11 to 12, 12 to Asc.
3450 ARC=180-ARC:'Distance from Asc. to I.C.
3460 AY=ARC/3:'Distance from Asc. to 2, and 2 to 3.
3470 HC(2)=MC+AX:MO=360:HC(2)=FNRO(HC(2)):'Eleven
3480 HC(3)=MC+(2)+AX:HC(3)=FNRO(HC(3)):'Twelfth
3490 HC(5)=MC(3)+AX+AY:HC(5)=FNRO(HC(5)):'Second
3500 HC(6)=MC(5)+AY:HC(6)=FNRO(HC(6))
3510 RETURN
3520 'Directory of Variables-- MC=Midheaven; AC=Ascendant;ARC is used
3530 'twice, first as the distance from MC to Asc., then as the
3540 'distance from Asc. to IC; AX=1/3 the ecliptic arc from MC
3550 'to Asc.;AY=1/3 the ecliptic arc from Asc. to IC.
3560 '
3600 'Meridian house routine **************************
3610 GOSUB1000:HC(1)=MC
3620 MO=360
3630 RM=RA:'Temporary storage for RAMC as RA changes value in this
3640 'program.
3650 FOR I=2TO6
3660 RA=RA+30:RA=FNRO(RA):GOSUB1000:HC(I)=MC:'The various houses
3670 NEXT
3680 RA=RM
3690 RETURN
3700 'Directory of variables-- MC=Midheaven and also the long. of the
3710 'intermediate cusps as returned by GOSUB1000; RM=Temporary storage
3720 'for RAMC as RA is used in GOSUB1000
```


MERCURY HOUR

The Astrologer's Astrological Magazine

3509 WATERLICK ROAD C-7, LYNCHBURG, VA. 24502

WE GUARANTEE THAT YOU HAVE NEVER READ ANOTHER ASTROLOGICAL MAGAZINE LIKE THE MERCURY HOUR. IT IS WRITTEN COMPLETELY BY ASTROLOGERS FOR ASTROLOGERS.

There are no "sun-sign" forecasts, just letters, articles, views, contributed by the more than fifteen hundred astrologers who already subscribe. In each of its four photo-type set editions (55 to 60 8½ by 11 pages) it keeps you up to date on what is happening in our world and shares the viewpoints and feelings of our community world-wide. It is interesting, informative and very often humorous.

Steve Arroyo writes of the MH: "The MH fills a communication need in the Astrological Community that no other publication does, just straight-forward honest, personal expression with no frills. It's really a very Aquarian publication. Bob Pelletier, John McCormick, Robert Jansky, Marc Robertson, all have echoed these sentiments about the MH. With endorsements like that, don't you think you owe it to yourself to see what these people are talking about?

See for yourself what it is really like by sending for some sample pages or better yet, enclose $13.00 (Canadian and Foreign subscriptions - $18.00) and start with the latest edition.

HOW MATRIX GOT IT'S NAME

We have been surprised at the interest on the part of our readers as to why we chose the word MATRIX as the name for this publication. So many of you have thought that it had to do with our knowledge of higher mathematical terms that I feel it worthwhile to mention why this name was chosen. Rather than paraphrase, I give you the definition of MATRIX straight from the OXFORD UNIVERSAL DICTIONARY:

I. The uterus or womb. II. A place or medium in which something is bred, or developed. b. A place or point of origin and growth.

The above says better than I am able what MATRIX is all about. We hope that out of this womb or MATRIX a new body of astrologers will grow with intimate practical aquaintance with all of the means and techniques at our disposal..a modern astrology.

PROGRAMMER'S TABLE OF TWO-LETTER VARIABLES

AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9
BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9
CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	C0	C1	C2	C3	C4	C5	C6	C7	C8	C9
DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9
EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	E0	E1	E2	E3	E4	E5	E6	E7	E8	E9
FA	FB	FC	FD	FE	FF	FG	FH	FI	FJ	FK	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY	FZ	F0	F1	F2	F3	F4	F5	F6	F7	F8	F9
GA	GB	GC	GD	GE	GF	GG	GH	GI	GJ	GK	GL	GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX	GY	GZ	G0	G1	G2	G3	G4	G5	G6	G7	G8	G9
HA	HB	HC	HD	HE	HF	HG	HH	HI	HJ	HK	HL	HM	HN	HO	HP	HQ	HR	HS	HT	HU	HV	HW	HX	HY	HZ	H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
IA	IB	IC	ID	IE	IF	IG	IH	II	IJ	IK	IL	IM	IN	IO	IP	IQ	IR	IS	IT	IU	IV	IW	IX	IY	IZ	I0	I1	I2	I3	I4	I5	I6	I7	I8	I9
JA	JB	JC	JD	JE	JF	JG	JH	JI	JJ	JK	JL	JM	JN	JO	JP	JQ	JR	JS	JT	JU	JV	JW	JX	JY	JZ	J0	J1	J2	J3	J4	J5	J6	J7	J8	J9
KA	KB	KC	KD	KE	KF	KG	KH	KI	KJ	KK	KL	KM	KN	KO	KP	KQ	KR	KS	KT	KU	KV	KW	KX	KY	KZ	K0	K1	K2	K3	K4	K5	K6	K7	K8	K9
LA	LB	LC	LD	LE	LF	LG	LH	LI	LJ	LK	LL	LM	LN	LO	LP	LQ	LR	LS	LT	LU	LV	LW	LX	LY	LZ	L0	L1	L2	L3	L4	L5	L6	L7	L8	L9
MA	MB	MC	MD	ME	MF	MG	MH	MI	MJ	MK	ML	MM	MN	MO	MP	MQ	MR	MS	MT	MU	MV	MW	MX	MY	MZ	M0	M1	M2	M3	M4	M5	M6	M7	M8	M9
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NM	NN	NO	NP	NQ	NR	NS	NT	NU	NV	NW	NX	NY	NZ	N0	N1	N2	N3	N4	N5	N6	N7	N8	N9
OA	OB	OC	OD	OE	OF	OG	OH	OI	OJ	OK	OL	OM	ON	OO	OP	OQ	OR	OS	OT	OU	OV	OW	OX	OY	OZ	O0	O1	O2	O3	O4	O5	O6	O7	O8	O9
PA	PB	PC	PD	PE	PF	PG	PH	PI	PJ	PK	PL	PM	PN	PO	PP	PQ	PR	PS	PT	PU	PV	PW	PX	PY	PZ	P0	P1	P2	P3	P4	P5	P6	P7	P8	P9
QA	QB	QC	QD	QE	QF	QG	QH	QI	QJ	QK	QL	QM	QN	QO	QP	QQ	QR	QS	QT	QU	QV	QW	QX	QY	QZ	Q0	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
RA	RB	RC	RD	RE	RF	RG	RH	RI	RJ	RK	RL	RM	RN	RO	RP	RQ	RR	RS	RT	RU	RV	RW	RX	RY	RZ	R0	R1	R2	R3	R4	R5	R6	R7	R8	R9
SA	SB	SC	SD	SE	SF	SG	SH	SI	SJ	SK	SL	SM	SN	SO	SP	SQ	SR	SS	ST	SU	SV	SW	SX	SY	SZ	S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
TA	TB	TC	TD	TE	TF	TG	TH	TI	TJ	TK	TL	TM	TN	TO	TP	TQ	TR	TS	TT	TU	TV	TW	TX	TY	TZ	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9
UA	UB	UC	UD	UE	UF	UG	UH	UI	UJ	UK	UL	UM	UN	UO	UP	UQ	UR	US	UT	UU	UV	UW	UX	UY	UZ	U0	U1	U2	U3	U4	U5	U6	U7	U8	U9
VA	VB	VC	VD	VE	VF	VG	VH	VI	VJ	VK	VL	VM	VN	VO	VP	VQ	VR	VS	VT	VU	VV	VW	VX	VY	VZ	V0	V1	V2	V3	V4	V5	V6	V7	V8	V9
WA	WB	WC	WD	WE	WF	WG	WH	WI	WJ	WK	WL	WM	WN	WO	WP	WQ	WR	WS	WT	WU	WV	WW	WX	WY	WZ	W0	W1	W2	W3	W4	W5	W6	W7	W8	W9
XA	XB	XC	XD	XE	XF	XG	XH	XI	XJ	XK	XL	XM	XN	XO	XP	XQ	XR	XS	XT	XU	XV	XW	XX	XY	XZ	X0	X1	X2	X3	X4	X5	X6	X7	X8	X9
YA	YB	YC	YD	YE	YF	YG	YH	YI	YJ	YK	YL	YM	YN	YO	YP	YQ	YR	YS	YT	YU	YV	YW	YX	YY	YZ	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9
ZA	ZB	ZC	ZD	ZE	ZF	ZG	ZH	ZI	ZJ	ZK	ZL	ZM	ZN	ZO	ZP	ZQ	ZR	ZS	ZT	ZU	ZV	ZW	ZX	ZY	ZZ	Z0	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	Z9

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Make some xerox copies of this table and use them to keep track of the variables you are using in programs in the higher level languages. Better yet, place a copy of this in a plastic envelope and circle variables with a china marking pen. Erase when thru. Dont forget to white-out the reserved words in your particular dialect of BASIC...such as ON, IF, OR and so forth.

OUTPUT DEPARTMENT

MATRIX SOFTWARE

1041 North Main Street
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ASTROLOGICAL SOFTWARE AVAILABLE ON CASSETTE NOW:

We have a good selection of astrological software permanently recorded on high-quality audio cassettes and ready to run on your Commodore PET, Radio Shack TRS-80 and APPLE II computer. We will replace any cassette should it ever break at a nominal fee.

These cassettes come with user-instructions on how to load and use the cassette and the astrological program recorded on it. The program snaps in the cassette unit on your computer and runs. That's all there is to it.

We have programs ready now for a wide variety of astrological techniques authored by Michael Erlewine. We will soon be able to offer many programs by other authors as well. We have a large ASTRODYNE program by John Molfese in the works, a series of statistical astrological programs by Charles S. Hocking, a 32K TRS-80 from Robert Hand and more. We intend to collect the finest astrological software from all over the world and see that it is available on these new home computers. These new machines combined with the proper software will allow astrologers to experience any number of complete astrological techniques--with chart examples of choice.

Towards the fall of 1979 we will be offering the first in our MATRIX PROGRAM SEMINAR series. This series will include a program tape along with a complete booklet on how to use the astrological technique written by an expert in that field. The program on cassette will handle the numbers...and the booklet will take you step by step towards using that technique for chart work and interpretation. We believe this will mark a new era in learning astrology at home. An individual with a small home computer can explore the many techniques of modern astrology without fear of numerical error...and using chart examples taken from their own life and experience.

Complete Natal Programs are available as low as $25 for the PET 8K and $50 for the TRS-80 16K machines (Level II BASIC). More advanced programs retail for about $50 per program and printing programs are available for most machines.

These programs accept the standard birth data used by astrologers: Birthdate, month, year, time and place (geographic coordinates). The 8k PET can print out a complete chart wheel on the TV monitor in about 40 seconds...with houses.

If you do not already have one, send for our TEMPORARY SOFTWARE CATALOG and see what is available to you thru these new machines. We have programs for Transits, Secondary Progressions, Solar & Lunar Returns, Uranian Planets, Composites, Heliocentrics, Solar Arc Directions, Asteroids and more. Many of these programs include aspects to planets, midpoints, 90-degree dials, harmonics and so forth.

INFORMATION PACKAGE: If you are thinking about buying a computer system for astrological work and dont know where to get information on what is available, this is for you. We have taken all of the information that we find useful from our files, xeroxed it and put it together under one spiral binding. Dont expect anything more than a collection of notes, specifications, pictures and what-not. We will add to this as more information becomes available as well as include notes about doing astrology on the various machines.

ORDER:INFO-1 POSTPAID $5 (FIRST CLASS) $6

TEMPORARY SOFTWARE CATALOG: Many of you already have this. A rough list of what we have available to fit the PET, TRS-80 and APPLE II computers. This is available to you upon request. We will bring out an updated version of this in a month or so but will not be mailing it to all MATRIX customers. If you want the new version, drop us a card. ORDER:INFO-2

MAJOR SOFTWARE CATALOG: This will not be ready until the fall of 1979 and will include not only the micro systems but also the programmable calculators and even large -machine programs. We will charge for this catalog due to it's size and each program will be described in detail. This should allow an individual to purchase the catalog and study what is available for the various machines...and what each program can do in terms of astrology. ORDER:INFO-3

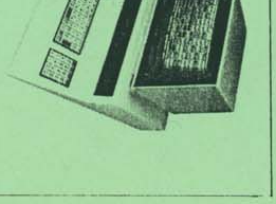
LISTINGS FOR A SPECIFIC MACHINE: Send us a STAMPED SELF-ADDRESSED ENVELOPE and the name of the machine for which you wish a listing of available programs and we will send you a xerox copy of what is available to date. This service will continue even after the major catalog is issued for those who are interested in simply a list of available programs. ORDER: INFO-4
description will be included.

PHONE CALLS: Feel free to call us during working hours (7:30 AM to 5:00 PM EST) with specific questions on computer hardware, software and programming. We will be glad to do what we can to answer you. We do not have time to answer questions thru the mail at this time unless they are very simple ones. Our phone number here in Ann Arbor is (313) 663-6677

COMPUTER HARDWARE TOO

We are now able to assist you in obtaining computer systems for your work. At this time we are able to ship (same day) Commodore PETS 8K. We also can obtain the 16K and 32K PETS and even the standard keyboard. We are working with a distributor of these machines. We are offering free software with each machine ordered thru us. For instance, the Commodore PET comes with a complete natal chart program with your choice of house systems.

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8K PET $795.
16K PET $995.
32K PET $1195.



1979 Summer-Fall

Issue V

MATRIX MAGAZINE

	1	ACT: ASTROLOGICAL CONFERENCE ON TECHNIQUES
Editors	2	NEWS & NOTES
James Neely	5	PERTURBATION CORRECTIONS FOR THE 1900-2000 YEAR OUTER BODY COORDINATES
Editors	8	A PROGRAM IN BASIC FOR THE NEELY CORRECTIONS
Tom P. Santiago	10	ON THE POLICHIAN THEORY OF TOPOCENTRIC GENEOLOGICAL CONNECTIONS
James Neely	19	VOLUME XII: OUTER BODY INTEGRATION ROUTINE
Dwight William Johnson	26	COMPUTING THE ORBITS OF JUPITER, SATURN, URANUS AND NEPTUNE ON SMALL COMPUTERS
Axel Harvey	43	FOURTEEN WAYS TO USE THE RISING FUNCTION
Axel Harvey	44	APPROXIMATE INVERSE INTERPOLATION
Editors	46	ASTRO-TALK: AN INTRODUCTION
Lee Wayne Holt	49	ASTRO-SYNTAX AND ASTRO-SEMANTICS
Roger Elliot	57	NOTES ON COMPUTER DELINEATION
inside front cover		THE 1979 JOHNDRO AWARD

Editors: Michael & Margaret Erlewine

1041 North Main Street ✧ Ann Arbor, Michigan 48104

THE 1979 JOHNDRO AWARD
to

CHARLES A. JAYNE

Commencing in 1978 the Johndro Award for excellence in the technical aspects of Cosmecology is being given to those who have distinguished themselves through some major contribution. Dr. Harlan T. Stetson of M.I.T coined the term COSMECOLOGY many years ago as the study of the Earth's adaptation to its cosmic environment. While this embraces the ancient science of Astrology, it also includes a number of other sciences. The award is named after the famous American Radio Engineer, Mathematician and Astrologer, L. Edward Johndro.

Charles Jayne is the father of modern technical astrology. To my knowledge, no other modern astrologer has labored so persistantly to bring to the attention of the average astrologer the need for a firm grounding in the astronomy and mathematics of astrology. Jayne has been writing highly technical articles and books for the last 40 years. He has been the common denominator linking dozens of research and technical astrologers together. He has been inspirational in establishing many research and communication efforts including the ASTROLOGIC RESEARCH SOCIETY, ASSOCIATION for RESEARCH in COSMECOLOGY (ARC), NCGR, MATRIX Magazine and the newly formed ACT conference. Jayne has been active as an editor and author of publications such as IN SEARCH and COSMECOLOGY BULLETIN plus dozens of books and articles on the technical aspects of astrology.

Charles Jayne is more than an historian or caretaker of these techniques. He practices and uses them. Jayne is a keen student of the entire esoteric tradition and the spiritual heritage of astrology is every bit as important to him as are the technical concerns. Thanks Charles!

- Michael Erlewine

JOURNAL OF GEOCOSMIC RESEARCH -Robert Hand
MATRIX MAGAZINE - Michael & Margaret Erlewine
PHENOMENA -Malcolm Dean
SIRIUS -David Cochrane
MUTABLE DILEMMA -Zip Dobyns

The First ACT

ASTROLOGICAL CONFERENCE ON TECHNIQUES

The first ASTROLOGICAL CONFERENCE ON TECHNIQUES (ACT) will be held in August of 1980 at the AFA convention. As many of you know we have been trying to put this conference together for the last year and a half. Bob Cooper, president of the AFA, has been kind enough to allow us to have our conference along with the AFA's convention next summer. The ACT technical conference will be held at the same time and place as the AFA's convention but will be independently organized.

The ACT conference is non-denomenational in that it will not be sponsored by any single astrological organization. At this point your editor plus Charles Jayne from ARC (Association for Research in Cosmecology) and Robert Hand representing NCGR are working on the general format of the conference. Charles Jayne will spend several days here in Ann Arbor during October and one of the main projects we will tackle will be the schedule of workshops and forums for this conference.

The main purpose of such a conference is to bring together technically oriented astrologers from all over the world. The goals of such a conference will be at least twofold. One goal will be to offer much needed workshops on the technical aspects of astrology. These would include beginning and advanced programming techniques for calculators and computers plus seminars on computer equipment and it's use for astrological practice and research. Beginning and advanced instruction on statistical and research techniques would also be offered. Workshops and forums on major astrological techniques such as Harmonics, Uranian, Cosmobiology and so on would be available.

The second and most important goal of the conference would be to bring many of the leading research and technical astrologers together with an interested and informed audience for a series of open forums and discussions. It is important that we gain some kind of consensus about the kinds of astrological research, what is being done, who is doing it, what should be done and where do we go from here, etc. This could be facilitated by a number of panel discussions with audience participation.

The advantages of holding such a conference at the AFA convention should be obvious. The AFA convention is sure to be well attended. We will not have to worry about finding funds (we dont have) to sponsor such a conference. A large number of non-technical astrologers will be exposed to all of us crazy technicians..with possible beneficial effect.

The AFA does not pay any of it's speakers nor can we. Each of us will have to get to New Orleans under our own steam. In my own case, it will mean a sacrifice in terms of getting that much cash together. I feel it is important that we all make an effort to be there. Bob Cooper has promised us some relief. Invited speakers will have the opportunity to share facilities at a reduced rate. I have set up a fund here in Ann Arbor to aid speakers who cannot afford to attend to be there. Bob Cooper, myself and several other astrologers have pledged a contribution to this relief fund. Any of you willing to help in this regard are welcome to contribute. Please send funds to the MATRIX address for the ACT SPEAKER FUND. Any contribution will be greatly appreciated and Charles Jayne, Robert Hand and myself will decide on the allocation of the monies.

I dont need to tell MATRIX readers that we are having a technical breakthru in astrology at this time. There is much confusion, even among researchers, as to what constitutes valid research..or even what research is. Jayne, Hand and myself have been trying to pull such a conference together for some time now. We plan to work very hard until next summer to see that the conference is a complete success. We need your support if it is going to happen. We need help to advertise the conference. MATRIX, Jayne's COSMECOLOGY BULLETIN, Cochrane's SIRIUS, Dean's PHENOMENA have pledged support. Noel Tyl has offered his support through ASTROLOGY NOW and Robert Hand through NCGR facilities.

Many of you will be asked to participate as speakers. Others of you may wish to lead a workshop or participate in a panel discussion. Let me know if you feel that you could lead a workshop. PLEASE take the time to consider what you would like to see happen at such a conference. Send your suggestions to MATRIX as soon as possible. Please help us to shape and build this conference into a significant event. We need the help of MATRIX readers in this regard, so please show us your support by writing a letter to us with ideas and suggestions as to what you feel would be worthwhile to cover at such a conference, what speakers you would like to see there and so on. Let me know if you feel such a conference would be worthwhile. How about some response from our readers on this subject?

On the personal side, we can look forward to meeting other MATRIX readers in person and sharing some time together. I will be there with as many computers as I can cart to New Orleans. Let's all be there!

- Michael Erlewine
Editor

From the Editors...

NEWS, NEWS, MORE NEWS & COMMENTS

Have a lot of news and comments to report since our last issue. Margaret and my summer schedule has made it impossible to put together another issue of MATRIX until now. For that matter, almost all of the articles and material in these issues has arrived during the latter part of the summer. Hope you agree that we have some dynamite material in MATRIX V and VI.

Our readership is growing with an ever increasing number of you taking the plunge into the world of the home computer. Thank you for the great response and all those letters and phone calls. As some of you will know, it has been more and more difficult for us to keep up with quick or thorough answers to some of your letters. We have received hundreds of letters that require an answer of several pages or more in length. Many letters from you consist of two or three pages of detailed technical questions. I just dont have the time to answer these. MATRIX was extablished to serve as an information service on some of the technical areas of astrology.

Until we can afford to hire the help we need, here is what I suggest. If you have technical questions about programming or computers, why not give me a call. Our phone is (313) 663-6677 and I am usually available for this kind of thing in the late afternoon (EST). It is possible to get to the heart of many questions in a brief time on the telephone. Another solution is to send a letter containing numbered questions with room for me to jot down a quick answer along with a self-addressed envelope. I can turn these kind of letters around in a hurry. I have received many letters requesting that I help in debugging user's versions of my own or other peoples programs from MATRIX. This kind of thing has not worked out very well. It turns out that there are so many opportunities for error on the part of the user that it is often difficult to pinpoint the error source. I have spent hours trying to decifer some of your program listings only to find that the problem was a typing error or improper data entry. If you require this kind of help in debugging planetary programs in BASIC, here is what I suggest. Run the program using my birth information (July 18, 1941 at 5:03 p.m. Eastern Daylight Time at Lancaster PA 76W18 40N02). Copy out as many intermediate variable results (RAMC, T, ASCENDANT, etc.) as you can. When this has been done, give me a call and perhaps we can trace down the problem. I am most used to all of the temporary results in my own chart since I use it for debugging in my own work.

Many of your questions about computers and software can be answered by purchasing a copy of our Full Software Catalog. This publication contains a detailed report by our staff on most of the home computers on the market today. A feature by feature comparison is performed. There is a lot of good general introductory information contained here that will answer many of the questions that we are getting. I am not complaining, since I am thrilled about the growing interest in computers among astrologers and am doing my best to answer questions. You can get an early answer and make it easy on me by following some of the suggestions given above.

MATRIX HARDWARE TOO

It has been too tempting to resist fiddling with the hardware business. We are stocking the complete Commodore PET and APPLE II line of computers, disks and printers. MATRIX is a registered Commodore dealer at this point. We started out by helping some of you make connections to purchase computers. Soon we found ourselves shipping computers here and there around the world...until, at this point, hardware sales have become a definite part of our operation. Please forgive a little sales pitch.

The advantage of your purchasing your computer through us is that you know who we are and can count on us to be there to answer questions or to get you service in the future. We do not discount prices but do offer MATRIX software as a bonus and an incentive to purchase thru us. We have the Commodore line in stock and most APPLE products as well. We have been getting a liberal education in the world of the micro businessman. That's a tough business world out there! We have one of the finest micro service centers in the country here in Ann Arbor. Much of the money we have made through hardware sales has gone into increased hardware support here at MATRIX. We are our own best customer (I am sorry to say)!

NEW MATRIX HARDWARE

The most important new piece of hardware is our N.E.C. SPINWRITER line-printer-terminal. The SPINWRITER is one of the new (and fine!) Japanese line of computer equipment that is just beginning to reach this country. The SPINWRITER is an impact printer that uses print thimbles and incremental spacing to produce high-quality printed output. The page you are reading, and much of these issues, were produced by the new machine. Your editor wrote the right-hand justification routine for this column. Notice that the spaces between words are spread evenly rather than inserting extra blanks. The spinwriter can make 120 increments horizontally per inch and 48 vertically. It can print forward and in reverse...as well as up and down vertically.

The importance of purchasing such a printer for MATRIX is obvious. We will be able to give our readers high quality print without having to pay the (very high) fee for a typesetting service. Notice that, thanks to our inexpensive Xerox production method, MATRIX Magazine is still here and not folded as areso many small magazines and journals. If we are careful, we will be here for many years to come.

We have also been instrumental in seeing that a special program has been designed that will 'dump' the high-resolution screen of the APPLE (almost 54,000 points) to the spinwriter. This will allow us to dump some of the screens of the new Astro-Geography programs we are writing for the APPLE II. (complete with maps of the U.S. and individual states!)

Some of the other equipment around MATRIX includes a Commodore PET with 40K connected to a dual drive COMPUTHINK disk with double-density and 400K of on-line storage. This PET is connected by a Networks bi-directional interface to our Spinwriter. We also have a 32K PET with large keyboard that is connected to a dual-drive Commodore disk with 370K of on-line storage. Our APPLE II has 48K and a ROM card plus an APPLE Disk drive with around 100K of on-line storage. The APPLE is hooked to a Sony color T.V (12 inch) and also to a B&W Sanyo video monitor (9 inch). We have a Radio SHack TRS-80 with 32K, Expansion Interface and dual drive Micropolis disks. Along with all of the other paraphenalia we have kicking around here we have some $16,000.00 invested in hardware! That's not small potatoes either.

MATRIX SOFTWARE REPORT

Let me give you an idea of what we have done with that hardware. Our goal has been to have complete libraries of astrological programs running on the PET, APPLE II and TRS-80. We have a very large number of 8K, 16K and 16K+ programs finished and ready to ship (cassette or disk) for the Commodore PET. We also have a good number of these same programs on the APPLE II. We have had nothing but a summer full of trouble with our TRS-80 and are running behind schedule with this machine. However, we do have a 16K natal program, 16K Solar & Lunar Returns, 16K Transits & Secondary Progressions and several other programs on the TRS-80.

Be sure to take a look the list of MATRIX programs given elsewhere in these issues. Not to say that writing and producing these programs has been headache free. Keeping over 40 different programs debugged and available has been something else! I have decided that there are just two kinds of program bugs...the Obvious bugs (the ones I find) and the Devilish bugs (someone else finds them). We hadn't planned it this way, but we have definitely debugged some of our programs in the field. Thanks to those of you who were kind enough to document bugs that you noticed in our programs. I felt pretty bad about having bugs found in our programs out in the field until I met several of the top programmer's in the micro field. They assure me that this is a universal condition.

And so I continue to say with true conviction "As far as I know there are no bugs in our programs". Each time I believe I am correct. Is there always at least one more bug? Those of you who feel they have found a bug, be sure to document the bug with complete data entry, anticipated results and unanticipated results (bug). We will fix and replace any bugs as soon as we become aware of them. Your average bug is something that can be repeated each time a given set of data is entered and a program run. Enough about our bugs, you may have some of your own!

SOFTWARE REVIEWS!!!

As many of you know, we have quite a wide selection of astrological programs available for home microcomputers. I would like to say something about some of our more recent additions.

PROGRAMS FROM THEODOR LANDSCHEIDT

Theodor Landscheidt has sent us several programs written for the Commodore PET for distribution through MATRIX Software. These include a Geocentric Node program that will provide accurate nodal positions for the planets, Sun's nodes plus the geometric and apparant position of the Sun for the years 1600-2100 with values exact to +/- 3 seconds of arc. A second 16K program called GEONODES & HARMONIC SCALES includes a graphic method of looking at harmonic positions. Any harmonic may displayed at a button's touch. The harmonic positions appear arranged in a scale across the screen. Conjunctions appear one above the other and orbs can be judged optically. Landscheidt's unique approach to looking at harmonics makes his contribution of real value. There is also a means by which the user can store up to 100 natal charts on a permanent basis.

Another program from Landscheidt is a 16K SOLAR ARC 100 CHARTS program that allows the user to do analysis by Solar Arc on up to 100 charts stored in memory. The Solar Arc positions can be viewed via the Harmonic Scales approach detailed above. And last, but not least, Landscheidt has recently sent us a 16K PRIMARY DIRECTIONS program. The program makes use of an unpublished system developed by Landscheidt for dealing with the "poles" of planets. We at MATRIX are very grateful for Dr. Landscheidts very creative programming efforts!

AN OVERBECK HARMONIC ANALYSIS PACKAGE

Here is a fantastic program from Buz Overbeck. This package written for the Commodore PET represents a breakthru of sorts for the serious researcher of Harmonics in astrology. The program performs a harmonic analysis on a collection of data, or sample. The data can be in the form of a frequency distribution or degree totals. The user may

enter any distribution of their own choosing or make use of the built-in Solar distribution (Sun positions) using either the Tropical or Sidereal zodiacs.

After the data has been entered, the program performs a harmonic analysis on a frequency distribution and calculates AMPLITUDE and PHASE for each of the 180 harmonics. At the end of the program run, the harmonics are scanned to see if any of the amplitudes pass a statistical test of significance. If significant harmonics are found, they are listed...if none are found, the program tells you that too!

In this very well put together program we have a glimpse into the future and use to which these new home computers can be put. Any of you who have every tried to implement some of the projects detailed in John Addey's HARMONICS will be glad to get your hands on this program. Thank you Buz for the first in what I hope will be a long line of statistically oriented astrology packages!

TOWNLEY'S CYCLE GRAPHS ON THE APPLE II

John Townley has sent us a fine program for the high-resolution graphics of the APPLE II. It analysis the overall effects of long-term cycles in the horoscope. The user can look at the cycles of the progressed Moon and transitiong Jupiter, Saturn and the outer planets in relatin to a given natal house or planet. The program also allows the user to average any two cycles and plot the average in relation to a third point. All of this is accomplished using the high-resolution plotting mode on the APPLE II. This program has been designed to accompany Townley's new paperback CYCLE DYNAMICS from Weiser books, 1980.

NON-ASTROLOGERS APPLAUD MATRIX SOFTWARE

A number of MATRIX programs written by your editor and the staff here have been reviewed by computer magazines. We have received particular attention from the REFERENCE LIST OF TRS-80, PET & APPLE II COMPUTER CASSETTES put together by Robert Purser. (PO BOX 466, El Dorado, CA 95623) Purser lists all known programs available for trade or purchase for the above machines. He also picks a small number of outstanding programs to review and present to the public. Our readers will be happy to know that MATRIX is the only software company to have had a program picked for special review in three consecutive issues of the magazine.

Purser is currently reviewing our 16K TRS-80 NATAL ASTROLOGY program which features a circular wheel (which is some programming job on the TRS-80). This program has been picked as a TRS-80 CLASSIC program that Purser suggests should be owned by every TRS owner (don't we wish!). Altho your editor did most of the basic internal programming, all of the credit goes to Stephen Erlewine for his fantastic screen format work. He has done an outstanding bit of graphics and program-flow work and it is this that has caught Purser's attention.

ASTRODYNE PACKAGE

William Keatley has sent us a large and well written ASTRODYNE package for the TRS-80. Any of you familiar with Astrodynes well know that they are next to impossible to calculate without a computer. Keatley has taken care of this for us and his remarkable program produces all of the major Astrodyne calculations. The program prints to the screen or to a line printer.

LARGE FORTRAN PACKAGE AVAILABLE

From programmer Larry Low we have received a large program written in FORTRAN IV using about 16K words with Dec. RT-11 overlay. The program generates planet positions with the capability of storing up to nine charts simultaneously. The program does extensive aspect analysis, Secondary Progressions, Composites, Cross Comparison, rulers, exaltations, and etc. Output includes square format chart wheel and all of the above. The program listings require 59 pages out of the 135 page manual that accompanies the package. The program is meticulously documented and is available thru MATRIX Software.

FUTURE PROGRAM REVIEWS

We intend to see that accounts and reviews of new astrological software becomes a standard feature of MATRIX magazine. We have received a number of letters to the effect that dated material..software, hardware reviews, book reviews etc. should be kept out of MATRIX. MATRIX should be kept for un-dated and more everlasting and eternal material. On the whole, I am in agreement with this but not to the exclusion of updates necessary to keep our readers informed as to what is happening in our field. If we have all "eternal" material we will lose touch with the current of events.

In short, I feel that news, notes , software and hardware updates do have a place in the pages of MATRIX and have an educational value in themselves. Let's face it, our readers are scattered all over the world with little opportunity to get together in person. Neely is in California, Borg and Landscheidt are in Europe and so on. It is important to me to share some of the flavor of what is happening with our readers. This can be done thru le tters that are published, articles and especially programs. I would like to assemble a rogue's gallery of snapshots of readers to publish in some future issue. Send your's in! That's where I am AT and future issues will have a liberal sprinkling of letters and other timely news along with our timeless material.

PERTURBATION CORRECTIONS
FOR THE 1900-2000 YEAR
OUTER BODY COORDINATES

JAMES NEELY

Perturbation correction coefficients for the positions of the outer bodies are tabulated in Table 1. An example of their use is given below. Although these corrections do not satisfy the goal that was hoped for (see MATRIX ONE, pages 6-7), they do allow the positions predicted by the 1900-2000 year elements to be improved considerably. It must be emphasized that the perturbation coefficients in Table 1 are tuned to the 1900-2000 year elements presented in MATRIX TWO (page 32) *only* and are not to be used with any different set of outer body elements. The following list shows the maximum error in the true heliocentric ecliptic longitude that can occur using the 1900-2000 year elements without and with the perturbation corrections.

Body	Uncorrected position error	Corrected position error
Jupiter	8'14"	35"
Saturn	7'37"	41"
Uranus	4'15"	5"
Neptune	10'19"	3"
Pluto	15'43"	30"

To compute the corrected heliocentric coordinates, proceed as follows. First, compute the heliocentric ecliptic rectangular coordinates for the outer body using the 1900-2000 year elements. Such a calculation is illustrated for Mercury in MATRIX FOUR (pages 37-41). These coordinates are denoted by x_H, y_H and z_H, and are the uncorrected coordinates. Next, the correction terms Δx, Δy and Δz are computed from the coefficients in Table 1. The general form of the correction is, for example,

$$\Delta x = c_1 + c_2T + c_3T^2 + a_1\cos(f_1T + p_1) + a_2\cos(f_2T + p_2) + \cdots$$

where T is the number of Julian centuries from January 0, 1900, Noon E.T. (see MATRIX FOUR, page 37) and c_1, c_2, c_3, a_i, f_i and p_i are the coefficients in Table 1. In particular, we can compute Δz for Pluto using the equation

$$\Delta z = 0.0145 - 0.0920T + 0.1195T^2 + 0.0117\cos(302.6401T - 77.3145) + 0.0020\cos(528.1363T + 48.5671) - 0.0002\cos(1000.3720T - 46.1170).$$

When the correction terms have been computed, we then add them to the uncorrected heliocentric coordinates to obtain the corrected coordinates. Thus

$$x_{HC} = x_H + \Delta x,$$
$$y_{HC} = y_H + \Delta y, \text{ and}$$
$$z_{HC} = z_H + \Delta z.$$

The computations now proceed in the usual manner (MATRIX FOUR, pages 41-42) to generate geocentric rectangular coordinates and then geocentric spherical coordinates.

So that the reader may verify his computations, Table 2 displays the uncorrected and corrected heliocentric rectangular coordinates of the outer bodies, the geocentric rectangular coordinates and the geocentric ecliptic spherical coordinates for April 10, 1979. The reader may obtain results that differ in the final figures owing to differences in carrying significant figures and in rounding procedures. The Solar coordinates were computed using the equations in MATRIX TWO, pages 31 and 41; all

computations were performed using the HP-67 and the 1900-2000 year data cards found in MATRIX TWO, page 32. The final column in Table 2 contains values of the planetary positions obtained from "The Complete Planetary Ephemeris" (C.P.E.) by the Hieratic Publishing Company and are included for comparison. The C.P.E. was chosen for the comparison because neither the C.P.E. coordinates nor the values in Table 2 are corrected for aberration.

Some observations regarding the values of the perturbation coefficients and their generation may be in order. It was found that the 1900-2000 year time span was too short to do a proper fit to Neptune and Pluto even though the residual Neptune error is the smallest. That the fit is not proper is evident by observing the large value of the quadratic (c_3) correction terms. The time span is sufficient to fit Jupiter and Saturn, but the harmonic content of the residuals is not "clean" as in the remaining outer bodies; most of this "raggedness" is undoubtedly owing to the large mass of both Jupiter and Saturn. It seems that not much more work would be required to fit Jupiter and Saturn for a 300 year period than a 100 year period, and 300 years will certainly allow a more aesthetically satisfactory fit for Neptune and Pluto. Uranus required the least work of all; the harmonic content is clean and the 100 year period is long enough that an excellent fit could be obtained without requiring a quadratic term.

TABLE 1: OUTER BODY PERTURBATION COEFFICIENTS (1900-2000)

	c_1	c_2	c_3	a_i	f_i	P_i
JUPITER						
Δx:	0.0020	-0.0134	0.0127	-0.0023	676.1597	0.9329
				0.0005	2361.3553	174.9531
				0.0015	1427.4621	-188.8358
				0.0006	2110.1291	153.6404
				0.0014	3606.8061	- 57.6744
				-0.0017	2540.1554	121.7431
				-0.0010	6704.7824	- 22.2534
				-0.0006	5480.1660	24.5140
				0.0010	1651.2817	-118.2299
				0.0006	6310.7640	- 4.8278
				0.0007	4826.6105	36.2451
Δy:	-0.0010	-0.0005	0.0045	0.0051	581.6589	- 9.7377
				-0.0005	2510.6543	- 12.5381
				-0.0026	1313.7145	- 61.4095
				0.0013	2370.7940	- 24.6397
				-0.0013	3599.2992	37.6800
				-0.0010	2574.6924	31.4306
				-0.0010	6708.1816	-114.4988
				-0.0006	5499.4267	- 74.9716
				-0.0013	1419.0437	54.2159
				0.0006	6339.2773	-109.0102
				0.0007	4824.4717	- 50.8501
Δz: No correction terms required.						
SATURN						
Δx:	-0.0014	0.0026	0.0000	0.0111	1242.1643	78.2635
				-0.0045	3034.9552	62.7616
				-0.0066	1829.2344	- 51.4882
				-0.0078	640.5852	24.1838
				-0.0016	2363.3877	-141.3975
Δy:	-0.0009	0.0037	0.0000	0.0134	1238.8465	- 16.3566
				-0.0043	3040.8883	- 25.1744
				0.0064	1835.3141	36.0670
				-0.0153	610.7838	- 44.2125
				-0.0015	2480.5295	- 69.3951
Δz:	0.0001	-0.0002	0.0000	-0.0005	1251.1274	43.6838
				0.0005	622.8114	13.6990
				0.0003	1824.6723	- 71.1088
				0.0001	2997.1258	78.2119

TABLE 1: Continued

URANUS						
Δx:	0.0134	-0.0219	0.0000	0.0317	404.3167	81.8714
				-0.0050	3037.9169	57.3171
				0.0040	993.5285	- 54.3977
				-0.0018	1249.3615	79.2063
Δy:	-0.0021	-0.0159	0.0000	0.0299	422.3112	- 17.6489
				-0.0049	3035.0905	- 31.3438
				-0.0038	945.3253	60.0624
				-0.0023	1227.0220	- 4.9901
Δz:	-0.0003	0.0005	0.0000	0.0005	352.5335	- 54.9869
				0.0001	3027.5497	54.1753
				-0.0001	1150.2644	- 88.0395
NEPTUNE						
Δx:	-0.1122	0.1660	-0.0544	-0.0050	3035.3106	58.6881
				0.0961	177.0669	- 68.8333
				-0.0073	630.9289	51.0002
				-0.0025	1236.5627	78.0073
Δy:	0.1832	-0.6718	0.2726	-0.1923	175.6493	31.8292
				0.0122	542.1394	189.6142
				0.0027	1219.3811	178.1203
				-0.0050	3035.5673	- 31.2939
Δz:	0.0020	-0.0119	0.0111	0.0001	3049.2853	44.1914
				-0.0002	893.9481	48.5128
				0.0001	1416.5211	- 25.1777
PLUTO						
Δx:	-0.0603	0.5002	-0.6127	0.0490	273.9737	89.9782
				-0.0049	3030.6202	61.3389
				0.0027	1075.2815	- 28.0824
				-0.0007	1402.3060	20.3145
Δy:	-0.0426	0.0730	-0.0292	0.0371	372.0049	-331.3258
				-0.0049	3049.5803	- 39.1961
				-0.0100	566.2111	318.2629
				0.0003	1746.4546	-238.3146
Δz:	0.0145	-0.0928	0.1195	0.0117	302.6401	- 77.3145
				0.0020	528.1363	48.5671
				-0.0002	1000.3720	- 46.1170

TABLE 2: Results for 10 April 1979.

BODY	HELIO UNCORR.	PERTURB	HELIO CORR.	GEOCENT RECT.	GEOCENTRIC SPHERICAL	C.P.E.[1]
SU	-0.94405	Not	-0.94405	0.94405	19°32'28"	19°32'.4
	-0.33507	used	-0.33507	0.33507	0°00'00"	0°00'.0
	0.0		0.0	0.0	1.0017	
JU	-3.4140	-0.0005	-3.4145	-2.4705	119°21'52"	119°21'.7
	4.0544	0.0013	4.0557	4.3908	0°41'00"	0°41'.0
	0.0601	0.0	0.0601	0.0601	5.0385	
SA	-8.8850	0.0106	-8.8744	-7.9304	157°49'12"	157°49'.3
	2.8969	0.0011	2.8980	3.2331	2°01'37"	2°01'.7
	0.3038	-0.0007	0.3031	0.3031	8.5695	
UR	-12.3704	0.0187	-12.3517	-11.4077	230°10'31"	230°10'.4
	-14.0272	0.0121	-14.0151	-13.6800	0°20'48"	0°20'.8
	0.1080	-0.0002	0.1078	0.1078	17.8126	
NE	- 5.9201	0.0176	- 5.9025	- 4.9585	260°24'46"	260°24'.6
	-29.7065	0.0149	-29.6916	-29.3565	1°26'08"	1°26'.1
	0.7466	-0.0005	0.7461	0.7461	29.7817	
PL	-27.5001	-0.0230	-27.5231	-26.5791	197°48'03"	197°47'.8
	- 8.8926	0.0234	- 8.8692	- 8.5341	17°42'12"	17°42'.2
	8.9067	0.0041	8.9108	8.9108	29.3033	

KEY						
	x_H	Δx	x_{HC}	x_G	λ	λ
	y_H	Δy	y_{HC}	y_G	β	β
	z_H	Δz	z_{HC}	z_G	r	

[1]The C.P.E. figures have been converted to the 360° circle for ease of comparison, but have been left in the 0'.1 format. That corrected 1900-2000 year coordinates are printed to the nearest second in no way implies that they are more accurate than the C.P.E. values.

An Implementation of the Neely Perturbation Corrections in the BASIC language.

by Michael Erlewine

PLEASE NOTE: This program was written in Microsoft BASIC on a Commodore PET computer. Permission is granted for personal use only of this program. The program is not to be sold, traded or given away in it's original form or as part of a larger program without the expressed permission of James Neely and Michael Erlewine. Persons wishing to use the programs in the development of larger commerical program are invited to contact MATRIX for details.

ONE MINUTE ACCURACY

It was less than two years ago that we were looking at accuracy of about 45 minutes of arc (worst case) for the outer planets. Here is a program with accuracy of about one minute of arc that will run in less than 8K of RAM on most machines! Astrology is indebted to James Neely for this change.

The program is divided into three sections. The First is a block of data values that include the new Neely harmonic terms. The Second is a utility subroutine that contains the Dimension statements, the Defined Functions and so forth. The Thirs section is the planetary routine.

The sections contain sufficient REMARK statements to make clear what is happening. Although this program was written on the Commodore PET, it should also run on the APPLE II and the TRS-80 (Level II).

It is good for a program of this accuracy and this compactness to be available and in the public domain. It will provide even the smallest home computers with great power. A version for the HP-67/97 programmable calculator authored by James Neely will also be made available through MATRIX Software.

```
9  REM  SUN ELEMENTS BEGIN AT 358.4758
10  DATA 358.4758,35999.0498,-.2E-3,.0167
    5,-.4E-4,0,1,101.2208,1.7192,.0005,0
    ,0
11  REM  MERCURY ELEMENTS BEGIN AT 102.27
    94
12  DATA 0,0,0,0,102.2794,149472.5151,0,.
    20561,.2E-4,0,.387098,28.7538,.3703
15  REM  VENUS ELEMENTS BEGIN AT 212.6032

16  DATA .0001,47.1459,1.185,.0002,7.0029
    ,.0019,-.2E-4,212.6032,58517.8039,.0
    013
18  DATA .00682,-.5E-4,0,.7233,54.3842,.5
    082,-.14E-2,75.7796,.8999,.4E-3
21  REM  MARS ELEMENTS BEGIN AT 319.5294
22  DATA 3.3936,.1E-2,0,319.5294,19139.85
    85,.2E-3,.09331,.9E-4,0,1.5237,285.4
    318
23  REM  JUPITER ELEMENTS BEGIN AT 225.49
    28
24  DATA 1.0698,.1E-3,48.7864,.77099,0,1.
    8503,-.7E-3,0,225.4928,3033.6879,0
28  DATA .04838,-.2E-4,0,5.2029,273.393,1
    .3383,0,99.4198,1.0583,0,1.3097
```



```
33  REM  JUPITER HARMONIC TERMS BEGIN AT
    -.001
34  DATA -.52E-2,0,-.001,-.0005,.0045,.00
    51,581.7,-9.7,-.0005,2510.7,-12.5
36  DATA -.0026,1313.7,-61.4,.0013,2370.7
    9,-24.6,-.0013,3599.3,37.7,-.001,257
    4.7
38  DATA 31.4,-.00096,6708.2,-114.5,-.000
    6,5499.4,-74.97,-.0013,1419,54.2,.00
    06
40  DATA 6339.3,-109,.0007,4824.5,-50.9,.
    0020,-.0134,.0127,-.0023,676.2,.9,.0
    0045
44  DATA 2361.4,174.9,.0015,1427.5,-188.8
    ,.0006,2110.1,153.6,.0014,3606.8,-57
    .7
46  DATA -.0017,2540.2,121.7,-.00099,6704
    .8,-22.3,-.0006,5480.2,24.5,.00096
47  REM  SATURN ELEMENTS BEGIN AT 174.215
    3
48  DATA 1651.3,-118.3,.0006,6310.8,-4.8,
    .0007,4826.6,36.2,174.2153,1223.5079
    6
52  DATA 0,.05423,-.2E-3,0,9.5525,338.911
    7,-.3167,0,112.8261,.8259,0,2.4908
55  REM  SATURN HARMONIC TERMS BEGIN AT -
    .0009
56  DATA -.0047,0,-.0009,.0037,0,.0134,12
    38.9,-16.4,-.00426,3040.9,-25.2,.006
    4
58  DATA 1835.3,36.1,-.0153,610.8,-44.2,-
    .0015,2480.5,-69.4,-.0014,.0026,0,.0
    111
60  DATA 1242.2,78.3,-.0045,3034.96,62.8,
    -.0066,1829.2,-51.5,-.0078,640.6,24.
    2
62  DATA -.0016,2363.4,-141.4,.0006,-.000
    2,0,-.0005,1251.1,43.7,.0005,622.8
63  REM  URANUS ELEMENTS BEGIN AT 74.1757

64  DATA 13.7,.0003,1824.7,-71.1,.0001,29
    97.1,78.2,74.1757,427.2742,0,.04682
67  REM  URANUS HARMONIC TERMS BEGIN AT -
    .0021
68  DATA .00042,0,19.2215,95.6863,2.0508,
    0,73.5222,.5242,0,.7726,.1E-3,0,-.00
    21
70  DATA -.0159,0,.0299,422.3,-17.7,-.004
    9,3035.1,-31.3,-.0038,945.3,60.1
74  DATA -.0023,1227,-4.99,.0134,-.02186,
    0,.0317,404.3,81.9,-.00495,3037.9,57
    .3
80  DATA .004,993.5,-54.4,-.0018,1249.4,7
    9.2,-.0003,.0005,0,.0005,352.5,-54.9
    9
81  REM  NEPTUNE ELEMENTS BEGIN AT 30.132
    94
82  DATA .0001,3027.5,54.2,-.0001,1150.3,
    -88,30.13294,240.45516,0,.00913,-.00
    127
83  REM  NEPTUNE HARMONIC TERMS BEGIN AT
    .1832
84  DATA 0,30.11375,284.1683,-21.6329,0,1
    30.68415,1.1005,0,1.7794,-.0098,0,.1
    832
88  DATA -.6718,.2726,-.1923,175.7,31.8,.
    0122,542.1,189.6,.0027,1219.4,178.1
90  DATA -.00496,3035.6,-31.3,-.1122,.166
    ,-.0544,-.00496,3035.3,58.7,.0961,17
    7.1
94  DATA -68.8,-.0073,630.9,51,-.0025,123
    6.6,78,.00196,-.0119,.0111,.0001
97  REM  PLUTO ELEMENTS BEGIN AT 229.781
98  DATA 3049.3,44.2,-.0002,893.9,48.5,.0
    0007,1416.5,-25.2,229.781,145.1781,0

100  DATA .24797,.002898,0,39.539,113.536
    6,.2086,0,108.944,1.3739,0,17.1514
101  REM  PLUTO HARMONIC TERMS BEGIN AT -
    .0426
102  DATA -.0161,0,-.0426,.073,-.029,.037
    1,372,-331.3,-.0049,3049.6,-39.2,-.0
    108
106  DATA 566.2,318.3,.0003,1746.5,-238.3
    ,-.0603,.5002,-.6126,.049,273.97,89.
    97
110  DATA -.0049,3030.6,61.3,.0027,1075.3
    ,-28.1,-.0007,1402.3,20.3,.0145,-.09
    28
116  DATA .1195,.0117,302.6,-77.3,.00198,
    528.1,48.6,-.0002,1000.4,-46.1
```

```
980  DATA EAR,MON,MER,VEN,MAR,JUP,SAT,URA
    ,NEP,PLU,NOD,ASC,"MC ",VTX
999  REM  UTILITIES
1000  DIM C$(14),C(14),R(12,2),M(79),H(13
    ),H$(12),A$(9)
1003 PI = 3.14159265: REM  DEFINE 'PI'
1005  DEF  FN R(X) = PI / 180 * X: REM  C
    ONVERTS DEGREES TO RADIANS
1010  DEF  FN D(X) = 180 / PI * X: REM  C
    ONVERTS RADIANS TO DEGREES
1015  DEF  FN Q(X) =  SGN (X) * ( INT ( ABS
    (X)) + ( ABS (X) -  INT ( ABS (X))) *
    100 / 60): REM  CONVERTS DEGREES/MIN
    UTES TO DEGREES DECIMAL
1020  DEF  FN U(X) = X - ( INT (X / MO) *
    MO): REM  MODULUS FUNCTION THAT RETU
    RNS RESULT WITHIN CIRCLE
1025  DEF  FN W(X) =  INT (X * 100 + .5) /
    100: REM  ROUNDS OFF TO TWO DECIMAL
    PLACES
1030  DEF  FN X(X) =  ATN (X /  SQR (1 -
    X * X)): REM  ARCSINE FUNCTION
1035  DEF  FN Y(X) =  ATN ( SQR (1 - X *
    X) / X): REM  ARCCOSINE FUNCTION
1040  DEF  FN S(X) =  SIN (PI / 180 * X):
     REM  SINE FUNCTION WHEN WORKING WIT
    H DEGREES
1045  DEF  FN C(X) =  COS (PI / 180 * X):
     REM  COSINE FUNCTION WHEN WORKING W
    ITH DEGREES
1050  DEF  FN T(X) =  TAN (PI / 180 * X):
     REM  TANGENT FUNCTION WHEN WORKING
    WITH DEGREES
1055  FOR I = 1 TO 14: READ C$(I): NEXT I
    : REM  FILL PLANET NAME ARRAY
1065  RETURN
```

```
3000  FOR I = 1 TO 9: REM  LOOP FOR PLANE
    TS
3010 MO = 2 * PI: REM  MOD FUNCTION IN RA
    DIANS
3015  GOSUB 3225:M =  FN U(S): REM  CALCU
    LATE MEAN ANOMALY
3020  GOSUB 3225:E =  FN D(S): REM  CALCU
    LATE ECCENTRICITY
3025 EA = M: FOR A = 1 TO 5:EA = M + E *
     SIN (EA): NEXT A: REM  SOLVE KEPLER
    'S EQUATION
3030  READ AU: REM  SEMI-MAJOR AXIS
3035 E1 = .01720209 / (AU ^ 1.5 * (1 - E *
     COS (EA))): REM  BEGIN VELOCITY COO
    RDINATES
3040 XW =  - (AU * E1) *  SIN (EA):YW = (
    AU * E1) * (1 - E * E) ^ .5 *  COS (
    EA): REM  PERIFOCAL COORD'S
3045  REM  CALCULATE ARGUMENT OF PERIHELI
    ON AND ASCENDING NODE
3050  GOSUB 3225:AP = S: GOSUB 3225:AN =
    S
3055  GOSUB 3225:IN = S: REM  CALCULATE I
    NCLINATION
3060 X = XW:Y = YW: GOSUB 3300: REM  ROTA
    TE VELOCITY COORDINATES
3065 XH = X:YH = Y:ZH = G: REM  HELIO ECL
    IPTIC RECTANGULAR VELOCITY COORDINAT
    ES
3070  REM  STORE SUN VELOCITY COORDINATES

3075 MO = 360: IF I = 1 THEN XA =  - XH:Y
    A =  - YH:ZA =  - ZH:AB = 0: GOTO 30
    95
3080  REM  GEO COMPONENTS OF SOLAR VELOCI
    TY
3085 XW = XH + XA:YW = YH + YA:ZW = ZH +
    ZA
3090  REM  PERIFOCAL COORDINATES FOR RECT
    ANGULAR POSITION COORDINATES
3095 X = AU * ( COS (EA) - E):Y = AU *  SIN
    (EA) * (1 - E * E) ^ .5
3100  GOSUB 3300:XX = X:YY = Y:ZZ = G: REM
     ROTATE FOR RECTANGULAR POSITION COO
    R'D
```

```
3105  REM  HARMONIC TERMS FOR OUTER PLANE
    TS
3110  REM  CORRECT RECTANGULAR COORDINATE
    S
3115  IF I > 5 THEN  GOSUB 3270:XX = XX +
    T(2):YY = YY + T(1):ZZ = ZZ + T(3)
3120 XK = (XX * YH - YY * XH) / (XX * XX +
    YY * YY): REM  COMPUTE HELIO DAILY M
    OTION
3125  PRINT  FN D(XK): REM  PRINT HELIO D
    AILY MOTION
3130 R$ = "  ": REM  SET RETROGRADE STRIN
    G TO BLANK
3135  REM  CONVERT HELIO RECTANGULAR TO S
    PHERICAL COORDINATES
3140 BR = 0: GOSUB 3200:AB = 1
3145 CH(I) = SS:CL(I) = C: REM  STORE HEL
    IO LONGITUDE & LATITUDE
3150  REM  STORE EARTH/SUN COORDINATES
3155  IF I = 1 THEN C$(1) = "SUN":X1 = XX
    :Y1 = YY:Z1 = ZZ: GOTO 3180
3160 XX = XX - X1:YY = YY - Y1:ZZ = ZZ -
    Z1: REM  HELIO TO GEO RECTANGULAR
3165 XK = (XX * YW - YY * XW) / (XX * XX +
    YY * YY): REM  GEO DAILY MOTION
3170 BR = .0057683 *  SQR (XX * XX + YY *
    YY + ZZ * ZZ) *  FN D(XK): REM  ABER
    RATION
3175  IF XK < 0 THEN R$ = " R": REM  RETR
    OGRADE CHECK
3180  REM  CONVERT RECTANGULAR TO SPHERIC
    AL
3185  GOSUB 3200:C(I) = SS:M(I) = P: PRINT
    : IF XK < 0 THEN C(I) =  - SS
3190  NEXT I
3192  END
3195  REM  RECTANGULAR TO SPHERICAL COORD
    INATES
3200 X = XX:Y = YY: GOSUB 3240:K = A:C =
     FN D(A) + NU - BR: IF I = 1 AND AB =
    1 THEN C =  FN U(C + 180)
3205 C =  FN U(C + SD):SS = C:Y = ZZ:X =
    R: GOSUB 3240: IF A > .35 THEN A = A
    - 2 * PI
3210 P =  FN D(A)
3215  GOSUB 1190:P$ = Z$ + R$:C = P: GOSUB
    1190: PRINT P$D$"  ";: RETURN
3220  REM  ASSEMBLE ORBITAL ELEMENTS
3225  READ S,S1,S2:S =  FN R(S + S1 * T +
    S2 * T * T): RETURN
3229  REM  POLAR TO RECTANGULAR COORDINAT
    ES
3230  IF A = 0 THEN A = 1.7E - 09
3235 X = R *  COS (A):Y = R *  SIN (A): RETURN

3239  REM  RECTANGULAR TO POLAR COORDINAT
    ES
3240  IF Y = 0 THEN Y = 1.7E - 09
3245 R = (X * X + Y * Y) ^ .5
3250 A =  ATN (Y / X): IF A < 0 THEN A =
    A + PI
3255  IF Y < 0 THEN A = A + PI
3260  RETURN
3265  REM  CALCULATE HARMONIC TERMS FOR O
    UTER PLANETS
3270 K(6) = 11:K(7) = 5:K(8) = 4:K(10) =
    4:K(9) = 4: REM  NUMBER OF HARMONIC
    TERMS FOR PLANET
3275  FOR IK = 1 TO 3: IF I = 6 AND IK =
    3 THEN T(3) = 0: RETURN
3280  IF IK = 3 THEN K(I) = K(I) - 1
3284  REM  ASSEMBLE TERMS
3285  GOSUB 3225:A = 0: FOR IJ = 1 TO K(I
    ): READ U,V,W
3290 A = A +  FN R(U) *  COS ((V * T + W)
    * PI / 180): NEXT IJ:T(IK) =  FN D(
    S + A): NEXT IK: RETURN
3295  REM  ROTATE ROUTINE USED FOR POSITI
    ON AND VELOCITY COORDINATES
3300  GOSUB 3240:A = A + AP: GOSUB 3230:D
    = X:X = Y:Y = 0: GOSUB 3240:A = A +
    IN: GOSUB 3230:G = Y:Y = X:X = D
3305  GOSUB 3240:A = A + AN: IF A < 0 THEN
    A = A + 2 * PI
3310  GOSUB 3230: RETURN
```

ON THE POLICHIAN THEORY OF TOPOCENTRIC GENEOLOGICAL CONNECTIONS

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INTRODUCTION

This small paper has been prepared more in the interests of facilitating the testing and application of a theory than that of a methodology, however provocative the methodology may seem to researchers. The term "topocentric" has a specific etymological denotation in geodesy, but is being used here in conformity with a method of astrological analysis which is familiar only to a select few outside of Latin American coutries, most notably Argentina, Venezuela, Peru and Columbia. The Topocentric System- as it is most often referred to- lays claim to a number of astonishing and even revolutionary procedures of astrological methodology which are fairly demanding in mathematical manipulation, at least for the "average astrologer". In the present inquiry, the claim in which we are specifically interested is the topocentric theory of ascensional transits, especially where this theory postulates the existence of acutely precise planetary connections (geneological) among the members of a given family. Its authors, the Hungarian-born mathematician and astrologer Wendel Polich, and the British-born A.P. Nelson Page, have for more than a decade advocated a sort of purely mathematical sysnastry, whereby Nature would ideally reveal the precision with which she is ordered.

The reader should be made aware that these transits (including this form of synastry) are not calculated in terms of ecliptical, zodiacal motion as is the convention, but are taken in terms of oblique ascension which is an equatorial value, not an ecliptical one. As a result, the procedure for most will seem a bit complex and time consuming, and hence ultimately a task performed beautifully by small computers and sophisticated calculators. The formulae section includes a flowchart for this purpose.

RATIONALE

After having studied a number of events on a certain radix, Polich and Page plotted a series of points on a transit graph, based on these events, which in the end defined a curve which belonged to a house cusp or more exactly, to where the real house curve should have been. Analysis of this house circle revealed to them that it in fact did not belong to the celestial sphere, having had the intrinsic property of a straight line. This meant that the true house lines, as well as the planes defined by the positions of the planets, did not converge or pass through the center of the Earth, but through the very body of the native which is the topographic center of any natus (topo = place). Thus, and in order for them to be commensurate with this topo-specific reality, the derived equations had to conform not to the postulates of spherical trigonometry, but to those of the trigonometry of plane surfaces. This has ever since been a very controversial and paradoxical point.

Let's see if we could follow their reasoning and develop a fairly inteligible explanation. It is a standard geometrical theorum that straight lines cannot be used for measurement on the surface of a sphere. This being so, and in light of their aforementioned graphic findings, suggested that the 100% efficacy of the celestial sphere as the sole medium of operable planetary influences was questionable. This was especially true regarding the mundane sphere, the one upon which astrological domification has been traditionally developed and depicted. Which one then was the true surface? Remember that house curve which was arrived at empirically, and which seemed to be more of a straight line? Upon which surface does this house line hold? Topocentric theory claims that this "curve" IS really a straight line on the surface of the rotational "cone of ascension".

To illustrate this without a minimum of abstraction is not easy, which is why we should start out with a brief discussion of time as measured on Earth. The interval of time defined by the axial rotation of the earth, the mean solar and sidereal days, is measured by astronomy via a "cylinder" of rotation [Fig. 1] whose radius (r) is considered equal to that of the celestial equatorial plane (r = 1). The radii of the parallels of declination (A,B,C...F), which in reality we know to physically and progressively decrease (A',B',C'...F') as propinquity to the celestial poles is defined, are also taken as unity (r = 1), which means that their radii are considered equal to the radius of the equator (Fig. 1). This must hold true for every single point on the surface of the cylinder, from 90 degrees north to 90 degrees south declination, despite the radius of the parallel that it traces along the sky. If, however, the parallels were each to be taken in terms of their own radii, then what rotation would generate is not the surface of a cylinder (Fig. 1), but the surface of a cone (Fig. 2).

[Insofar as this cone is generated by the Earth's rotation perpendicularly in relation to the equator, it is a "right cone" or a cone on the "right sphere" and is very good for a theoretical grasp of its generation. The reader is invited though, to compare it with the topocentric cone of Fig. 3 whose surface is described by the geocentric horizon and whose radius is defined by the TANGENS ϕ.

We will not enter here into the complex subject of transposing this cone over to a topographical point such that its center would be a certain ϕ and λ, and vice versa. The important thing here is that a cone IS generated and that its center should be considered the very geocenter, i.e. of the Earth. As long as we in astrology work with geocentric positions of the planets as depicted in the common ephemeris, this procedure can and should be considered correct.

In summary, it is due to the possibility of this representation (Fig. 2) that a difference exists, both conceptually and astronomically, between spherical coordinates and topocentric, conic coordinates. In an unorthodox mathematical sense, these 1st conic coordinates are the ones we need to test Polich's fundamental ideas relative to all techniques which constitute his Topocentric System.

The spherical values arrived at via the equations which yield the traditional Placidean Proportions (meridian distance (MD), ascensional difference (AD), semi-arc (SA), etc.), which we have defined in the Formulae section of the present paper, and which are known to all who have worked with primary directions, ARE EQUIVALENT TO THE SAME VALUES ON THE CONE WHEN BOTH ARE MEASURED ON THE CELESTIAL EQUATOR. This is borne out mathematically as the circumference described by the rotation of any point on the surface of the cylinder (Fig. 1) is equal to the circumference of the cone, i.e. the celestial equator. Thus, transversal values such as right ascension (α), oblique ascension (OA), ascensional difference (AD) , meridian distance (MD), and semi-arc (SA), are EQUAL both in terms of the sphere as well as the cone, for they are all measured segments of equatorial arc (in Fig's. 1 & 2 above, A = A', but B, C...F do not equal B',C'...F'). It is this fact which justifies the utilization of spherical formulae in practice which, besides being more straightforward to manipulate, allow one to dispense with the need to work with astrologically unfamiliar arcs in radians, which is how measurement is made on the surface of any geometrical cone.

MATHEMATICAL SYNASTRY: THE GENEOLOGICAL CONNECTIONS

Besides having offered both a theoretical and practical solution to the perpetual problem of spherical house division in the polar regions (90- ε), defining the poles (polar elevations) of all cusps on up to the very north and south poles, the Topocentric System has also proven to contain a very and surprisingly precise method of primary directions. In addition to these, Polich has deviised an astro-mathematical thesis to explicate what he terms "The Laws of the Materialization of Events", whereby events would ideally taly with transits taken in terms of the aforementioned oblique ascensions of the planets. These OA points are calculated "under" the polar elevations (pole for short) of the planets in question, and probably warrant some discussion

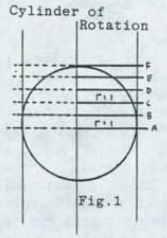


Fig.1

Right Celestial Cone

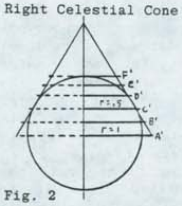


Fig. 2

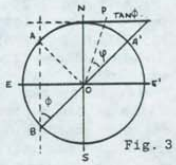


Fig. 3

The heart of Polich's and Page's astrology is the "topocentric pole". To understand what this pole is, the reader is urged to take notice of Fig. 3. The line EE' defines the plane of the equator. NS is the Earth's axis; O the geocenter, and A a native's place of birth through which passed the topocentric axis (dotted line) parallel to the terrestrial axis (NS). The bold line is the geocentric horizon, parallel to the apparent horizon which in this graph has not been depicted. AO is the prime vertical. Now, the angle defined by NOA' or ABA' is the geographical latitude (ϕ); if a planet were to be situated at P, its "latitude" or topocentric polar elevation would be defined by the angle POA' which, as can be seen, claims a certain proportion to TANGENS ϕ.

Where do the OA's fit in? As will be seen more clearly in the Formulae section, to calculate the OA's we need to first find the values of the AD's which are arrived at by using the tangens function of ϕ . When this AD is added or subtracted from the right ascension, we have an OA point which has been taken "under the pole of ϕ " (polar elevation or pole is synonymous here to latitude). If we substitute TANGENS ϕ with TANGENS ψ , we will have computed a value "under the topocentric pole of the planet". When this value is used to calculate the OA's, these then will also be points under ψ , which make them coordinates which are really peculiar to the surface of the aforementioned cone, for the poles under which they are taken are proportions of the function

of the natural tangent of the geographical latitude, TANGENS ϕ being a straight line that during the course of the sidereal day, defines the surface of the cone for that particular place. A close inspection of Fig. 3 should reveal this nicely. Instead of imagining that the diagram will rotate around NS, have it do so around AB (topo axis), as it does from the apparent and relative point of view of the observer at A.

Getting back to ascensional transits, the main reason for any researcher to design a program for them, on any computing system or calculator, would be to facilitate all of the iterative and time consuming computations which must be executed (72 in all, 36 of which are trigonometric operations, per chart!) to check the ascensional transits. This is especially true insofar as they relate to the geneological contacts in OA which topcentric theory says must exist among members of a family, or any group with strong natural vinculations. To this end one must compute and subsequently compare the respective planetary contacts (without even resorting to intrinsic planetary symbology!) which should be present say, between a mother and her daughter. Polich holds that if the times of the relavent radices were accurately stopwatched to within 4 seconds of mean solar time (4s= 1' arc OA), there should be found a series of no-orb configurations which, if not present, astronomically justify the need then for rectification. A modified procedure for doing the comparison is included in the Appendix.

As will be demonstrated shortly, planetary meridian distances in right ascension occupy a vital place in the equations used in the Topocentric System. The local meridian, of the RAMC (LST), being an intersection of the equatorial plane with the meridian of birth, is a coordinate conventionally calculated from the UT meridian (Greenwich). As is known, this UT meridian does not rotate at a uniform velocity, and has been slowly decreasing in speed as of April 1903. According to Polich's experience "on thousands of charts", this all has profound implications for delineation and his hypothesis is this: that all MD's calculated from this meridian, in synastry or otherwise, always coincide with the pertinent event BUT with some type of orb, i.e. they tally with events over which the NATIVE HAS A CERTAIN DEGREE OF CONTROL.

For the purposes then of securing the possibility of no-orb contacts between radices, Polich has introduced an astrological application of the INVARIABLE prime meridian of terrestrial rotation, the ET meridian (Ephemeris time M.), as also valid as an alternate and conditional reference plane from which to calculate MD's. The conditional aspect of this meridian is that MD's reckoned from it are supposed to coincide with events over which the NATIVE HAS NO CONTROL. Of course, the ET meridian is not really a meridian at all, but is defined as the place at which the UT meridian would have been had the Earth's axial rotation been uniform in accordance with pure ephemeris time. The IAU (International Astronomical Union) places it at about 1.002738 Δ T east of the variable, UT meridian. To grasp the astrological significance and reason for trancends the limits which we have set for the present purposes, and would imply some pretty effervescent theorizing best left alone in our present inquiry.

To compare coordinates between two or more charts implies referring them to a plane which is common to each one. The only circle in the sky which meets these requirements is the celestial equator, which is the FUNDAMENTAL CIRCLE of the celestial sphere and, as was mentioned, is the only real reference plane common to both charts (with the exception of the ecliptic). It is conceivable then that for it to be considered such, a true synastry would have to conform to this principle, that is if it were to be considered astronomically and hence astro-logically correct. It is well known that in order for two people to effectively communicate, they should be able to "relate on the same level", or at least refer to that level with some degree of ease.

Now, as the OA's (OA on cone) and ψ's calcualated via the formulae appended to this paper will be very useful to those interested in primary directions, the force of any test of the genealogical contacts would lie in a sort of modified MD, the MDo (MD on cone), the equation for which has been outline in the following section. The contacts cannot be readily checked with the OAo's and polar elevational values (ψ), as in the case of the former they must be "transposed", in Polich's own nomenclature, to the place and time of the chronologically latter chart via the increment calculated simply by the expression:

RAMC(e) - RAMC(r)

where RAMC= Right Ascension of the Midheaven.

(e)= event or later natus, (r)= radix or later event.

...the difference of which must be added to all radical OAo's before the comparision can be made. If for example it is found that Mercury OA(e) is conjunct the Sun OA(r), the poles of the same planets should also superimpose. For this to be true however, it should be remembered that the ψ's are values calculated in terms of the planet's own parallels of declination , and cannot then be compared either unless projected onto the celestial equator by the formula:

$$\psi e = \text{TAN}^{-1}\frac{\text{RAMC-OAo}}{90}\ \text{TAN}\phi$$

where RAMC- OAo = the absolute value of the difference between the RAMC and OAo of the planet.

ψe = topocentric pole of the planet projected upon equator.

Thanks to a third and easily-arrived-at proportion, these two previous operations can be dispensed with. This value, the MDo, will serve to show if there are in fact any contacts in OAo, without having to even compute the latter. This is made such by the very nature of the topo proportions, and the reader can use the following equations to prove say, that if in a certain comparison Sun OA(e) is conjunct Mars OA(r) is true, so will Sun ψ conjunct Mars ψ , and Sun MDo conjunct Mars MDo... This should be taken into acount when coding a program (computer or calculator), as much valuable memory or key steps can be saved.

FORMULAE SECTION AND FLOWCHART LOGIC FOR COMPUTER & CALCULATOR IMPLEMENTATION: A FEW WORDS ABOUT I/P DESIGN, MINIMIZING OPERATOR INTERVENTION, ETC.

An economical programmer's first and foremost interest is his I/P design. Even before asking the question: How will I do it?, one should ask: With what shall I do it? In the present case, there are a few alternatives, depending on:

a) Operator intervention: to what extent does one want to participate actively in the input and computational process?

b) How much memory and/or key steps can your computer and/or calculator offer you? The extent of (a) depends on (b).

If you have enough memory or key steps, the present topocentric (ψ, ADψ, OAo, MDo) O/P generation can be arrived at by these I/P pareameters: Ecliptic longitude, Ecliptic latitude, RAMC, geographical latitude (ϕ). Since formulae for performing coordinate transformation from ecliptic to equator (α , δ to λ , β) have been amply demonstrated in previous issues of MATRIX, we will only outline computations with this I/P data: RAMC, ϕ , α , δ .

Assuming then that these are initial I/P parameters, the very first computation executed should reveal planets angular distance in RA from the local meridian, depending on which quadrant of the chart it is situated in.

(1.1a) MD = RAMC - RA (if planet in Quadrant I)

(1.1b) MD = RA - RAMC (if planet in Quadrant II)

(1.1c) MD = RAIC- RA (if planet in Quadrant III)

(1.1d) MD = RA - RAIC (if planet in Quadrant IV)

MD = meridian distance, RA = Right Ascension of planet

No example is needed, as the subtraction is simple and straightforward. It should be noted though , that for a computer or calculator to decide whether a planet is in a certain quadrant based on I/P data supplied, its conditional branching (IF: decision statements) possibilities should not be very limited.

(1.2) This equation will calculate what the difference of arc would be between the body's rising or setting point and 90 degrees from its meridian passage, on the horizon. This has to be done in accordance with the value of ϕ , and is given by:

AD = ARCSINE(TAN δ TAN ϕ)

where AD = ascensional difference

EXAMPLE: for δ = -01 degrees 42' 15"

ϕ = +41 degrees 49' 53"

AD= ARSINE(TAN -1.704166667 TAN 40.83138889)
= ARCSINE(-.0297520934)(.8641333182)
= ARCSINE(-.0257097752)
= -1.473223939
= -01 degrees 28' 24"

(1.3) The semi-arc (SA) of a planet refers to the apparent arc that said planet traces along the sky, on its own parallel of declination, during the course of sidereal day. One half of that arc when above horizon is the semi-diurnal arc (SDA), when below horizon, the semi-nocturnal arc (SNA). When subsequent equations call for SA, either one must interven to make sure that if planet is above horizon that SDA is taken for SA, and vice versa, or a routine should be designed such that machine in use will do this internally. In this case, only one semi-arc will be computed (SDA or SNA), and will imply inserting a decision instruction (IF h<0, GOTO..., for example) after the program calculates whether the planet is below (SNA) or above (SDA) the horizon via the formula for Altitude:

(1.3a) h = ARCSINE(SIN ϕ SIN δ)+ (COS ϕ COS δ COS t)

where h = Altitude, t = hour angle given by RAMC - RA

Example: for RAMC = 279 52'45"
RA = 173 10' 27" (moon)
δ = -01 42' 15" (moon)
ϕ = as above

Compute t = RAMC - RA
= 279.8791667 - 173.1741667
= 106.7055000
= 106 42'18"

then

h=ARCSINE((SIN 40.73138889 SIN -1.7041667)+(COS 40.831388 COS -1.7041667 COS 106.7055))
=ARCSINE[(.653839)(-.029738)+(.7566369 .9995577 -.287444)]
=ARCSINE((-.0194443624)+(-.2173946408))
=ARSINE(-.2368390033)
= -13.70005055
= -13 degree 42'00"

since 'h' has a negative algebraic value (below horizon), the computer would be instructed to branch off and calculate SNA as SA. The calculation of SA is very simple, and is accomplished by:

SNA = 90 - AD; for AD = -0 28' 24" (moon), carefully noting algebriac sign we then have:

SNA = 90 - (-1.4733333)
= 91.47333333 = 91 28' 24"
and if SDA is also desired,
SDA = 90 + (-1.473333333)
= 88.52666667 = 88 31' 36"
NOTE: SDA + SNA must equal 180 degrees

These values can also be arrived at via the cosine function of the product of tangent δ and tangent ϕ :

EXAMPLE:

SA = ARCOSINE(TAN δ TAN ϕ) for δ and ϕ values as in 1.3
= ARCCOSINE(TAN -1.70416667 TAN 40.83138889)
= ARCCOSINE(-.0297520934)(.8641333182)
= ARCCOSINE(-.0257097752)
= 91.47322394
= 91 deg 28' 24" SNA or semi-nocturnal arc

The equation will give SNA if the declination term is left in literal algebraic form as above. To use for computing SDA, algebraic inverse of the declination should be taken.

(1.4) This formula, which denotes the planets proportionality to TANGENT ϕ , (see Fig. 3), reads thus:
ψ = ARCTANGENT ((MD/SA) TAN ϕ)
where ψ = topocentric pole
EXAMPLE:
ψ = ATN((73.29500/91.47322394) TAN(40.83138889))
= ATN((.8012727314)(.8641333182))
= ATN(.6924064642)
= 34.69897898 = 34 41' 56"
for MD = 73 17'42" as computed via eq. 1.1d and for SNA and ϕ as above.

(1.5) an argument in terms of the topocentric polar elevation of the planets own parallel of declination, as opposed to the same expressed "under the pole" of ϕ as in eq. 1.2:

AD ψ = ARSINE(TAN δ TAN ψ t)
where AD ψ = ascensional difference under ψ for ψ and δ as above.

EXAMPLE
AD ψ = SINE(TAN -1.70416667 TAN 34.69897898)
= ARCSINE((-.0297520934)(.6924064642))
= ARCSINE(-.0206005418)
= -1.180407601 = -01 10' 49"

The reader is invited to compare this value with the one calculated with eq. 1.2 The effect of substituting ϕ with a proportion of ϕ should seem evident.

(1.6) Mathematically conceived, this sample expression will describe a coordinate on the surface of the cone (see Fig.2) which will rise or set on the horizon at the same time as will the degree of the equator which the equation calculated. In a geometrically abstract sense the secondary circles which these OAo and ODo points define and are intersected by are in fact NOT great circles but straight lines. THESE are those very sensitive points of the genealogical connections.

OAo = RA - ADψ (oblique ascension upon cone) if east of meridian
ODo = RA + ADψ (oblique descension upon cone) if west of meridian

Again, in lieu of the the arithmetical simplicity of equation, no example is warranted. The expression reflects the relationship of a planet's "right" ascension with its "oblique" ascension, i.e. its ascension difference which, in plain words, points to the discrepancy between the planets rising (or setting) point on a right sphere and on an oblique sphere.

(1.7) This equation will give that "modified" MD position of which we spoke earlier. It is a position in terms of the cone, in that it is a linear projected value on the celestial equator, which, as was seen in Fig. 2, is the very base circumference of the cone. Multiplication here by 90 degrees has effect of cancelling out the planets orthogonal value (declination).

MDo = (MD/SA) 90 whre MDo = meridian distance upon cone

EXAMPLE:
MDo = (73.295000/91.47322394)* 90
= (.8012727314)(90)
= 72.11454583
= 72 06' 52"
APPENDIX
In what follows the reader will find a practical example of how to use the MDo's calculated with formula 1.7 for comparing topocentric ascensional contacts between the radices of the members of a small family. This is nor a special set of data, not was it picked because of its somewhat impressive category which we admit, in the light of the wishes of a no-orb astrology, falls short of really being impressive. The sample comparison has been generated from officially documented birthdata, and in no way is being presented as a singular or conclusive example of the validity of topocentric genealogical connections. It is being simply outlined in the interests of illustrating how one can proceed to use the equations in research as well as in practice.

The reader would do well in remembering that the topocentric equations illustrated herein will most of all attract the attention of the

Primary Directionalists. These are directions whose fundamentation lie in the axial rotation of the Earth. We repeat: for the mathematical comparison of the genealogical connections in OA, positions in MDo suffice. Only conjunctions between respective MDo's are valid, as what we are looking for are congrous angular separations from the local meridian. Also, it MUST be noted that all birthdata which one would want to subject to this type of analysis should be sufficiently documented. In the topocentric astrology of Polich and Page there is no room for dubious birth information, as a few minutes of mean solar time will render a correct study all the more complex AND open to speculation. What's more, as the indefatigable Dr. D. Ferriz of the Faculty of Cosmobiology of Peru (not to be confused with the Ebertin system) has stated: "place = precision"; geographical coordinates should ideally be derived from a topographic quadrangular map available from the U.S. Geological Survey in Washington D.C., or through most map stores.

CH1 - Father B. Certificate
Feb. 16, 1957
JD= 2435886.543
UT= 135000 hrs
ϕ = 40 49' 53"+
λ = 73 54' 30"-
RAMC= 279 52'45"
RAIC= 099 52'45"

CH2 - Mother B. Certificate
Jan. 28, 1957
JD= 2435867.560
UT= 142400 hrs
ϕ = 40 43' 59"+
λ = 40 43' 59"-
RAMC= 269 33'59"
RAIC= 089 33' 59"

CH3 - Son
Stopwatched

Dec. 23, 1978
JD= 2443865.230
UT= 091259 hrs
ϕ=40 52' 44" +
λ= 73 52' 49" -
RAMC= 155 55' 45"
RAIC= 335 55' 45"

REFERENCES AND SUGGESTED READING

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4) McNally, Dr. D., POSITIONAL ASTRONOMY: London: Frederick Muller Limited, 1974
5) Page, A.P.N, Polich, Wendel, IN SEARCH: New York, 1961
6) Page, A.P.N, Polich, Wendel, Marr, Alexander, TABLES DE ASCENSION RECTA ECLIPTICA CON MANUAL DE DIRECCIONES PRIMARIES: Buenos Aires, Argentina: Centro Astrologico de Buenos Aires, 1970 - Contains very good right tables computed for obliquity of 1969 (23.44333333), besides many other fine auxiliary tables. Also includes an outline of a very effective system of primary directions.

READING SUGGESTIONS (continued)

7) Polich, Wendel, THE TOPOCENTRIC SYSTEM: Buenos, Aires, Argentina: Editorial Regulus, 1975, translated by Jose M. Lebron
8) Weiss, Dr. Adolf, ASTROLOGIA RACIONAL: Buenos Argentina: Editorial Kier, 1973. Originally written and published in German in 1924-25

NOTES TO GENEALOGICAL CONTACTS chart on next page

The above MD and MDo positions have been calculated in accordance with the UT meridian of variable terrestrial rotation. No allowance has been made for values reckoned from the ET meridian, which is the ideal reference plane, according to Polich, from which MD's should be calculated if a no-orb comparison were to be a rality. Worth noting is the fact that the contacts between the above charts would progressively narrow (in orb) if the Father and Mother would have been born anywhere from 1 to 3 minutes earlier, a possibility which is totally conceivable. These 2 latter charts were erected for times which were ronded off to the nearest minute, on hospital based clocks, which are usually in error by a minute or two to start with. The rounded birth times were taken to be fixed points in time and positions were calculated therof to the second of arc, so as to prevent the accrueing of residual errors caused by rounding off values which have themselves been derived from other rounded data. Right Ascension and Declination positions from the Sun to Neputune were interpolated from the American Ephemeris and Nautical Almanac; the rest were arrived at trigonometrically from coordinates (ecliptic) calculated from Michelsen's American Ephemeris.

Note: minimum orb (in arc measure) in above comparison = 00 02' 51"
maximum orb = 00 44' 52"
mean value (average) or orb = .3526543211 = 00 21' 46"

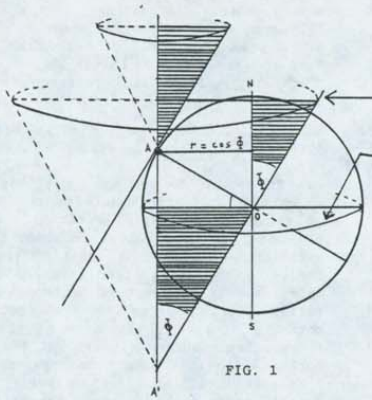


FIG. 1

Fig.1 TOPOCENTRIC CONE FOR A

Apparent Horizon

Geocentric Horizon

Plane of Equator

NS = earth's axis
AA' = topocentric axis
AO = prime vertical
A = birth or event place
0 = geocenter
ϕ = geographical latitude (elevation of earth's pole angularly over gencentric horizon): note that ϕ = angular elevation of point A above the horizon (A's pole), i.e. A's latitude is A's polar elevation (pole).
r = radius of circumference that A describes during rotation.

"A" is a point on the 'biosphere'; it is from the surface (and NOT the center) that we all view and experince the world: biologically, psychologically, sociologically, and the horosocope should be a true depiction of this. FOr an observer at A, the universe, along with the very center of the earth itself, seems to rotate around the topocentric axis AA'. During the rotational cycle which is the sidereal day, the geocentric horizon will sweep and trace the surface of a cone (specific for A with its inherent velocity) whose vertex in the above example turns out to be A'. In a theoretical sense, the apparent horizon will do the same, but its vertex will lie at the very body of the nataive (A).

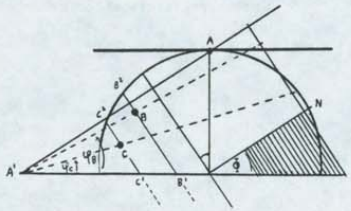


FIG. 2

Fig. 2 TOPOCENTRIC POLE OF PLANETS B & C

This diagram is the same as above but with geocentric horizon depicted horizontally. The polar elevations (poles for short) of two planets situated at B & C, with their respective axes converging at A', are values defined precisely the same way as the ϕ of A. If for example B were to have the same angular elevation as does A, its pole (ψ) would be equivalent to ϕ. B^1 B^2 & C^1 C^2 are the SEMI ARCS (diurnal) of B and C respectively. The SEMI NOCTURNAL ARCS would be the extension of these (dotted line) below the geocentric horizon.

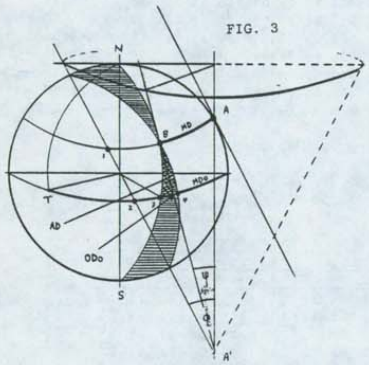


FIG. 3

Fig. 3 "PLACIDEAN" VALUES VERSUS TOPOCENTRIC VALUES

Here we again have the same diagram but this time from the due West perspective. Upon it are to be found the spherical and conic values for planet B, thus depicting with sufficient clarity those points which can be calculated via the appended equations of the Formulae section. In analyzing the diagram, the reader should recall Eq. 1.6 where the planet's (or star's) oblique descension (OD) was needed if west of the local meridian , here defined as NAS. Strictly speaking, in this example (west) we must really speak of a "descensional difference" (DD), but for the sake of illustration and definition the more familiar AD has been used.

NAS = local meridian of A
B = planet or star
γ = Vernal Equinox
1 = setting point (on geocentric horizon) of B
2 = setting point of OD of B
3 = α of B
4 = oblique descension of B under ϕ
B34 = ascenional difference of B under ϕ
MD = meridian distance in α of B
MDo = meridian distance in α of B upon equator (or cone)
ψ = pole (topocentric) of B

As Geoffrey Dean of Australia has pointed out, oblique ascension and descension are really points in RA, and not angular measurements per se. This is made clear by taking note of point '4' above. When, in this diagram, the planet or star situated at B corporally reaches the horizon, the degree on the equator that will set with it simultaneously is defined by '4', i.e. '4' is the OD point of B (under ϕ). At that time (of setting) B will become '1' and '4' will become '2'. The arguement as to why the RA of B and the OD of B will not set at the same time is depicted by the dark spherical triangle B34; this is the AD under ϕ. The point on the equator (within this triangle) defined and intersected by the pole of B, will in this example set a little before point '4': this is B's oblique descension under its own, topocentric pole (OAo = upon cone). The new triangle thereby defined is the ascensional difference also under B's pole: ADψ.

It should seem evident by now that in this example, MD would = MDo if B's declination were equal to zero, i.e. were it to lie on the plane of the equator. The same would of course be true of its AD and ADψ, & hence of its OD and ODo.

THE GENEALOGICAL CONTACTS

	CHART 1									CHART 2									CHART 3								
	SA			MD			MDo			SA			MD			MDo			SA			MD			MDo		
	d	'	"	d	'	"	d	'	"	d	'	"	d	'	"	d	'	"	d	'	"	d	'	"	d	'	"
SUN	079	07	36	049	57	02	056	48	05	073	35	31	041	16	44	050	28	57	112	02	16	064	38	15	051	55	24
MON	091	28	24	073	17	42	072	06	52	072	39	14	014	39	16	018	09	12	088	16	47	032	29	00	033	06	59
MER	071	39	27	028	11	31	035	24	30	070	42	18	015	19	14	019	30	05	107	58	14	087	53	45	073	16	00
VEN	074	00	47	036	16	07	044	06	09	069	25	30	021	46	19	028	13	28	077	44	05	070	09	00	081	13	06
MAR	075	24	10	060	57	25	072	45	27	079	17	14	061	55	31	070	17	32	112	45	05	057	03	30	045	32	42
JUP	088	54	42	080	58	30	081	57	58	090	35	14	087	34	11	087	00	07	107	11	23	025	31	45	021	26	07
SAT	070	58	08	027	47	05	035	14	08	071	10	49	018	52	50	023	52	21	096	58	52	009	58	30	009	15	25
URA	071	47	48	026	34	15	033	18	27	072	03	20	037	44	16	047	08	09	074	25	57	071	00	00	085	50	59
NEP	080	36	21	069	24	45	077	30	07	080	36	29	058	33	29	065	22	51	110	00	33	078	17	15	064	02	53
PLU	087	55	--	055	47	--	057	06	--	069	27	--	066	32	--	086	14	--	097	14	--	047	59	--	044	25	--
TNO	072	58	--	048	27	--	059	45	--	072	24	--	035	31	--	044	09	--	093	02	--	015	57	--	015	26	--
MNO	072	52	--	048	00	--	059	18	--	072	40	--	036	40	--	045	25	--	092	52	--	015	26	--	014	57	--
PFO	075	40	--	058	33	--	069	37	--	080	43	--	070	06	--	078	10	--	100	24	--	004	40	--	004	12	--

TNO= True Lunar Node, MNO= Mean Lunar Node (North) PFO= Part of Fortune

RIGHT ASCENSION & DECLINATION

	CHART 1						CHART 2						CHART 3					
	RA			Decl.			RA			Decl.			RA			Decl.		
	d	'	"	d	'	"	d	m	"	d	'	"	d	'	"	d	'	"
SUN	329	49	47	-12	17	40	310	50	43	-18	09	39	271	17	30	-23	26	10
MON	173	10	27	-01	42	15	284	13	15	-19	05	49	188	24	45	-01	59	11
MER	308	04	16	-20	00	37	284	53	13	-20	59	33	248	02	00	-19	37	05
VEN	316	08	52	-17	40	42	291	20	18	-22	12	02	226	04	45	-13	47	22
MAR	038	55	20	+16	15	33	027	38	28	+12	10	51	278	52	15	-24	04	29
JUP	180	51	15	+01	15	33	181	59	48	+00	40	55	130	24	00	+18	51	05
SAT	252	05	40	-20	40	27	250	41	09	-20	32	11	165	54	15	-17	13	34
URA	126	27	00	+19	52	31	127	18	15	+19	41	10	226	55	45	-17	13	34
NEP	210	58	00	-10	41	47	211	00	30	-10	43	49	257	38	30	-21	34	09
PLU	155	40	--	+02	24	--	156	06	--	+22	11	--	203	55	--	+08	16	--
TNO	231	26	--	-18	44	--	234	03	--	-19	05	--	171	53	--	+03	30	--
MNO	231	52	--	-18	50	--	232	54	--	-19	05	--	171	22	--	+03	18	--
PFO	221	20	--	-15	59	--	334	24	--	-10	37	--	151	15	14	+11	46	40

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OUTER BODY COORDINATES FOR DATES IN THE DISTANT PAST OR FUTURE OBTAINED BY NUMERICAL INTEGRATION

BASIC and FORTRAN programs by James Neely

INTRODUCTION by Editors

Outer body (Jupiter through pluto) positions have always presented a variety of difficulties. Only very low precision (about 45' of arc, worst case) is possible for these planets using equations for the Mean Elements. Some kind of perturbation theory is necessary. The fine curve fitting work of James Neely has brought the outer body positions to within several minutes of arc using only a special set of Mean Elements. The addition of a series of harmonic terms (given in this issue) allows accuracy of about one minute of arc to be obtained for dates in this century. One minute accuracy is excellent for most kinds of astrological work. But what about other centuries?

The 'Bible' as far as outer body positions for dates in the past has been Volume XII of the Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac. This 327 page book, containing some one and one-half million figures, has the title COORDINATES OF THE FIVE OUTER PLANETS 1653-2060. All of the mutual attractions of the five planets and the Sun were included and the resulting set of simultaneous non-linear differential equations of the thirtieth order was solved numerically with an accuracy of fourteen decimals.

The starting positions and velocities for the integration were determined from all the available observations. Approximately 25,000 observations from about 1780 to 1940 were used. The final integration in Volume XII was continued back to 1653 because observations of eclipses of Jupiter's satellites near that date are still of value.

What Neely has accomplished is to write a program that duplicates the results of Volume XII..digit for digit. However, the Neely program can be run beyond either the 1653 or the 2060 limits as set by Volume XII. The Volume XII program could also be extended were it available in a form that could be implemented on a small machine. The resulting positions will give astro-computers the first set of quite accurate outer-body values for time spans beyond the limits 1653-2060 limits.

It should be made clear that this program does not allow access to a specific date in the past or future. Rather, the program must run backwards, using forty day intervals, to the desired epoch or date. The resulting values may then be used for our purposes. In other words, this process is a relatively slow and time consuming one...something that should be done only once. The program should be run and the forty day outer-body coordinates stored on disk. These stored coordinates may then be used to assemble an ephemeris that may be accessed using various interpolation schemes.

Neely is now working with MATRIX to provide a variety of ways to access this information. We are in the process of putting the integration routine on our TRS-80 which has the double-precision needed to extend this program into the distant past or future. Machines with less precision will suffer from an accumulation of round-off errors. After the program is run on the TRS-80 and the 40-day results stored on disk, these results will be communicated to both the PET and APPLE computers. The resulting disk-based ephemerides will be made available through MATRIX on the PET, APPLE II and TRS-80 home computers. These ephemerides will be accessed by a simple interpolation program to provide outer planet positions of high accuracy for past and future dates. The number of years of ephemerides that can be placed on a single disk will vary accordning to the storage limits of the particular disk (PET= 170K, APPLE= 100K, TRS-80= 55K).

We are experimenting with two methods of accessing this information. One will be in the form of coordinates stored by forty-day (or larger perhaps) intervals. A second method will store the osculating orbital elements at 400 day (or larger/smaller) intervals. These orbital elements would then be used to assemble position coordinates for a given date.

MATRIX will make available disk based ephemerides that extend back to around 400-500 B.C. as well as for several hundred years into the future. Once again, the staff here at MATRIX would like to ackowledge our gratitude for the pioneering work of James Neely. The existence of Mr. Neely provides life with one of those "even better than I might have dreamed it could be" experiences. Thanks!

NOTE: The BASIC program given here was written on a 16K Commodore PET. It produces heliocentric rectangular coordinates for both the Equinox and Equator of date and for the Equinox and Equator of 1950.0. The positions for the Equator and Equinox of date are those you will want to use for erecting a chart for that date or for interpolating between two forty day positions. The positions for the Equator and Equinox of 1950.0 are useful to refer positions to those given in Volume XII. The rectangular coordinates of date may then be combined with the rectangular coordinates of the Sun (thru a sun program) to produce the Geocentric rectangular coordinates. These in turn may be transformed to Geocentric spherical coordinates in the traditional manner. Included below is a test run of the program on a Commodore PET.

```
    REM  APAE VOLUME XII. OUTER PLANET
3   REM  COORDINATES IN 40-DAY INCREMENTS.

5   PI = 3.14159265
8   RD = PI / 180:SD = RD / 3600
9   DIM PR(3,3)
10    DIM BN$(5),X(3,5),DX(3,5,5),R2(5),D2(
      5,5),R3(5),D3(5,5),EM(5),SM(5),K1(5)

11    DIM K2(5),S(3,5),T(3,5,5),U(3,5),BX(3
      ,10,5),BP(3,10,5),A(10),RT(5),IX(20)

12    DATA  JU,SA,UR,NE,PL
13    DATA 1.00000597682,1047.355,3501.6,22
      869,19314,360000
14    DATA 159667200,-9458775,94880274,-428
      607748,1148601188,-2023224114,244995
      2000
15    DATA -2069052724,1207940748,-47098246
      3,113257214
16    PRINT "                EPOCH 1950.0"
17    PRINT "         HELIOCENTRIC EQUATORIA
      L"
18    PRINT "    COORDINATES OF THE OUTER PL
      ANETS"
19    PRINT "         USING THE METHOD OF TH
      E "
20    PRINT "           ASTRONOMICAL PAPERS"
      : PRINT "                OF THE"
21    PRINT "           AMERICAN EPHEMERIS":
       PRINT "                AND"
22    PRINT "            NAUTICAL ALMANAC": PRINT
       "               VOLUME XII"
23    PRINT "        PROGRAMMED BY JAMES NEE
      LY"
26  GS = 1720209895 / 1E11:W2 = (40 * GS) ^
      2
28    FOR I = 1 TO 5: READ BN$(I): NEXT : FOR
       I = 0 TO 5: READ EM(I): NEXT
30    READ A(0): FOR I = 1 TO 10: READ A(I)
      :A(I) = A(I) / A(0):IX(I) = I:IX(I +
      10) = I: NEXT
35    FOR I = 1 TO 5:EM(I) = 1 / EM(I):SM(I
      ) = EM(0) + EM(I):RT(I) = EM(I) / SM
      (I)
36    FOR K = 9 TO 10: FOR L = 1 TO 3: READ
       BP(L,K,I):BP(L,K,I) = BP(L,K,I) / 1E
      14: NEXT L,K
37    FOR K = 1 TO 10: FOR L = 1 TO 3: READ
       BX(L,K,I):BX(L,K,I) = BX(L,K,I) / 1E
      14: NEXT L,K,I
39    PRINT "       BACKWARD INTEGRATION": PRINT
       "       FROM 6.0 JANUARY 1941"
40    PRINT "INPUT NUMBER OF 40-DAY TIME ST
      EPS": INPUT MX: PRINT "THIS IS WORK!
      !"
42  JD = 2430000:KL = 9: FOR IT = 1 TO MX:
      JD = JD - 40:KL = KL + 1: IF KL = 20
       THEN KL = 10
44  KT = IX(KL):KP = IX(KL + 1):KM = IX(KL
      - 1): FOR I = 1 TO 5: FOR L = 1 TO
      3:KS = KL - 9:Q = 0: FOR K = 1 TO 10

46  KT = IX(KS):Q = Q + BX(L,KT,I) * A(K):
      KS = KS + 1: NEXT K
48  TP = 2 * BP(L,KT,I) - BP(L,KM,I) + BX(
      L,KT,I):BP(L,KP,I) = TP:TP = TP + Q:
      X(L,I) = TP: NEXT L,I
50    FOR L = 1 TO 3: FOR I = 1 TO 4: FOR J
       = I + 1 TO 5:DX(L,I,J) = X(L,J) - X
      (L,I): NEXT J,I,L
52    FOR I = 1 TO 5:TP = 0: FOR L = 1 TO 3
      :TP = TP + X(L,I) ^ 2: NEXT L:R2(I) =
      TP:R3(I) = TP *  SQR (TP): NEXT I
54    FOR I = 1 TO 4: FOR J = I + 1 TO 5:TP
       = 0: FOR L = 1 TO 3:TP = TP + DX(L,
      I,J) ^ 2: NEXT L:D2(I,J) = TP
56  TP = TP *  SQR (TP):D3(I,J) = TP: NEXT
      J,I
58    FOR I = 1 TO 5:E1(I) =  - W2 * SM(I) /
       R3(I): NEXT : FOR I = 1 TO 4: FOR J =
       I + 1 TO 5:E2(I,J) = W2 / D3(I,J)
60    NEXT J,I: FOR I = 1 TO 5: FOR L = 1 TO
      3:TP = E1(I) * X(L,I):S(L,I) = TP:U(
      L,I) = TP * RT(I): NEXT L,I
62    FOR I = 1 TO 4: FOR J = I + 1 TO 5:PD
       = E2(I,J): FOR L = 1 TO 3:TP = PD *
      DX(L,I,J):T(L,I,J) = TP * EM(J)
64  T(L,J,I) =  - TP * EM(I): NEXT L,J,I
66    FOR I = 1 TO 5: FOR L = 1 TO 3:TP = S
      (L,I): FOR J = 1 TO 5: IF I = J GOTO
       70
68  TP = TP + T(L,I,J) + U(L,J)
70    NEXT J:BX(L,KP,I) = TP: NEXT L,I
72    PRINT "JD = ";JD + .5
73    PRINT "    HELIO: EQUINOX AND EQUATOR
       OF 1950.0
74    FOR J = 1 TO 5: PRINT BN$(J);" ";: FOR
       I = 1 TO 3: PRINT X(1,J);X(2,J);X(3,
      J): NEXT J
75    GOSUB 100
78    NEXT IT
79    PRINT "                WHEW!!!"
80    PRINT "DO YOU WANT THE RE-START VALUE
      S": PRINT "PRINTED OUT: Y OR N?"
82    GET C$: IF C$ = "N" GOTO 200
84    IF C$ <  > "Y" GOTO 82
86    REM  THE FOLLOWING PRINT STMTS SHOULD
       BE DUMPED ONTO TAPE OR DISK
87    REM  SO MODIFY THEM ACCORDING TO YOUR
       NEEDS
89    PRINT JD + .5
90    FOR I = 1 TO 5: FOR L = 1 TO 3: PRINT
       BP(L,KT,I) * 1E14: NEXT L
92    FOR L = 1 TO 3: PRINT BP(L,KP,I) * 1E
      14: NEXT L:KS = KL - 8
94    FOR K = 1 TO 10:KQ = IX(KS): FOR L =
      1 TO 3: PRINT BX(L,KQ,I) * 1E14: NEXT
      L
96  KS = KS + 1: NEXT K,I: END
100   REM  PRECESS AND ROTATE TO ECLIPTIC
       OF DATE
105 TJ = (JD + .5 - 2415020) / 36525:T5 =
      (JD + .5 - 2433282.423) / 36524.2198
      79
110 EP = (((.00181 * TJ - .0059) * TJ - 4
      6.845)  * TJ + 84428.26) * SD:CE =  COS
      (EP):SE =  SIN (EP)
115   PR(1,1) = T5 * T5 * ( - 13 * T5 - 296
      96) / 1E8 + 1
120   PR(2,1) = ((221 * T5 - 676) * T5 - 22
      34941) * T5 / 1E8:PR(1,2) =  - PR(2,
      1)
125   PR(3,1) = ((96 * T5 + 207) * T5 - 971
      690) * T5 / 1E8:PR(1,3) =  - PR(3,1)

130   PR(2,2) = T5 * T5 * ( - 15 * T5 - 249
      75) / 1E8 + 1
135   PR(2,3) =  - 10858 * T5 * T5 / 1E8:PR
      (3,2) = PR(2,3)
140   PR(3,3) =  - 4721 * T5 * T5 / 1E8 + 1

145   PRINT "   HELIO: EQUINOX AND ECLIPTI
      C OF DATE
150   FOR K = 1 TO 5: FOR I = 1 TO 3:S8(I)
       = 0: FOR J = 1 TO 3:S8(I) = S8(I) +
      PR(J,I) * X(J,K): NEXT J,I
155 H1 = S8(1):H2 = S8(2) * CE + S8(3) *
      SE:H3 =  - S8(2) * SE + S8(3) * CE
160   PRINT BN$(K);" ";H1;H2;H3: NEXT K: RETURN

200   REM  JUPITER. BASIC DATA: PG. 322,
       VOL. XII WITH PG. XVI CORRECTION.
201   DATA 320122013661805,355074301652795
      ,144499321318713
202   DATA 343056759900034,335493907199972
      ,135538111299972
203   DATA -365516441054,-1655124624800,-7
      01140174172
204   DATA -476621272909,-1641010746960,-6
      92370081775
205   DATA -587545304976,-1620165976647,-6
      80716754638
206   DATA -697755224719,-1592491890713,-6
      66150954247
207   DATA -806695246540,-1557930699543,-6
      48661414143
208   DATA -913791252663,-1516468872744,-6
      28256296393
209   DATA -1018455587568,-1468140363576,-
      604964461633
210   DATA -1120092466950,-1413029317862,-
      578836504517
211   DATA -1218103941778,-1351272158502,-
      549945508872
212   DATA -1311896336242,-1283058948349,-
      518387481919
300   REM  SATURN. BASIC DATA: PG. 323,
      VOL. XII WITH PG. XVI CORRECTION.
301   DATA 647353510709228,611630651767277
      ,224941030170100
302   DATA 664179534400008,597187515000000
      ,218242664199994
303   DATA -313568256436,-447517857140,-17
      1490455226
304   DATA -325284651806,-439541275633,-16
      7683609014
305   DATA -336712342591,-431293072181,-16
      3776732229
306   DATA -347841793302,-422782194884,-15
      9774038192
307   DATA -358663818411,-414017390524,-15
      5679667383
308   DATA -369169717152,-405007161852,-15
      1497659557
309   DATA -379351444313,-395759769215,-14
      7231938542
310   DATA -389201800670,-386283289375,-14
      2886315790
311   DATA -398714615968,-376585735935,-13
      8464516727
312   DATA -407884890650,-366675232572,-13
      3970229840
400   REM  URANUS. BASIC DATA: PG. 324,
      VOL. XII
401   DATA 1113261044216486,14770744987639
      63,631452713633278
402   DATA 1126310446300000,14695336592000
      12,627963894700000
403   DATA -64988945413,-100063585552,-429
      05873408
404   DATA -65897176121,-99513524800,-4265
      1049775
405   DATA -66799086755,-98951878653,-4239
      1292914
406   DATA -67694149209,-98378561534,-4212
      6578150
407   DATA -68581823585,-97793529428,-4185
      6899180
408   DATA -69461562336,-97196785205,-4158
      2270310
409   DATA -70332814527,-96588383480,-4130
      2728477
410   DATA -71195030196,-95968434770,-4101
      8334951
411   DATA -72047664766,-95337108700,-4072
      9176615
412   DATA -72890183522,-94694636060,-4043
      5366721
500   REM  NEPTUNE. BASIC DATA: PG. 325,
      VOL. XII
501   DATA -3016463609531526,1541918593536
      56,139095726170264
502   DATA -3015526882500000,1657003137000
      00,143786002500000
503   DATA 51337716544,-2763130239,-245398
      0821
504   DATA 51224156391,-2945454515,-252555
      8435
505   DATA 51110001169,-3121276089,-259433
      3595
506   DATA 50995759064,-3290499750,-266027
      7921
507   DATA 50881959521,-3453069128,-272338
      0218
508   DATA 50769149285,-3608970135,-278364
      7851
509   DATA 50657887807,-3758234036,-284110
      7953
510   DATA 50548742056,-3900940039,-289580
      8408
511   DATA 50442280807,-4037217317,-294781
      8580
512   DATA 50339068479,-4167246346,-299722
      9738
600   REM  PLUTO. BASIC DATA: PG. 326,
      VOL. XII
601   DATA -2119451277339817,2835984936429
      069,1538226504694547
602   DATA -2112384867995637,2844653041993
      903,1538827695994400
603   DATA 17810259775,-24092523265,-13574
      934779
604   DATA 17603339329,-24910542504,-13543
      420981
605   DATA 17396902896,-24911729656,-13509
      096749
606   DATA 17191463992,-24905996356,-13471
      936718
607   DATA 16987557380,-24893292699,-13431
      932450
608   DATA 16785735053,-24873610683,-13389
      093915
609   DATA 16586561588,-24846987303,-13343
      450606
610   DATA 16390608916,-24813507155,-13295
      052585
611   DATA 16198450566,-24773304482,-13243
      971208
612   DATA 16010655474,-24726564531,-13190
      299565

900   REM  THE AUTHOR APOLOGIZES FOR THE C
      ONJESTION OF THE STATEMENTS IN THIS
901   REM  PROGRAM. IT IS THE FIRST PROGRA
      M THAT HE HAS WRITTEN IN BASIC AND H
      E
902   REM  WAS (UNNECESSARILY) AFRAID OF R
      UNNING OUT OF MEMORY.
905   REM  THE CONSTANTS USED IN THIS PROG
      RAM ARE TO THE SAME PRECISION AS GIV
      EN
906   REM  IN VOLUME XII EVEN THOUGH PET B
      ASIC DOES NOT RECOGNIZE THE FULL
907   REM  14-DIGIT PRECISION.
910   REM  REMARKS FOLLOW BY LINE NUMBER:
911   REM  13: MASS OF THE SUN PLUS THE IN
      NER BODIES; RECIPROCAL MASSES OF THE

912   REM       OUTER BODIES.
913   REM  14 & 15: COWELL INTEGRATION COE
      FFICIENTS
914   REM  26: GRAVITATIONAL CONSTANT AND
      SQUARE OF THE PRODUCT OF THE TIME ST
      EP
915   REM       AND GRAVITATIONAL CONSTANT
916   REM  30: A=COWELL INTEGRATION FACTOR
      S. IX IS AN INDEXING SET FOR SUBSCRI
      PT
917   REM       CONTROL.
918   REM  35: EM=PLANETARY MASS; SM=SUM O
      F PLANET, INNER BODY AND SOLAR MASS;

919   REM       RT=THE RATIO OF THESE QUANT
      ITIES.
920   REM  36: READ BODY'S SECOND SUMMATIO
      N TERMS AND RESCALE.
921   REM  37: READ BODY'S ATTRACTION TERM
      S AND RESCALE.
922   REM  42: SET UP LOOP FOR THE NUMBER
      OF TIME STEPS & INITIALIZE THE INDEX
       KT
923   REM  44: KT, KP AND KM ARE INDICIES
       USED FOR SUBSCRIPTING.
924   REM
930   REM  FOR LINES 46-70 SEE VOLUME XII,
       PAGES XII & XIII, FOR THE FOLLOWING

931   REM  VARIABLES AND STEP NUMBERS.
932   REM  STEP 11 (LINES 44-48): Q IS AS
      GIVEN, BX=X, TP IS TEMPORARY STORAGE
      ,
933   REM         BP=''X(.), AND X=LOWER CA
      SE X.
934   REM  IN THE FOLLOWING THE INDEX
935   REM      L=1 MEANS THE X-COORDINATE,
936   REM      L=2 MEANS THE Y-COORDINATE,
      AND
937   REM      L=3 MEANS THE Z-COORDINATE.
940   REM  STEP 2: THE SCALE FACTOR (LOWER
       CASE S) IS SET TO 1 FOR ALL INDICIE
      S.
```

```
941   REM  STEP 3 (LINE 50): DX(L,I,J)=X(L
      ,I)-X(L,J)
942   REM  STEP 4 (LINES 52 & 54): D2(I,J)
      =DELTA(I,J)^2
943   REM  STEP 5 IS NOT REQUIRED
944   REM  STEP 6 (LINES 52-56): R3=R^3 AN
      D D3=DELTA^3
945   REM  STEP 7 (LINE 58): E1(I)=K(I) AN
      D E2(I,J)=K(I,J)
946   REM  STEPS 8 & 9 (LINES 62-64): S, U
      , AND T ARE AS DEFINED IN VOL. XII.
947   REM  STEP 10 IS EXECUTED ON LINES 66
      -70.
948   REM
950   REM  LINES 89-94 ARE USED TO DUMP TH
      E FINAL VALUES OF THE SECOND SUMMATI
      ONS
951   REM  AND ATTRACTIONS SO THAT THE PRO
      GRAM CAN BE RESTARTED AT THE FINAL
952   REM  JULIAN DAY NUMBER WITHOUT HAVIN
      G TO START THE INTEGRATION AT
953   REM  JULIAN DAY 2430000.5 AGAIN.
954   REM
960   REM  THE FORWARD INTEGRATION AND THE
       BACKWARD INTEGRATION DIFFER ONLY IN
       THE
961   REM  STARTING VALUES (LINES 200 TO 6
      12) AND IN LINE 42:
962   REM       JD=JD+40 FOR THE FORWARD I
      NTEGRATION AND
963   REM       JD=JD-40 FOR THE BACKWARD
      INTEGRATION.
```

FORWARD INTEGRATION VALUES

```
199   DATA 2430000
200   REM  JUPITER. BASIC DATA: PG. 322,
       VOL. XII
201   DATA 364679609802144,3146304537987
      73
      ,1260585137992289
202   DATA 343056759900164,3354939071999
      41
      ,1355381111299946
203   DATA -1879230862514,-435743370212,-1
      40985403438
204   DATA -1846007295582,-545076415061,-1
      88706163145
205   DATA -1804542433765,-651880371372,-2
      35543402875
206   DATA -1755090212584,-755562209993,-2
      81236418372
207   DATA -1697965100967,-855556472458,-3
      25534846850
208   DATA -1633537935324,-951331322841,-3
      68201370299
209   DATA -1562230878998,-1042393966369,-
      409014169969
210   DATA -1484511633973,-1128295333494,-
      447769084668
211   DATA -1400887055286,-1208633951414,-
      484281434599
212   DATA -1311896336242,-1283058948349,-
      518387481919
300   REM  SATURN. BASIC DATA: PG. 323,
      VOL. XII
301   DATA 680597673200141,582377703000144
      ,211410328000041
302   DATA 664179534400012,597187514999992
      ,218242664199986
303   DATA -474701575889,-269490092292,-90
      925526314
304   DATA -468675725586,-280865025086,-95
      885233342
305   DATA -462301622582,-292123949755,-10
      0811908930
306   DATA -455578560500,-303254437776,-10
      5700595401
307   DATA -448505814354,-314244121671,-11
      0546379542
308   DATA -441082715789,-325080888475,-11
      5344457650
309   DATA -433308795437,-335753074238,-12
      0090194522
310   DATA -425183986071,-346249628270,-12
      4779165606
311   DATA -416708863809,-356560215300,-12
      9407172913
312   DATA -407884890650,-366675232572,-13
      3970229840
```

```
400   REM  URANUS. BASIC DATA: PG. 324,
       VOL. XII
401   DATA 11392869581999 92,146189812500000
      01,624434640400001
402   DATA 11263104463000 00,146953365920000
      12,627963894700000
403   DATA -79940308632,-88477867068,-3761
      2745863
404   DATA -79208947122,-89200836128,-3793
      9333157
405   DATA -78463876628,-89917190374,-3826
      3319944
406   DATA -77705331617,-90626264019,-3858
      4412734
407   DATA -76933598017,-91327416850,-3890
      2327624
408   DATA -76149009300,-92020041590,-3921
      6793596
409   DATA -75351942096,-92703570834,-3952
      7555652
410   DATA -74542811490,-93377483356,-3983
      4377701
411   DATA -73722066172,-94041309585,-4013
      7045092
412   DATA -72890183522,-94694636060,-4043
      5366721
500   REM  NEPTUNE. BASIC DATA: PG. 325,
       VOL. XII
501   DATA -30145398163999 95,1772046007999
      98,148473281599998
502   DATA -30155526882500000,1657003137000
      00,143786002500000
503   DATA 49638886002,-5110809571,-335036
      9345
504   DATA 49691413822,-5020810835,-331687
      1273
505   DATA 49751005301,-4928313009,-328247
      6307
506   DATA 49817420278,-4832749291,-324693
      5365
507   DATA 49890361079,-4733579257,-321000
      9270
508   DATA 49969476463,-4630294690,-317147
      1656
509   DATA 50054366368,-4522424808,-313110
      9823
510   DATA 50144587363,-4409540790,-308872
      9811
511   DATA 50239658651,-4291259495,-304415
      5148
512   DATA 50339068479,-4167246346,-299722
      9738
600   REM  PLUTO. BASIC DATA: PG. 326,
       VOL. XII
601   DATA -21053024479959 83,2853296420994
      206,1539415696994688
602   DATA -21123848679956 37,2844653041993
      903,1538827695994400
603   DATA 14599970146,-24066872604,-12616
      321156
604   DATA 14726898834,-24156066213,-12685
      766564
605   DATA 14862032054,-24242505335,-12754
      334821
606   DATA 15005128071,-24325619974,-12821
      775932
607   DATA 15155887287,-24404866422,-12887
      849764
608   DATA 15313956182,-24479733079,-12952
      328634
609   DATA 15478932065,-24549745658,-13014
      999652
610   DATA 15650368529,-24614471678,-13075
      666784
611   DATA 15827781463,-24673524171,-13134
      152583
612   DATA 16010655474,-24726564531,-13190
      299565
```



```
C
C     VOLUME XII
C
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*8 X(3,5),V(3,5),A(3,5),M(5),D2(5,5),R3(5,5),D3(5,5),EM(5),S(5),
     1 T(5),AT(3,5),ABT(3,5),VEL(3,5)
     2 REAL*4 BN(5)/'JUP','SAT','URA','NEP','PLU'/
      INTEGER*4 INDX(20)
      REAL*8 AXI(3,5)
C
C     GRAVITATIONAL CONSTANT, EMO = SUM OF SUN AND INNER BODY MASSES
C     AND RECIPROCAL MASSES OF THE OUTER BODIES
C
      GAUSS = 0.01720209895D0
      EMO = 1.00000597682D0
      EM(1) = 1047.3550D0
      EM(2) = 3501.600
      EM(3) = 22869.00
      EM(4) = 19314.00
      EM(5) = 136000.00
      INF = 1
C
C     READ STARTING VALUES - SECOND SUMMATIONS AND ATTRACTIONS
C
      CT = 10 * 15
      EM(1) = 1.00/EM(1)
      EM(2) = 1.00/EM(2)
      EM(3) = 1.00/EM(3)
      READ(INF,1000) ((BXP(I,K),I=1,3),K=9,10)
      READ(INF,1000) (( BXI(I,K),I=1,3),K=1,10)
 1000 FORMAT(3F24.14)
   10 CONTINUE
C
C     GENERATE COWELL INTEGRATION COEFFICIENTS
C
      A(10) =    1132 57214.00
      A(9)  =   -4705 82463.00
      A(8)  =   12706 40748.00
      A(7)  =  -24499 52006.00
      A(6)  =   32232 24114.00
      A(5)  =  -29172 96775.00
      A(4)  =   19686 01188.00
      A(3)  =   -8266 07748.00
      A(2)  =    1908 42175.00
      A(1)  =  -  161 91596 67200.00
      DO 20 I = 1,10
   20 INDX(I+10) = I
C
C     STARTING DATE AND INITIAL SUBSCRIPT
C
      JD = 2430000
      KL = 9
C
C     START ITERATION LOOP FOR DESIRED NUMBER OF TIME-STEPS
C
      DO 970 ITIME = 1,2215
      DO 970 ITIME = 1,30
      DO 950 ITIME = 1,10
      USE NEXT CARD FOR FORWARD INTEGRATIONS:
      JD = JD + 40
      USE NEXT CARD FOR BACKWARD INTEGRATIONS:
C     JD = JD - 40
      KL = KL + 1
      IF (KL .GE. 20) KL = 10
      KSTC = INDX(KL)
      KSTM1 = INDX(KL-1)
      KSTM2 = INDX(KL-2)
C
C     COMPUTE SECOND SUMMATIONS (BXP) & POSITIONS (X).  (STEP 11)
C     NOTE CORRESPONDENCE TO PAGES XII
C     AND XIII OF APNA VOLUME XII
C
      DO 40 I = 1,5
      DO 40 L = 1,3
      KS = KL - 9
      C = 0.0D0
      DO 30 K = 1,10
      KT = C + INDX(KS)
      KS = KS - 1
   30 BXP(L,KT,I) = BXI(L,KT,I)*A(K)
      EXPL = BXP(L,KSTC,I) - BXP(L,KSM1,I) + BXI(L,KSTO,I)
      TEMP = 2.0D0*BXP(L,KSTO,I) = TEMP
      BXP(L,KSTC,I) = TEMP + Q
      Q = TEMP
      TABP(L,I) = TEMP
   40 CONTINUE
C
C     COMPUTE COORDINATE DIFFERENCES (STEP 3)
C
      DO 100 I = 1,3
      DO 100 J = 1,4
      J1 = I + 1
      DO 100 J = J1,5
      DXL(L,I,J) = X(L,I) - X(L,J)
  100 CONTINUE
C
C     R(I) SQUARED AND CUBED (STEPS 4 AND 6)
C
      DO 120 I = 1,5
      SUM = 0.00
      DO 110 L = 1,3
  110 SUM = SUM + X(L,I)*X(L,I)
      R2(I) = SUM
      R3(I) = SUM*DSQRT(SUM)
C
C     DELTA(I,J) SQUARED AND CUBED (STEPS 4 AND 6)
C
      DO 140 I = 1,4
      J1 = I + 1
      DO 140 J = J1,5
      SUM = 0.00
      DO 130 L = 1,3
  130 SUM = SUM + DX(L,I,J)*DX(L,I,J)
      D2(I,J) = SUM
      SUM = SUM*DSQRT(SUM)
      D3(I,J) = SUM
  140 CONTINUE
C
C     K(I) AND K(I,J) COMPUTATION (STEP 7)
C
      DO 150 I = 1,5
      EK(I,I) = -WK2*SM(I)/R3(I)
      DO 160 I = 1,4
      J1 = I + 1
      DO 160 J = J1,5
      EK2(I,J) = WK2*D3(I,J)
C
C     S & U MATRIX COMPUTATIONS (STEPS 8 AND 9)
C
      DO 170 I = 1,5
      DO 170 L = 1,3
```

```
      TEMP = EK1(I)*X(L,I)
      S(L,I) = TEMP
  170 U(L,I) = TEMP*RATIO(I)
C
CCC           T-MATRIX COMPUTATION (STEP 8 AND 9)
C
      DO 190 I = 1,4
      J1 = I + 1
      DO 190 J = J1,5
      PROD = EK2(I,J)
      DO 180 L = 1,3
      TEMP = PROD*DX(L,I,J)
      T(L,I,J) =  TEMP*EM(J)
  180 T(L,J,I) = -TEMP*EM(I)
  190 CONTINUE
C
CCC           COMPUTE NEW ATTRACTIONS (STEP 10)
C
      DO 310 I = 1,5
      DO 310 L = 1,3
      SUM = S(L,I)
      DO 300 J = 1,5
      IF (I .EQ. J) GO TO 300
      SUM = SUM + T(L,I,J) + U(L,J)
  300 CONTINUE
      BX(L,K5P1,I) = SUM
  310 CONTINUE
      WRITE(6,2000) JD,X
 2000 FORMAT(1X,F7.1,'.5'/(1X,3F25.15))
C
      IF (ITM .NE. 5) GO TO 970
      IF (ITIME .LT. 10) GO TO 970
C
CCC           COMPUTE 400-DAY VELOCITIES BY FINITE DIFFERENCES
C
      DO 350 I = 1,5
      DO 350 L = 1,3
      VEL(L,I) = (-(TAB(4,L,I) - TAB(8,L,I))
     1           - 9.D0*(TAB(3,L,I) - TAB(9,L,I))
     2           +45.D0*(TAB(2,L,I) - TAB(10,L,I)))/2400.D0
  350 CONTINUE
C
CCC           PRINT AND PUNCH 400-DAY POSITIONS AND VELOCITIES
C
C     USE NEXT CARD FOR FORWARD INTEGRATIONS:
      JDP = JD - 160
C     USE NEXT CARD FOR BACKWARD INTEGRATIONS:
      JDP = JD + 240
      DO 360 I = 1,5
      WRITE(7,7000) BN(I),JDP,(TAB(L,L,I),L=1,3),(VEL(L,I),L=1,3)
 7000 FORMAT(A2,1X,F7.1,'.5',1X,3F13.9,1X,9P3F9.0)
      WRITE(6,6000) BN(I),JDP,(TAB(L,L,I),L=1,3),(VEL(L,I),L=1,3)
 6000 FORMAT(1X,A2,1X,F7.1,'.5',1X,3F18.9,1X,9P3F14.0)
  360 CONTINUE
C
  970 CONTINUE
C
CCC                   PRINT AND PUNCH RESTART VALUES
C
      WRITE(6,1001) JD
 1001 FORMAT('1',F7.1,'.5')
      DO 990 I = 1,5
      WRITE(7,1002) (BXP(L,KSM1,I),L=1,3)
      WRITE(6,1002) (BXP(L,KSM1,I),L=1,3)
 1002 FORMAT(5X,3F24.14)
      WRITE(7,1003) (BXP(L,KST0,I),L=1,3)
      WRITE(6,1002) (BXP(L,KST0,I),L=1,3)
      KS = K1 - 9
      DO 980 K = 1,10
      KI = 100X(KS)
      WRITE(7,1000) ( BX(L,KI,I),L=1,3)
      WRITE(6,1002) ( BX(L,KI,I),L=1,3)
      KS = KS + 1
  580 CONTINUE
  990 CONTINUE
C
      STOP
      END
```

```
      VEL. XII FORWARD INTEGRATION STARTING VALUES
+ 3.6467960980214 4  + 3.1463C4537 9E773  + 1.2605851379929 9
+ 3.4305675990016 4  + 3.3549390719994 1  + 1.3553811129994 6
  0.0187923086251 4  - 0.0043574337021 2  - 0.0014098540343 8
- 0.0184600729558 2  - 0.0054507641506 1  - 0.C018870616314 5
- 0.0180454243176 5  - 0.0065188037137 2  - 0.0023554340281 5
- 0.0175505021258 4  - 0.0075556220599 3  - 0.0028123641837 2
- 0.0169796510096 7  - 0.0085555647245 8  - 0.0032553484685 0
- 0.0163353793532 4  - 0.0095133132284 1  - 0.0036820137029 9
- 0.0156223087899 8  - 0.0104239396636 9  - 0.0040901416996 9
- 0.0148451163319 3  - 0.0112829533349 4  - 0.0044776904668 8
- 0.0140268705528 6  - 0.0121086339514 6  - 0.0048442814345 9
- 0.0131189633624 2  - 0.0128305894834 9  - 0.005183874E1919
+ 6.8C5967632001 41  + 5.8237770300014 4  + 2.1141032800004 1
+ 6.4417553446C0012  + 5.5718151499599 2  + 2.1824266419998 6
  0.0047470157588 9  - 0.0026949009229 2  - 0.CCC9095526314
- 0.CC468675725586  - 0.0028C865025086  - 0.0009588523334 2
- 0.0046230162258 2  - 0.0029212394575 5  - 0.0010081190893 0
- 0.0045557856050 0  - 0.0030325443776 6  - 0.001C57005954C1
- 0.CC4485C5814354  - 0.0031424412167 1  - 0.0011054637954 2
- 0.0044108271578 9  - 0.0032508088847 5  - 0.CC1153444576 50
- 0.0043330879543 7  - 0.0033575307423 8  - 0.0012009019452 2
- 0.0042518398607 1  - 0.0034624962827 0  - 0.0012477916560 6
- 0.0041670886380 9  - 0.0035654021530 0  - 0.0012940382713
- C.0040788489065 0  - 0.0036667523257 2  - 0.0013397022984 0
+11.3928695819999 2  +14.6189E1250000 01  + 6.2443464040000 1
+11.2631044630000 0  +14.6953365920001 2  + 6.2796389470000 0
- C.CCC7954030863 2  - 0.0008847786706 8  - 0.0003761274586 3
- 0.0007920894712 2  - 0.0008920083612 8  - 0.0003793933315 7
- C.0078463876628  - 0.0008971190374  - 0.0003826331994 4
- C.CCC777C5331617  - 0.C009C626264019  - 0.0003858441273 4
- 0.0007693359801 7  - 0.0009132741685 0  - 0.CCC3890232762 4
- C.CCC7614900930 0  - 0.0009202004159 0  - 0.0003921679356 6
- 0.0007535194209 6  - 0.0009270357C834  - 0.0003952755565 2
- 0.0007454281149 0  - 0.0009337148335 6  - 0.0003983437771 1
- C.CCC7322C65172  - 0.0009394130585  - 0.0004013704505 2
- 0.0007289018352 2  - 0.0009469636060  - 0.CCC4043536672 1
-3C.1453981639995  + 1.7720460079999 8  + 1.4847328159599 8
-3C.1552688E2500000  + 1.6570031370C0000  + 1.4378602500000 0
+ 0.0004963886002  - 0.0000511080957 1  - 0.CCCC3350365345
+ C.CCC4969141382 2  - 0.0000502081083 5  - 0.0000331681727 3
+ 0.0004971005301  - 0.0000492831309  - 0.0000328476356 7
+ 0.0004981742027 8  - 0.0000483274929 1  - 0.0000324693534 5
+ C.CCC4785C361079  - 0.0000473357925 7  - 0.0000321000927 0
+ 0.0004996476463  - 0.0000463029469 0  - 0.0000317147135 6
+ 0.0005005436368  - 0.0000452242490 8  - 0.0000313110982 3
+ 0.0005314587363  - C.CCC0440954C790  - 0.0000308872981 1
+ 0.0005229365651  - 0.0000429125949 5  - 0.0000304415514 8
+ C.CCC5C339068479  - 0.0000416724634 6  - 0.0000299722973 8
-21.0530244795983  +28.5329642099420 6  +15.3541569699468 8
-21.1218486799663 7  +28.4465304199390 3  +15.3882769599440 0
+ C.CCC1455591014 6  - 0.0002406877260 4  - 0.0001261632115 6
+ 0.0031472689083 4  - 0.0002415606621 3  - 0.CCC1268576654 4
+ C.CC0154C87056  - 0.0002424250531 5  - 0.0001275433482 1
+ 0.0001500512307 1  - 0.0002432561597 4  - 0.0001282177593 2
+ 0.0001515588728 7  - 0.0002440486642 2  - 0.0001288784576 4
+ 0.CCC1513956182  - 0.0002447973307 9  - 0.0001295232863 4
+ 0.0001547893206 5  - C.0002454975465 8  - 0.CCC1301499965 2
+ C.CCC1565516196  - 0.0002461447167 8  - 0.CCC1307566714
+ 0.0001582778453  - 0.0002467352417 1  - 0.CCC1314152583
+ 0.0001601165547 4  - 0.0002472656453 1  - 0.CCC1319079565
```

```
      BACKWARD INTEGRATION STARTING VALUES
      FROM 6.0 JANUARY 1941
      JD = 2429960.5
      HELIO: EQUINOX AND EQUATOR OF 1950.0
JU  3.64562847  3.1452971  1.2601814 7
SA  6.80562946  5.8234798 9  2.1113996 44
UR  11.3928082  14.618902 9  6.2443112 96
NE -30.1453563  1.7720443  1.4847302 8
PL -21.0530113  28.532943 2  15.394146

      HELIO: EQUINOX AND ECLIPTIC OF DATE
JU  3.65312636  3.3789237 5  -.0955394 8121
SA  6.81931785  6.1686875 3  -.3777737 018
UR  11.42801 31  15.871124 2  -.0881743 403
NE -30.1403683  2.2833063 5  -.6570990 05
PL -20.9813586  32.348857 7  2.7698121 9
```

COMPUTING THE ORBITS OF JUPITER, SATURN, URANUS AND NEPTUNE ON SMALL COMPUTERS

by DWIGHT WILLIAM JOHNSON

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I. INTRODUCTION - TWO METHODS OF COMPUTING ORBITAL POSITIONS

Various methods may be used to obtain precise, computerized coordinates for an orbiting body. In this paper two such methods will be contrasted and algorithms for the computation of the orbits of Jupiter, Saturn, Uranus and Neptune will be given which result from the second method. In the first method, the differential equations which define the motion of the body may be solved directly by numerical integration at equidistant intervals to produce a computerized ephemeris. This may be stored on the computer's disk memory storage and the computer program merely interpolates between the precomputed values to determine the coordinates at a given instant of time. Computerized ephemerides may be obtained from the U. S. Naval Observatory on 1/2 inch magnetic tape and they are used by physical scientists, cycle researchers and commercial horoscope services such as that of Neil F. Michelsen. The

main disadvantage of the computerized ephemeris for the person who wants to compute the orbits of the planets on a microcomputer is the amount of disk storage required. About 2 million bytes of disk storage are required for each 100 year interval of computerized ephemerides for the Sun, Moon and planets. This estimate is based on the following computation:

100 years = 36525 days

40 day ephemerides for 5 outer planets = 5(36525/40) positions

1 day ephemerides for 4 inner planets and the Moon = 5(36525) positions

1 position = 3 coordinates

1 double precision floating point number = 4 eight bit bytes

5(36525/40+36525)(3)(4)=2,246,288 bytes

In the second method mean values for the variables which define the orbit of the body from gravitational theory are developed and applied to the equations of the elliptic orbit. These equations are then solved to give the mean position of the body in its orbit at a given instant of time. This is called the unperturbed position of the body, that is, only the gravitational attractions between the orbiting body and the body it revolves around are considered. The gravitational attractions of other bodies to the orbiting body are next considered and applied as corrections to the mean values at various points in the computing process.

In general, two kinds of corrections are applied. The first kind of correction is called a secular term, and it is a polynomial

of the form

$$A_0+A_1T+A_2T^2+A_3T^3+\ldots$$

where the A_i are constants and T is a measure of the interval of time from a given fixed Epoch. The second kind of correction is called a periodic term and it is a trigonometric function such as

$$B_1\cos a+B_2\sin a$$

where the B_i are constants and a is a function of the mean elements.

Before the invention of electronic computers, the amount of computation required made the direct numerical integration of the differential equations of motion, as in the first method we looked at, impossible to consider. Therefore, the second method which involves a large number of complicated mathematical procedures, but which ultimately greatly simplifies the amount of actual computation involved for each calculated position, was developed by such mathematical geniuses as Newton, Laplace, Lagrange and Gauss, culminating in the late 19th and early 20th centuries in the work of Leverrier, Newcomb, Hill and Brown. These latter men developed the first actual tables using the second method which could accurately predict the orbital motions of the planets and the Moon to a 0".1 of arc level of precision.

In astrological work a one minute level of precision is usually sufficient. To achieve this for the Sun, Mercury, Venus and Mars all of the periodic terms may be neglected, and, after the secular terms have been applied to the mean elements, the equations for the elliptic orbit may be computed directly with little difficulty.

For the giant outer planets Jupiter, Saturn, Uranus and

Neptune, however, the effects of the periodic terms are quite large. So the periodic terms for these planets must be included to achieve a one minute level of precision.

Algorithms are given below for computing the heliocentric geometric longitude, latitude and radius vector of Jupiter, Saturn, Uranus and Neptune which include both secular and periodic terms. These algorithms were developed directly from and are a simplification of the expressions contained in the Tables of Jupiter and Saturn by George Hill and the Tables of Uranus and Neptune by Simon Newcomb which constitute Volume VII of the Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac, (A.P.A.E.), published in 1898.

Computer programs have been developed from these simplified algorithms and tested against a sample of coordinates taken from "Coordinates of the five outer planets, 1653-2060", A.P.A.E. Volume XII, 1951, by Eckert, Brouwer and Clemence. The results of these tests are summarized in Table 1 below and given in detail in Section III.

Algorithm	Average Residual		
Planet	Longitude	Latitude	Radius Vector
Jupiter	4".44	2".16	752×10^{-7}
Saturn	4".71	7".35	1575×10^{-7}
Uranus	3".12	1".98	1398×10^{-7}
Neptune	4".86	0".50	3232×10^{-7}

Table 1

The precision of these algorithms as shown by Table 1 suggests that they could be used over a much wider, but as yet undetermined,

interval of time than the 1653-2060 interval tested to compute the positions of Jupiter, Saturn, Uranus and Neptune to a 1'.0 of arc level of precision.

Because the programmed algorithms require much less memory storage than computerized ephemerides they are better suited to microcomputer implementation. The direct programming of the algorithms contained in Section II, however, results in very long execution times. In Section V we show how the algorithms may be modified so that their execution times compete more favorably with the computerized ephemeris method.

II. ALGORITHMS FOR THE PERTURBED MOTION OF JUPITER, SATURN, URANUS AND NEPTUNE

The algorithms in this section follow the terminology and computing methodology of the original documents so far as it was practical to do so. In all measures of time from the Epoch a time before the Epoch gives a negative measure and a time after the Epoch gives a positive measure. Time is measured primarily in units of mean solar days, Julian years of 365.25 mean solar days and Julian centuries of 36525 mean solar days.

ALGORITHM FOR JUPITER

(after George William Hill, "Tables of Jupiter", 1895)

Epoch=January 0, 1850, noon, Greenwich Mean Time

(This is the same as December 31, 1849, noon, GMT.)

n_d=299".12837656=Jupiter's mean motion per mean solar day

n=109256".63954=Jupiter's mean motion per Julian year

P=4332.58795067 mean solar days=Jupiter's mean sidereal orbital period

T_E=1781.57063 mean solar days=time elapsed since Jupiter passed its perihelion at the Epoch

p=50".264708=general precession of the equinox per Julian year

z=time from the Epoch in mean solar days

t=time from the Epoch in Julian years

m=z/P=time from the Epoch in mean orbital periods of Jupiter

L=159°56'25".05=Jupiter's mean longitude at the Epoch

Π=11°54'26".72=Jupiter's perihelion at the Epoch

e=0.04825382=Jupiter's eccentricity

loga=0.7162373716=logarithm of Jupiter's semi-major axis

g=(L-Π+nt)mod360°=mean anomaly of Jupiter

g'=(284°43'0".42+43996".2041l4t)mod360°=mean anomaly of Saturn

g"=(220°10'10".35+15425".752t)mod360°=mean anomaly of Uranus

(g,g' and g" are the arguments for the periodic terms δz and $\delta \log \frac{r}{R}$ which follow.)

δz=0.00003919 m^2

+0.0399278	m	sin(- g+	227° 27' 45".7)
+0.00003267	m^2	sin(- g+	298° 22'.0)
+0.0003156	m	sin(-2g+	224° 50'.8)
+0.037294		sin(g'+	150° 56' 5")
+0.266919		sin(- g+ g'+	79° 12' 10".0)
+0.022776		sin(2g'+	123° 49'.3)
+0.411235		sin(- g+2g'+	1° 24' 46".9)
+0.0005025	m	sin(- g+2g'+	301° 24'.3)
+0.650670		sin(-2g+2g'+	336° 53' 48".5)
+0.012319		sin(+3g'+	270° 58'.6)

+0.046930		sin(- g+3g'+	312° 11' 29")
+0.276299		sin(-2g+3g'+	127° 22' 55")
+0.0004560	m	sin(-2g+3g'+	30° 1'.0)
+0.054251		sin(-3g+3g'+	57° 42' 53")
+0.056290		sin(-2g+4g'+	98° 28' 4")
+0.050072		sin(-3g+4g'+	26° 2' 42")
+0.012072		sin(-4g+4g'+	129° 27'.7)
+3.998745		sin(-2g+5g'	-81".97009t+67° 8' 55".73)
-0.0022133	m	sin(-2g+5g'	-81".97009t+67° 8' 55".73)

(Note minus sign of coefficient.)

+0.538023		sin(-3g+5g'+	176° 27' 51")
+0.0018879	m	sin(-3g+5g'+	80° 53'.7)
+0.012256		sin(-4g+5g'+	133° 33'.6)
+0.036853		sin(-4g+10g'	-145".72t+ 313° 41'.0)
-0.0000347	m	sin(-4g+10g'	-145".72t+ 313° 41'.0)

(Note minus sign of coefficient.)

+0.011961		sin(-5g+10g'+	63° 18'.2)
+0.028956		sin(-2g+6g'-3g"+	187° 50'.0)

(Coefficients of the $\delta \log \frac{r}{r}$ terms are in units of the 7th decimal.)

$\delta \log \frac{r}{R}$=-2.053 m

+125.634m		cos(- g+	227° 27' 3")
+0.10268m^2		cos(- g+	297° 58'.9)
+3.025	m	cos(-2g+	227° 13'.7)
+46.87		cos(g'+	341° 13'.9)
+545.14		cos(- g+ g'+	79° 11' 26")
+61.05		cos(2g'+	305° 11'.3)
+383.02		cos(- g+2g'+	356° 11' 18")

+2303.37		cos(-2g+2g'+	336° 54' 2".4)
+62.33		cos(-3g+2g'+	333° 10'.7)
+43.89		cos(3g'+	90° 51'.0)
+56.45		cos(- g+3g'+	133° 2'.4)
+738.42		cos(-2g+3g'+	126° 35' 36")
+241.37		cos(-3g+3g'+	58° 30' 55")
+85.28		cos(-2g+4g'+	94° 3'.3)
+193.21		cos(-3g+4g'+	27° 0'.7)
+59.81		cos(-4g+4g'+	127° 51'.1)
+229.34		cos(-2g+5g'+	237° 53'.6)
+1679.20		cos(-3g+5g'+	176° 23' 50")
+5.896	m	cos(-3g+5g'+	80° 52'.6)
+65.06		cos(-4g+5g'+	141° 13'.5)

z_T=(T_E+z+δz)modP

(z_T is the number of mean solar days which have elapsed since Jupiter passed its perihelion in its current revolution. Note that in this algorithm secular and periodic terms are applied to correct the time variable.)

f=($n_d z_T$+ 19900".339sin$n_d z_T$+599".829sin2$n_d z_T$+25".070sin3$n_d z_T$ +1".198sin4$n_d z_T$)mod360°

(f is the true anomaly.)

R=27".029sin(2f+5° 56'.4)

(R is the reduction to the ecliptic.)

λ=(Π+f+R+pt)mod360°

(λ is the heliocentric geometric longitude of Jupiter referred to the mean equinox of date.)

logr=loga+log(1-e^2)-log(1+ecosf)+($\delta \log \frac{r}{R}$)10^{-7}

r=10^{logr}

(r is the heliocentric radius vector measured in a.u.)

$m_T=z_T/P$

$\Pi-\Lambda=272^\circ\ 57'\ 22".33+161".07m_T$

(Λ is the ecliptic ascending node of Jupiter's orbit.)

$i=1^\circ\ 18'\ 42".8\ -2".35m_T$=Jupiter's inclination

$\sin\beta=\sin i\sin(f+(\Pi-\Lambda))+4".37431m\sin(f+35^\circ\ 31'\ 23".2)$

$\beta=\sin^{-1}(\sin\beta)$= Jupiter's heliocentric geometric latitude

ALGORITHM FOR SATURN

(after George William Hill, "Tables of Saturn", 1895)

Epoch=January 0, 1850, noon, Greenwich Mean Time

$n_d=120".45504214$=Saturn's mean motion per mean solar day

$n=43996".2044$=Saturn's mean motion per Julian year

P=10759.200918 mean solar days=Saturn's mean sidereal period

$T_E=8509.236324$ mean solar days=time elapsed since Saturn passed its perihelion at the Epoch

p=50".2581+1=general precession of the equinox per Julian year

z=number of mean solar days since the Epoch

t=number of Julian years since the Epoch

m=z/P=number of orbital periods since the Epoch

L=14° 49' 39".95=Saturn's mean longitude at the Epoch

$\Pi=90^\circ$ 6' 39".53=Saturn's perihelion at the Epoch

e=0.05606075=Saturn's eccentricity

loga=0.9794957103=logarithm of Saturn's radius vector

$g=(148^\circ\ 1'\ 58".33+109256".6395+t)\bmod 360^\circ$=Jupiter's mean anomaly

$g'=(L-\Pi+nt)\bmod 360^\circ$=Saturn's mean anomaly

$g''=(220^\circ\ 10'\ 10".35+15425".752t)\bmod 360^\circ$=Uranus' mean anomaly

$\delta z=0.0012927\ m^2$

+0.657765	m	sin(	g'+	237° 59' 1".4)

+0.0012439	m^2	sin(	g'+	142° 22'.0)
+0.02169		sin(	2g'+	121° 24'.2)
+0.013440	m	sin(	2g'+	237° 21'.0)
+0.10041		sin(- g+		86° 45' 58")
+0.05977		sin(- g+ g'+		189° 35' 5")
+3.50470		sin(- g+2g'+		181° 25' 45")
+0.010207	m	sin(- g+2g'+		122° 26' 59")
+0.27834		sin(- g+3g'+		121° 13' 45")
+0.002027	m	sin(- g+3g'+		31° 8'.0)
+0.02296		sin(-2g+ g'+		250° 7'.7)
+0.26600		sin(-2g+2g'+		156° 58' 15")
+0.21710		sin(-2g+3g'+		135° 33' 9")
+0.002237	m	sin(-2g+3g'+		42° 1'.6)
+5.67852		sin(-2g+4g'+		277° 23' 46".9)
+0.040453	m	sin(-2g+4g'+		179° 34' 58")
+0.0001099	m^2	sin(-2g+4g'+		84° 31'.9)
+24.15265		sin(-2g+5g'	-82".0017t+247°	6' 43".97)
+0.034245	m	sin(-2g+5g'	-82".0017t+ 67°	6' 44")
+0.0002154	m^2	sin(-2g+5g'	-82".0017t+221°	43'.0)
+0.005052	m	sin(-2g+6g'+		125° 59'.7)
+0.05410		sin(-3g+3g'+		234° 23'.1)
+0.03820		sin(-3g+4g'+		203° 15'.6)
+0.02699		sin(-3g+5g'+		174° 37'.4)
+0.02773		sin(-3g+6g'+		157° 20'.7)
+0.05189		sin(-3g+7g'+		31° 24'.2)
+0.07330		sin(-4g+9g'+		163° 42'.4)
+0.22255		sin(-4g+10g'+	-148".145t+133°	37' 12")
+0.06604		sin(- g'+ g"+		79° 2'.1)

+0.06313		sin(- g'+2g"+		354° 17'.1)
+0.10175		sin(-2g'+2g"+		336° 43'.3)
+0.234440		sin(- g'+3g"+		321° 46'.5)
+0.19196		sin(-2g'+3g"+		119° 19'.8)
+0.23778		sin(-2g+6g'-3g"+		6° 56'.0)
+0.001897	m	sin(-2g+6g'-3g"+		242° 4'.0)

(Coefficients of the $\delta\log\frac{r}{r}$ terms are in units of the 7th decimal.)

$\delta\log\frac{r}{r}=1826.0+12.37m$

+187.4		cos(g'+		295° 24'.7)
+834.91	m	cos(g'+		57° 58' 50")
+1.571	m^2	cos(g'+		322° 22'.6)
+49.9		cos(2g'+		293° 9')
+23.17	m	cos(2g'+		58° 38'.0)
+82.0		cos(- g+		110° 49'.0)
+3782.7		cos(- g+ g'+		79° 45' 10")
+2443.3		cos(- g+2g'+		176° 2' 38")
+6.36	m	cos(- g+2g'+		121° 29'.6)
+241.3		cos(- g+3g'+		305° 54'.4)
+55.2		cos(-2g+ g'+		98° 52'.0)
+643.8		cos(-2g+2g'+		156° 34'.6)
+421.1		cos(-2g+3g'+		141° 57'.9)
+3.33	m	cos(-2g+3g'+		46° 59')
+7005.4		cos(-2g+4g'+		277° 15' 22")
+50.26	m	cos(-2g+4g'+		179° 38'.4)
+1141.6		cos(-2g+5g'	-88".928t+	62° 49' 33")
+5.73	m	cos(-2g+6g'+		306° 10'.0)
+147.2		cos(-3g+3g'+		233° 56'.1)

102.2		cos(-3g+4g'+		206° 23'.9)
+59.7		cos(-3g+5g'+		177° 52'.0)
+44.5		cos(-4g+4g'+		311° 30'.0)
+93.1		cos(-4g+9g'+		163° 39'.0)
+58.4		cos(- g'+ g"+		79° 3'.0)
+152.6		cos(-2g'+2g"+		336° 43'.3)
+235.0		cos(-2g'+3g"+		119° 5'.6)

$z_T=(T_E+z+\delta z)\bmod P$

(z_T is the number of mean solar days which have elapsed since Saturn passed its perihelion in its current revolution. Note that in this algorithm secular and periodic terms are applied to correct the time variable.)

$f=(n_d z_T+23117".641\sin n_d z_T+809".380\sin 2n_d z_T+39".293\sin 3n_d z_T$
$+2".180\sin 4n_d z_T)\bmod 360^\circ$

(f is the true anomaly.)

$R=97".774\sin(2f+135^\circ\ 31'\ 44".9)$

(R is the reduction to the ecliptic.)

$\lambda=(\Pi+f+R+pt)\bmod 360^\circ$

(λ is the heliocentric geometric longitude of Saturn referred to the mean equinox of date.)

$\log r=\log a+\log(1-e^2)-\log(1+e\cos f)+(\delta\log\frac{r}{r})10^{-7}$

$r=10^{\log r}$

(r is the heliocentric radius vector measured in a.u.)

$m_T=z_T/P$

$\Pi-\Lambda=-(22^\circ\ 21'\ 27".04)+550".24m_T$

(Λ is the ecliptic ascending node of Saturn's orbit. Note minus sign.)

$-i=2^\circ\ 29'\ 42".36-3".92m_T$=Saturn's inclination

$\sin\beta = \sin i \sin(f+(\Pi-\Omega)) + 24".2666 m \sin(f+77^\circ\ 3'\ 36")$

$\beta = \sin^{-1}(\sin\beta)$ = Saturn's heliocentric geometric latitude

ALGORITHM FOR URANUS

(after Simon Newcomb, "Tables of Uranus", 1898)

Epoch = January 0, 1900, noon, Greenwich Mean Time

T = number of Julian centuries since the Epoch

$\Delta l = 33".086T^2 - 0".0173T^3 - 0".0622T^4$

$l = (243^\circ\ 21'\ 44".66 + 154763".44T + 1".109T^2 + \Delta l) \bmod 360^\circ$ = Uranus' mean longitude

$g = (74^\circ\ 81'.8177 + 428^\circ\ 30'.1547T + \Delta l) \bmod 360^\circ$ = Uranus' mean anomaly

$\Omega = 73^\circ\ 29'\ 24".9 + 1834".8T + 2".29T^2 + 0".31T^3$ = Uranus' ecliptic ascending node

$i = 0^\circ\ 46'\ 21".597 + 2".203T$ = Uranus' inclination

(Note that in the algorithm for Uranus secular and precessional terms have been applied to correct the mean elements.)

$g_0 = (225^\circ.417 + 3034^\circ.904T) \bmod 360^\circ$ = mean anomaly of Jupiter

$g_1 = (175^\circ.753 + 1222^\circ.113T) \bmod 360^\circ$ = mean anomaly of Saturn

$g_1' = (74^\circ.412 + 428^\circ.498T) \bmod 360^\circ$ = mean anomaly of Uranus

$g' = (74^\circ.320 + 428^\circ.498T) \bmod 360^\circ$ = mean anomaly of Uranus

$g'' = (41^\circ.339 + 218^\circ.467T) \bmod 360^\circ$ = mean anomaly of Neptune

(Note that two different mean anomalies of Uranus are used.)

$A_1 = -3g' + 6g_1 - 2g_0 = 20^\circ.45 - 22^\circ.61T$

$I = g' - g''$

$II = g_1 - g_1'$

$III = g_0 - g_1'$

$IV = g_1 - 2g_1'$

$V = 3g_1' - g_1$

$(v.c.0) = 12".03 - 11".31T$

-1".93	cos A_1	-29".44	sin A_1
+0".805 T	cos A_1	+0".410 T	sin A_1
-27".871	cos (I)	+19".869	sin (I)
+28".793	cos2(I)	+10".035	sin2(I)
+4".327	cos3(I)	+14".28	sin3(I)
+2".063	cos4(I)	-2".672	sin4(I)
-18".585	cos (II)	+12".603	sin (II)
+1".658	cos2(II)	+3".752	sin2(II)
-21".32	cos (III)	-48".623	sin (III)
+19".508	cos (IV)	+142".938	sin (IV)
+75".7	cos (V)	-102".3	sin (V)

$(v.s.1) = 6".86 + 112".317T - 1".551T^2 - 0".516T^3 - 0".014T^4$

-5".13	cos A_1	-5".66	sin A_1
+0".219 T	cos A_1	-0".100 T	sin A_1
-1".191	cos (I)	-1".012	sin (I)
+0".619	cos2(I)	-2".068	sin2(I)
-16".44	cos3(I)	+8".353	sin3(I)
+4".244	cos4(I)	+2".195	sin4(I)
+0".409	cos5(I)	+3".037	sin5(I)
+0".456	cos (II)	-1".406	sin (II)
+1".390 T	cos (II)	+0".984 T	sin (II)
-0".907	cos2(II)	+3".045	sin2(II)
+4".469	cos (III)	-1".833	sin (III)

$(v.c.1) = -2".92 - 68".339T - 9".721T^2 - 0".067T^3 + 0".016T^4$

+5".62	cos A_1	-7".79	sin A_1
+0".175 T	cos A_1	+0".259 T	sin A_1
-4".54	cos (I)	+3".743	sin (I)

+0".878	cos2(I)	+0".373	sin2(I)
+8".913	cos3(I)	+18".376	sin3(I)
+2".539	cos4(I)	-4".664	sin4(I)
+2".855	cos5(I)	-0".429	sin5(I)
+1".406	cos (II)	+0".456	sin (II)
+0".986 T	cos (II)	-1".398 T	sin (II)
+1".575	cos2(II)	+1".597	sin2(II)
-0".803	cos (III)	-2".009	sin (III)

$(v.s.2) = 6".605T$

+0".841	cos5(I)	+2".822	sin5(I)
+1".83 T	cos (II)	+0".15 T	sin (II)

$(v.c.2) = -4".013T - 0".572T^2$

+2".808	cos5(I)	-0".841	sin5(I)
+0".15 T	cos (II)	-1".83 T	sin (II)

$(v.s.3) = -5".016$ cos (II) $+3".426$ sin (II)

$-2".129$ cos2(II) $-2".22$ sin2(II)

$(v.c.3) = 3".43$ cos (II) $+5".018$ sin (II)

$-2".218$ cos2(II) $+2".133$ sin2(II)

(The terms in T alone in the above expressions are secular terms and terms of long period expressed as polynomials in T. Some constant terms are epoch corrections.)

$E = 19401".813 \sin g + 570".161 \sin 2g + 23".233 \sin 3g$

(This is the equation of the center.)

$L = l + E + (v.c.0) + (v.s.1)\sin g + (v.c.1)\cos g + (v.s.2)\sin 2g + (v.c.2)\cos 2g + (v.s.3)\sin 3g + (v.c.3)\cos 3g$

(Note that perturbation terms correct the true orbital longitude L.)

$u = (L - \Omega) \bmod 360^\circ$

$R = -9".38 \sin 2u$

(This is the reduction to the ecliptic.)

$\lambda = (L + R) \bmod 360^\circ$

(λ is the heliocentric geometric longitude of Uranus referred to the mean equinox of date. The mean elements of Uranus were previously corrected for general precession.)

$\beta_0 = \sin^{-1}(\sin i \sin u)$

(β_0 is Uranus' heliocentric geometric latitude.)

$10^8(r.c.0) = -984T$

-1139	cos (I)	-1597	sin (I)
-642	cos2(I)	+1840	sin2(I)
-1895	cos3(I)	+571	sin3(I)
+403	cos4(I)	+315	sin4(I)
+530	cos (II)	+7672	sin (II)
-809	cos2(II)	+378	sin2(II)
-10302	cos (III)	+4518	sin (III)

$10^8(r.s.1) = 437 - 308 - 2874T - 4327T - 1024T^2 - 7T^3 + 2T^4$

+556	cos A_1	-807	sin A_1
-404	cos (I)	+314	sin (I)
+436	cos2(I)	+130	sin2(I)
-450	cos3(I)	-839	sin3(I)
-119	cos4(I)	+243	sin4(I)
-406	cos5(I)	+52	sin5(I)
-2533	cos (II)	-13179	sin (II)
-91 T	cos (II)	+132 T	sin (II)
-244	cos2(II)	-225	sin2(II)
-461	cos (III)	-952	sin (III)

$10^8(r.c.1) = 555 - 724 + 1175T - 12980T + 164T^2 + 54T^3 + 1T^4$

+523 cos A_1 +564 sin A_1

+18 cos (I) -12 sin (I)

+26 cos2(I) -122 sin2(I)

-1107 cos3(I) +528 sin3(I)

+307 cos4(I) +171 sin4(I)

+54 cos5(I) +376 sin5(I)

-13459 cos (II) +2493 sin (II)

+132 T cos (II) +91 T sin (II)

-239 cos2(II) +600 sin2(II)

-586 cos (III)+261 sin (III)

10^8(r.s.2)=-201T-306T-72T^2

+1709 cos (II) +2654 sin (II)

-282 cos2(II) +21 sin2(II)

10^8(r.c.2)=-918T

+2642 cos (II) -1703 sin (II)

+15 cos2(II) +276 sin2(II)

10^8(r.s.3)=+366 cos (II) +540 sin (II)

+184 cos2(II) -174 sin2(II)

10^8(r.c.3)=+540 cos (II) -366 sin (II)

-174 cos2(II) -184) sin2(II)

(The terms in T alone in the above expressions are secular terms and long period terms expressed as polynomials in T. Some constant terms are epoch corrections.)

logr=1.2833371l4-0.020411l4cosg-0.00071990cos2g-0.00003197cos3g

+((r.c.0)+(r.s.1)sing+(r.c.1)cosg+(r.s.2)sin2g

+(r.c.2)cos2g+(r.s.3)sin3g+(r.c.3)cos3g)10^{-8}

(Note that perturbation terms correct logr.)

$r=10^{logr}$

(r is the heliocentric radius vector measured in a.u.)

ALGORITHM FOR NEPTUNE

(after Simon Newcomb, "Tables of Neptune", 1898)

Epoch=January 0, 1900, noon, Greenwich Mean Time

T=number of Julian centuries since the Epoch

Δl=0".4l+0".56T-22".401T^2+0".0l4T^3+0".042T^4

Δh=0".12-17".673T+0".503T^2+0".159T^3+0".007T^4

+0".687T

Δk=-0".17+1".061T+12".192T+1".962T^2+0".027T^3-0".006T^4

l=(85° 1' 30".63+791505".84T+1".109T^2+Δl)mod360°=Neptune's mean longitude

g=(41° 16'.173+13108'.007T+Δl)mod360°=Neptune's mean anomaly

Λ=130° 40' 44".0+3963".93T+2".30T^2+0".067T^3=Neptune's ascending ecliptic node

i=1° 46' 45".32-33".07T-0".015T^2-0".005T^3=Neptune's inclination

(Note that in the algorithm for Neptune secular and precessional terms have been applied to correct the mean elements.)

I =g -g'=(32°.982+210°.033T+0°.015T^2)mod360°

II =l_1-g'=(180°.966+1003°.999T+0°.l47T^2-0°.01T^3)mod360°

III=l_2-g'=(153°.264+2816°.243T-0°.01T^2+0°.017T^3)mod360°

(Here g=mean anomaly of Uranus,

g'=mean anomaly of Neptune,

l_1=mean longitude of Saturn from the perihelion of Neptune,

l_2=mean longitude of Jupiter from the perihelion of Neptune.)

(v.c.0)=+1".571 sin (I) -2".208cos (I)

+2".931 sin2(I) +8".649cos2(I)

-1".750 sin3(I) -0".489cos3(I)

+18".553sin (II)

+34".138sin (III)

(v.s.l)=+2Δk

+4".299 sin (I) -0".734cos (I)

-4".850 sin2(I) +9".194cos2(I)

+0".836 sin3(I) +1".647cos3(I)

(v.c.l)=-2Δh

+1".426 sin (I) +4".037cos (I)

-9".330 sin2(I) -4".386cos2(I)

-1".657 sin3(I) +0".884cos3(I)

(v.s.2)=-1".613 sin3(I) -0".494cos3(I)

(v.c.2)=+0".490 sin3(I) -1".607cos3(I)

10^7(r.c.0)=-2+175.83T+0.5T^2-0.33T^3

-236 sin (I) -168 cos (I)

+140 sin2(I) -48 cos2(I)

-10 sin3(I) +34 cos3(I)

+397 cos (II)

+701 cos (III)

10^7(r.s.l)=-3+357.5T-10.5T^2-3T^3

-1 sin (I) -50 cos (I)

+57 sin2(I) +28 cos2(I)

10^7(r.c.l)=+4-278.5T-41.5T^2-1T^3

+48 sin (I) -13 cos (I)

-28 sin2(I) +53 cos2(I)

(The terms in T alone in the above expressions including Δh and Δk are long period perturbations and secular variations.)

E=3520".252sing+18".774sin2g

(This is the equation of the center.)

L=l+E+(v.c.0)+(v.s.l)sing+(v.c.l)cosg+(v.s.2)sin2g+(v.c.2)cos2g

(L is the true longitude of Neptune in its own orbit. Note that perturbation terms correct L.)

u=(L-Ω)mod360°

R=(-49".736+0".513)sin2u

(R is the reduction to the ecliptic. The term 0".513 is referred to in "Tables of Neptune" as a secular variation. Quite likely, therefore, the reduction should be corrected to R=(-49".736 +0".513T)sin2u.)

λ=(L+R)mod360°

(λ is the heliocentric geometric longitude referred to the mean equinox of date.)

$\beta=\sin^{-1}$(sinisinu)

(β is the heliocentric geometric latitude.)

loga=1.4781431l4

logr=loga+0.00000790-0.00370591cosg

-0.00002372cos2g-0.00000019cos3g

+((r.c.0)+(r.s.l)sing+(r.c.l)cosg))10^{-7}

(Note that perturbation terms correct logr.)

$r=10^{logr}$

(r is the heliocentric radius vector measured in a.u.)

III. TESTING THE ALGORITHMS

Each algorithm given above has been tested against a sample taken from "Coordinates of the five outer planets, 1653-2060", A.P.A.E. Volume XII, 1951, by Eckert, Brouwer and Clemence. The coordinates in this volume were generated

Table 2.1 - Test of the Jupiter algorithm against A.P.A.E. V.12

Date (midnight)	A.P.A.E. helio long.	Algorithm helio long.	Avr. long. residual	A.P.A.E. helio lat.	Algorithm helio lat.	Avr. lat. residual	A.P.A.E. rad. Vector	Algorithm rad. Vector	Avr. r res.x10^{-9}
07/14/1653	310°02'43"	310°02'43"	-5".87	0°-13'-48"	0°-13'-48"	0".23	5.059175802	5.059175626	+59140
02/08/1660	157 26 51	157 26 46	-4.81	1 09 01	1 09 01	0 .13	5.413592817	5.413576811	-152770
09/04/1666	352 36 36	352 36 46	+9.78	-1 36 -45	-1 36 -47	0 .13	5.496300299	5.496296020	+427158
03/31/1673	193 7 20	193 7 19	+2.22	-1 18 51	-1 18 48	0 .16	4.977801345	4.977831177	-029832
10/26/1679	35 27 38	35 27 38	-0.94	-1 09 -48	-1 09 -47	0 .16	5.411968639	5.411968839	-1.2205
03/22/1713	323 24 57	323 25 3	+6.12	0 -56 -51	0 -56 -51	0 .11	5.012996805	5.012998662	-171647
08/07/1718	83 51 36	83 51 39	-3.41	0 -18 -59	0 -18 -59	0 .08	5.122168695	5.122168955	-026058
02/01/1764	165 43 42	165 43 42	+2.52	1 13 03	1 13 03	0 .02	5.430855937	5.430855934	-814447
12/02/1794	282 26 30	282 26 07	-3.18	0 -05 -39	0 -05 -36	0 .16	5.183878479	5.183879752	-096720
06/23/1821	19 58 19	19 58 18	+4.40	-1 -17 -17	-1 -17 -16	0 .38	4.950172265	4.950172008	-976234
01/19/1875	106 07 58	106 08 05	-1.92	0 09 57	0 09 53	0 .82	5.210582450	5.210582621	-581779
11/14/1875	222 21 55	222 21 56	-4.36	1 05 50	1 05 53	0 .63	5.021702759	5.021702966	+606284
09/08/1902	315 14 08	315 13 57	+10.13	-1 -56 -56	-1 -56 -53	0 .63	5.058206396	5.058206717	-468446
07/08/1929	58 07 12	58 07 16	+4.34	0 -52 -09	0 -52 -07	0 .59	5.037960852	5.037960729	-15878
04/29/1950	321 50 55	321 50 55	+0.85	0 -45 -21	0 -45 -21	0 .72	5.037960852	5.037960729	-15878
01/24/1977	64 59 27	64 59 31	-3.36	0 -45 -30	0 -45 -32	0 .59	5.038052856	5.038052771	-998715
10/20/2004	277 45 58	277 45 58	+2.76	1 04 -59	1 04 -59	0 .72	5.382760749	5.382760918	-238071
07/14/2032	359 39 57	359 39 57	-6.48	-1 -16 -31	-1 -16 -31	0 .81	4.961259418	4.961205878	+535341

- on a computer as the output of a direct numerical integration of the partial differential equations of motion of Jupiter, Saturn, Uranus, Neptune and Pluto, taking into consideration the mutual gravitational attractions of the Sun and all nine major planets in the solar system to each other. The coordinates are heliocentric equatorial X,Y,Z coordinates listed to 9 decimal places and referred to the mean equinox of 1950.0. It suffices to state that these published coordinates are considered the authority on the positions of the outer planets, and their use by professional astronomers and ephemeris makers has superceded the use of the tables of Newcomb and Hill which are the basis of the much simplified algorithms given in section II of this paper. Newcomb's tables are still used by professional astronomers and ephemeris makers to determine the positions of the inner planets and the Sun. For testing the computer subroutines which were developed from the algorithms of section II, the test program converted the coordinates from A.P.A.E. Volume XII to heliocentric ecliptic longitude, latitude and radius vector referred to the mean equinox of date using formulae for these purposes listed in the Explanatory Supplement to the Astronomical Ephemeris and the American Ephemeris and Nautical Almanac, 1961. On output of the test results the test program further rounded the printed longitudes and latitudes to the nearest second of arc. The residuals in these quantities, however, were printed to 0".01 of arc. In the tables of test results, Tables 2.1-4, these converted and rounded longitudes and latitudes are the

Table 2.2 - Test of the Saturn algorithm against A.P.A.E. V.12

Date (midnight)	A.P.A.E. helio long.	Algorithm helio long.	Avg. long. residual	A.P.A.E. helio lat.	Algorithm helio lat.	Avg. lat. residual	A.P. A.E. rad. Vector	Algorithm rad. Vector	Avg. r res.x10^{-9}
07/14/1653	135°12'17"	135°12'24"	-6".80	1°02'25"	1°02'16"	9".09	9.156581179	9.156777879	-196700
03/22/1690	224 09 40	224 09 35	5 .55	2 18 02	2 17 59	2 .40	9.908671970	9.908571641	+100329
01/20/1717	193 43 59	193 44 00	-0 .35	2 28 43	2 28 42	0 .78	9.651032486	9.651336161	-303974
06/07/1744	168 43 56	168 44 05	-8 .68	2 06 05	2 06 05	-0 .09	9.420001433	9.420182471	-181038
10/24/1771	142 15 31	142 15 35	-4 .18	1 16 11	1 16 06	4 .93	9.198503353	9.198533575	-30222
02/04/1798	99 59 29	99 59 25	3 .71	0-31-04	0-31-12	8 .84	9.016133557	9.015779751	+353806
06/23/1825	72 05 13	72 05 15	-1 .91	-1-36-21	-1-36-17	-3 .94	9.047413544	9.047537396	-123852
02/12/1850	9 13 21	9 13 25	-3 .97	-2-25-42	-2-25-44	2 .03	9.431184447	9.431109928	+74519
11/08/1875	325 21 51	325 21 52	-0 .76	-1-20-55	-1-21 00	5 .70	9.821519044	9.821206937	+312107
06/30/1900	271 55 38	271 55 33	5 .23	0 53 17	0 53 24	-6 .97	10.069854863	10.070045001	-190138
09/07/1925	225 01 38	225 01 40	-1 .77	2 18 27	2 18 41	-14 .35	9.876038965	9.876212079	-173115
11/15/1950	174 44 03	174 44 02	1 .31	2 11 16	2 11 16	-0 .40	9.446697551	9.446631374	+66177
07/07/1975	112 11 08	112 11 05	3 .67	0-03-20	0-03-35	14 .70	9.045038749	9.045168886	-130136
02/26/2000	47 43 57	47 44 09	-11 .65	-2-16-08	-2-16-20	11 .62	9.172076438	9.171912536	+163902
05/05/2025	353 52 27	353 52 29	-2 .53	-2-09-09	-2-09-17	7 .66	9.592724087	9.592908974	-184887
07/13/2050	305 06 23	305 06 26	-3 .17	0-28-33	0-28-25	-7 .52	9.956390231	9.956399788	-9557
12/07/2060	74 00 33	74 00 48	-14 .76	-1-36-05	-1-36-15	9 .25	9.059338683	9.059422336	-83654

Table 2.3 - Test of the Uranus Algorithm against A.P.A.E. V.12

Date (midnight)	A.P.A.E. helio long.	Algorithm helio long.	Avg. long. residual	A.P.A.E. helio lat.	Algorithm helio lat.	Avg. lat. residual	A.P.A.E. rad. Vector	Algorithm rad. Vector	Avg. r res.x10^{-9}
07/14/1653	269°05'35"	269°05'27"	8".47	0°-13'-27"	0°-13'-24"	-2".82	19.370935286	19.370896710	+ 38577
04/03/1680	15 59 11	15 59 09	1 .92	0 -38 -32	0 -38 -32	-0 .46	19.951117259	19.950976448	+140811
02/02/1707	131 11 08	131 11 13	-4 .88	0 39 36	0 39 33	3 .05	18.446735773	18.446809563	- 73789
12/02/1733	254 49 07	254 49 07	0 .24	0 -01 -46	0 -01 -45	-1 .19	19.131938995	19.131977360	- 38365
03/15/1760	1 02 43	1 02 44	-0 .58	0 -43 -02	0 -43 -58	-3 .59	20.066080725	20.066083735	- 3010
06/27/1786	111 02 34	111 02 34	-0 .22	0 28 38	0 28 36	1 .77	18.657955380	18.657879601	+ 75779
03/23/1812	230 47 32	230 47 39	-7 .38	0 17 36	0 17 33	3 .37	18.752371402	18.752331114	+ 38288
01/21/1839	341 57 46	341 57 46	-0 .48	0 -46 -18	0 -46 -19	0 .74	20.088057853	20.088114015	- 56162
05/04/1865	89 03 59	89 03 58	1 .36	0 12 35	0 12 35	0 .00	18.979199518	18.979237093	- 37575
08/16/1891	210 52 54	210 52 52	1 .67	0 31 24	0 31 22	2 .30	18.495322578	18.495450799	-128221
11/28/1917	322 52 03	322 52 05	-2 .60	0 -43 -20	0 -43 -22	1 .39	19.988980077	19.989197092	-217015
03/11/1944	68 00 20	68 00 20	0 .31	0 -04 -39	0 -04 -36	-2 .41	19.343581093	19.343976272	-395179
06/23/1970	187 52 41	187 52 39	1 .96	0 42 22	0 42 22	-0 .17	18.325504754	18.325476688	+ 28066
10/04/1996	303 23 05	303 23 02	3 .45	0 -35 -10	0 -35 -13	3 .03	19.785367719	19.785553197	-185777
01/16/2023	47 40 02	47 40 04	-2 .85	0 -20 -39	0 -20 -40	0 .62	19.667143001	19.667904559	-472558
10/11/2048	162 02 38	162 02 31	7 .33	0 46 20	0 46 23	-3 .10	18.291137359	18.291320588	+116771
12/07/2060	219 04 09	219 04 02	7 .35	0 26 44	0 26 47	-3 .61	18.544017291	18.543687243	+330048

Table 2.4 - Test of the Neptune Algorithm against A.P.A.E. V.12

Date (midnight)	A.P.A.E. helio long.	Algorithm helio long.	Avg. long. residual	A.P.A.E. helio lat.	Algorithm helio lat.	Avg. lat. residual	A.P. A.E. rad. Vector	Algorithm rad. Vector	Avg. r res.x10^{-9}
12/21/A653	263°27'34"	263°27'17"	16".41	1°51'48"	1°51'49"	-1".01	30.260864049	30.259912677	+951372
05/08/A681	323 20 29	323 20 19	10 .26	0-28-04	0-28-04	-0 .38	30.012656343	30.012390505	+332796
05/08/A708	22 57 58	22 57 57	.77	-1-43-50	-1-43-50	-0 .25	29.825351735	29.824709560	+642174
02/06/A735	82 54 37	82 54 36	.87	-1-17-24	-1-17-23	-0 .66	29.870868687	29.870849967	+ 18721
03/15/A760	138 36 56	138 36 56	.17	0 17 42	0 17 42	-0 .57	30.088589929	30.088589768	-356839
01/13/A787	197 04 19	197 04 21	-1 .95	1 39 18	1 39 18	-0 .24	30.297596133	30.297801493	+205197
04/27/A813	253 57 30	253 57 29	1 .47	1 28 40	1 28 40	-0 .30	30.290205023	30.290656971	+451807
08/09/A839	311 14 56	311 14 53	2 .59	0-02-19	0-02-18	-0 .83	30.078651377	30.078613437	+ 936
11/20/A865	9 27 35	9 27 37	-1 .81	-1-31-50	-1-31-49	-0 .53	29.854583968	29.854356200	+226168
03/03/A892	68 13 25	68 13 26	-1 .78	-1-34-37	-1-34-37	-0 .17	29.854956200	29.854835076	+121114
06/16/A918	126 33 45	126 33 45	-0 .58	0-08-01	0-08-02	-0 .76	30.040968511	30.040615476	+353034
04/15/A945	185 11 13	185 11 19	-5 .67	1 26 10	1 26 11	-1 .17	30.271331709	30.271202557	+129152
07/28/A971	242 05 21	242 05 27	-5 .95	1 39 32	1 39 33	-1 .31	30.319687335	30.319529374	+157961
11/08/A997	299 13 34	299 13 36	-2 .69	0 23 02	0 23 03	-0 .32	30.114602635	30.114601417	+ 16218
02/20/B024	357 12 16	357 12 35	-19 .79	-1-15-13	-1-15-13	-0 .25	29.901534763	29.902338656	-703893
12/20/B050	57 09 15	57 09 01	14 .33	-1-42-24	-1-42-24	-0 .64	29.816887729	29.816696884	+409156
12/07/B060	79 24 54	79 24 38	16 .00	-1-24-35	-1-24-36	0 .64	29.863125722	29.862911655	+214067

ones listed. All times listed in the tables are midnight Gregorian calendar dates.

IV. ANALYSIS OF THE RESIDUALS

The residuals of Table 1 and Tables 2.1-4 reflect largely the exclusion of the smaller periodic perturbation terms from the algorithms. Another significant source of the residuals, however, is undoubtably errors in the source documents and errors which have arisen in the translation process from the source documents to the computer programs. This appears especially likely in the case of Saturn. Also, the planet Pluto was unknown in the time of Newcomb and Hill, and thus its perturbing effects were not considered in their work and is not considered in the algorithms of section II. This may be a source of residuals in the planet Neptune. Finally, a likely source of residuals in the Neptune algorithm is a possible error in the programming of the secular variation for the reduction to the ecliptic (see section II).

The effect of the residuals in the heliocentric longitude and latitude on the geocentric coordinates will be a maximum when the planet is in geocentric opposition to the Sun. In the figures below let S be the position of the Sun, E the position of the Earth, P the true position of the planet and P' the position of the planet calculated by the algorithm. Then in figure 1 the angle PŜP' is the heliocentric residual in longitude or latitude and the angle PÊP' is the geocentric residual. Now the triangle ΔSPP' is close to being a right triangle and so, knowing PŜP', we may calculate PÊP', since

$$P\hat{E}P' = \tan^{-1}(SP \tan P\hat{S}P'/EP)$$

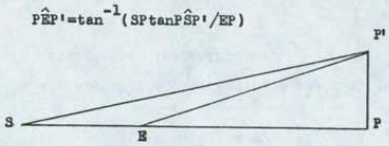


Figure 1

From Table 1 we see that the largest residual in longitude or latitude is about 7" for Saturn's latitude, so in this case we have

$$SP \approx 9 \text{a.u.}, \quad EP \approx 8 \text{a.u.}, \quad P\hat{S}P' \approx 7'',$$
$$P\hat{E}P' \approx \tan^{-1}(9 \tan 7''/8) \approx 8''$$

We see therefore that we may have to add as much as 1" to the heliocentric residuals to give us the geocentric residuals in longitude and latitude.

Turning to the effects of the residuals in the radius vector, in figure 2 the line segment PP' represents the residual in the radius vector and SE the Sun to Earth distance. SP is the radius vector. The residual in geocentric longitude generated by the error PP' in the radius vector is represented by the angle PÊP'. We wish to determine when PÊP' will be a maximum. Assuming the orbits are circular, i.e., holding SE and SP constant, we have

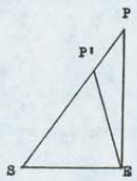


Figure 2

$$\sin P\hat{E}P' = \frac{PP' \sin S\hat{P}E}{SE}$$

and this implies that, holding PP' constant,

$$\max P\hat{E}P' = \sin^{-1}\left(\frac{PP' \max(\sin S\hat{P}E)}{SE}\right)$$

But

$$\sin S\hat{P}E = \frac{SE \sin S\hat{E}P}{SP}$$

and this implies that

$$\max(\sin S\hat{P}E) = \frac{SE \max(\sin S\hat{E}P)}{SP}$$

Now $\max(\sin S\hat{E}P)=1$ when $S\hat{E}P=90^{\circ}$, and so

$$\max(\sin S\hat{P}E) = SE/SP$$

or

$$\max P\hat{E}P' = \sin^{-1}\left(\frac{PP'}{SP}\right)$$

The largest residuals in geocentric longitude from the residuals in the radius vector are those of Saturn. Using the residual from Table 1

$$SP \approx 9 \text{a.u.}, \quad PP' = 0.0001575,$$
$$\max P\hat{E}P' \approx \sin^{-1}(PP'/SP) \approx 4''$$

So the geocentric residuals in longitude may be as much as 4" larger than those of the heliocentric longitude due to the residual in the radius vector.

The effects of the residuals in the radius vector on the geocentric latitude may be estimated by examining figure 3. Here the planet is assumed to be in geocentric opposition to the Sun and at the greatest latitude of its orbit. The line segment PP' represents the residual in the radius vector, SE the Sun to Earth distance and SP the radius

vector.

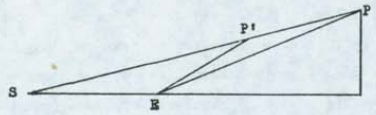


Figure 3

We may calculate the residual in latitude $P\hat{E}P'$ from the relations

$$\sin P\hat{E}P' = PP' \sin S\hat{P}E / SE,$$

$$\sin S\hat{P}E = SE \sin E\hat{S}P / PE,$$

$$PE = (SE^2 + SP^2 - 2SE \cdot SP \cdot \cos E\hat{S}P)^{\frac{1}{2}},$$

leading to

$$P\hat{E}P' = \sin^{-1}\left(\frac{PP' \sin E\hat{S}P}{(SE^2 + SP^2 - 2SE \cdot SP \cdot \cos E\hat{S}P)^{\frac{1}{2}}}\right)$$

The worst case is again Saturn which reaches a maximum heliocentric latitude of about $2^\circ.5$. Here we have from the above formula, using the average radius vector residual from Table 1 for PP',

$$SP \approx 9 \text{ a.u.}, \quad PP' = .0001575, \quad E\hat{S}P \approx 2^\circ.5$$

$$P\hat{E}P \approx \sin^{-1}\left(\frac{(1575 \times 10^{-7}) \sin 2^\circ.5}{(1+9^2 - 2(9)\cos 2^\circ.5)^{\frac{1}{2}}}\right) \approx 0''.18$$

and so the effects of the radius vector residuals on the geocentric latitude are insignificant.

V. MICROCOMPUTER IMPLEMENTATION

The tables of the outer planets of Newcomb and Hill from which the algorithms of section II were derived were prepared for hand calculation more than half a century before the invention of electronic computers. The calculation methods used are very inefficient from the computer point of view. Nevertheless, because of the difficulty of working with the source document, A.P.A.E. Volume VII, it was most practical, for the purpose of debugging computer programs, to use methods as close to the original as possible. This initial programming effort was accomplished in January and February of 1977 in FORTRAN IV on a Datacraft 6000, a scientifically oriented minicomputer.

For implementation on microcomputers it is extremely desirable to supercede this initial programming effort with programs based on more efficient algorithms. Of the many possible improvements which will readily suggest themselves to a person with sufficient mathematical and programming skill, one improvement will be explored in depth in this section which claims special attention because of its potential to reduce the run-time of the algorithms executed together a thousand fold.

This improvement is to reduce to a minimum the computation of the trigonometric functions SIN and COS in the series of perturbation terms. The SIN and COS functions are subroutines which necessitate the execution of many dozens of machine language instructions. These time-costly subroutine calls

may be reduced to simple "adds" and "multiplies" by the application of simple trigonometric identities.

Consider, for example, the series of terms for $\delta \log \frac{r}{r}$ in the Jupiter algorithm. We may represent this as

$$\delta \log \frac{r}{r} = \sum_n \left[A_n \cos(a_n + B_n)\right] \quad \text{where}$$

$$\cos(a_n + B_n) = \cos a_n \cos B_n - \sin a_n \sin B_n$$

Now $\cos B_n$ and $\sin B_n$ may be computed in advance and stored in the program as an array of constants. Thus we may represent them as

$$CB(n) = \cos B_n, \quad SB(n) = \sin B_n$$

Also
$$\cos a_n = \cos(i_{ng}' + j_{ng}) = \cos i_{ng}' \cos j_{ng} - \sin i_{ng}' \sin j_{ng},$$

$$\sin a_n = \sin(i_{ng}' + j_{ng}) = \sin i_{ng}' \cos j_{ng} + \cos i_{ng}' \sin j_{ng}$$

for some integers i_n and j_n, that is, $\cos a_n$ and $\sin a_n$ may be represented as sums and products of $\cos i_{ng}'$, $\sin i_{ng}'$, $\cos j_{ng}$, $\sin j_{ng}$, and these may in turn be represented as sums and products of cosg', sing', cosg, sing. Thus $\delta \log \frac{r}{r}$ may be represented completely as sums and products of these last four trigonometric functions.

Making use of the following trigonometric identities,

$$\sin(a+b) = \sin a \cos b + \cos a \sin b,$$

$$\cos(a+b) = \cos a \cos b - \sin a \sin b,$$

$$\sin 2a = 2 \sin a \cos a,$$

$$\cos 2a = \cos^2 a - \sin^2 a,$$

we demonstrate this procedure for $\delta \log \frac{r}{r}$ of Jupiter. Since the development of terms in g' is identical to that of g, only the g terms are developed.

CG(1)=cosg, SG(1)=sing, CGP(1)=cosg', SGP(1)=sing,
CG(2)=(CG(1))^2-(SG(1))^2, SG(2)=2SG(1)CG(1),
CG(3)=CG(2)CG(1)-SG(2)SG(1),
SG(3)=SG(2)CG(1)+CG(2)SG(1),
CG(4)=(CG(2))^2-(SG(2))^2, SG(4)=2SG(2)CG(2),
CG(5)=CG(4)CG(1)-SG(4)SG(1),
SG(5)=SG(4)CG(1)+CG(4)SG(1),
and so forth.

So we have, giving only representative examples of the terms,

cos(-g+B_2)=CG(1)CB(2)+SG(1)SB(2),
cos(-2g+B_4=CG(2)CB(4)+SG(2)SB(4),
cos(g'-g+B_6)=(CGP(1)CG(1)+SGP(1)SG(1))CB(6)
-(SGP(1)CG(1)-CGP(1)SG(1))SB(6),
cos(4g'-2g+B_{15})=(CGP(4)CG(2)+SGP(4)SG(2))CB(15)
-(SGP(4)CG(2)-CGP(4)SG(2))SB(15),
and so forth.

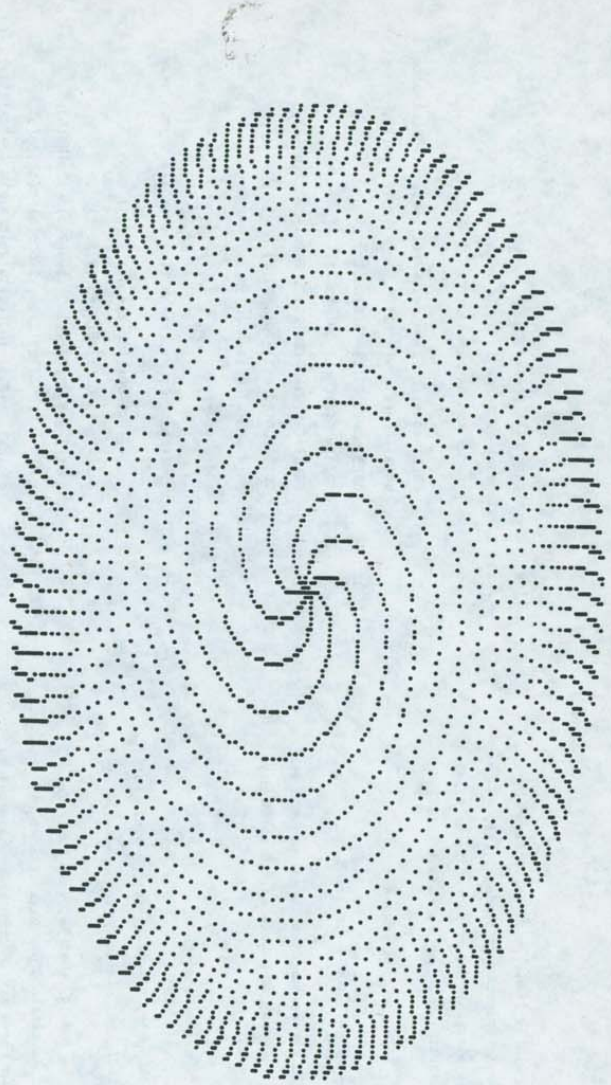
We see that within the procedure are two subprocedures and each subprocedure may become an iteration saving space within the computer. Thus after defining CG, SG, CGP and SGP, we execute the first subprocedure as
if n even: C(n)=(C(n/2))^2-(S(n/2))^2, S(n)=2S(n/2)C(n/2);
if n odd: C(n)=C(n-1)C(1)-S(n-1)S(1), S(n)=S(n-1)C(1)+C(n-1)S(1)

We then execute the second subprocedure as

$$\log_F^E \sum_R \left\{ A_n \left[(GGP(i_n)OG(j_n)+SGP(i_n)SG(j_n))CB(n) \right. \right.$$
$$\left. \left. -(SGP(i_n)OG(j_n)-GGP(i_n)SG(j_n))SB(n) \right] \right\}$$

The arrays which feed this second subprocedure must have zero coefficients where one or both of g, g' are undefined.

The memory requirements of these proposed improved algorithms remain large for microcomputers. But with careful programming the job can be done.



FOURTEEN WAYS TO USE THE RISING FUNCTION

by Axel Harvey
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[EDITOR'S NOTE: I still have a letter written by me in the early 1970s to Axel Harvey that was returned with "ADDRESSEE UNKNOWN" written on it. Imagine my surprise to receive a letter from Harvey containing two fine contributions for MATRIX. Some of you may not be familiar with the fine work of Axel Harvey. Harvey has been an important contributor to the THE ASTROLOGICAL JOURNAL published by The Astrological Association in Great Britain. In particular, Harvey has contributed to the sub-section of the JOURNAL called CORRELATION. CORRELATION contained technical and advanced theoretical subject matter- very similar to what we have in MATRIX. This material and, in particular, the articles written by Axel Harvey were inspirational and helped to encourage my interest in technical matters. MATRIX magazine is, among other things, an extension of the kind of articles that Axel Harvey wrote in CORRELATION back in the early seventies. Thank You Axel Harvey!]

The rising function is a three-variable function, say R(X,Y,Z), which is equal to the longitude of the ascendant when the variables are respectively the right ascension of the zenith meridian, the geographic or geocentric latitude, and the obliquity; it can then be written $R(\alpha, \phi, \varepsilon)$. In general:

R = ATN COS X/ -g + h

where g = TAN X SIN Z + SIN X COS Z
and h = 0 if -g >= 0
180° if -g < 0

For obvious reasons this function has turned up in several programs listed in MATRIX, but not all readers may be aware of its usefulness in domification (Houses) and coordinate conversion. Hereunder is a table providing the variables X, Y, Z for a number of common calculations. In some cases there may be faster or more elegant ways to calculate cusp longitudes, or to change coordinates, that do not make use of the rising function. But the methods listed here eliminate quadrant errors automatically, and besides they allow a great many routines to be built around one simple subroutine. This may be an advantage when one wishes to incorporate a great number of house systems in a single program.

In the table, these symbols stand for the following values:

ϕ Geographic or geocentric latitude
$\alpha_\circ$ Right ascension of the zenith meridian
α_p, δ_p Right ascension and declination of a point, such as a planet.
α_k, δ_k Right ascension and declination of a Placidus cusp.
λ, β longitude and latitude , Ecliptic
A Azimuth
ε Obliquity
R Value of the rising function.

The values to be substituted for X and Y appear in the columns marked "X" and "Y". The two cases in which a special value must be used for Z (right ascension and azimuth) are indicated; in every other case the obliquity is substituted for Z.

TABLE		
	X	Y
ASCENDANT	$\alpha_\circ$	ϕ
MIDHEAVEN	$\alpha_\circ - 90°$	0
VERTEX	$\alpha_\circ + 180°$	$90° - \phi$
LONGITUDE	α_p	δ_p
	$\lambda = R - 90°$	
RT. ASCEN.	λ	β
	Let $Z = -\varepsilon$; $\alpha_p = R - 90°$	
AZIMUTH	$\alpha_p - \alpha_\circ - 90°$	δ_p
	Let $Z = 90° - \phi$; A = R	

Astronomical azimuth A is measured from the zenith meridian through East. It might be useful to define an astrological azimuth measured from the western vertex through North. This would be 270 degress - R. In the three cases above one will want to calculate the corresponding second coordinates- respectively celestial latitude, declination, and altitude. All are given by:

ARCSIN (SIN Y COS Z - SIN X COS Y SIN Z)

... where X, Y and Z are the variables used with the rising function to obtain the first coordinate of the pair.

REGIOMONTANUS		
XI	$\alpha_\circ - 60°$	ATN(1/2 TAN ϕ)
XII	$\alpha_\circ - 30°$	ATN($\sqrt{3}$/2 TAN ϕ)
II	$\alpha_\circ + 30°$	ATN($\sqrt{3}$/2 TAN ϕ)
III	$\alpha_\circ + 60°$	ATN(1/2 TAN ϕ)

TOPOCENTRIC		
XI	$\alpha_\circ - 60°$	ATN(1/3 TAN ϕ)
XII	$\alpha_\circ - 30°$	ATN(2/3 TAN ϕ)
II	$\alpha_\circ + 30°$	ATN(2/3 TAN ϕ)
III	$\alpha_\circ + 60°$	ATN(1/3 TAN ϕ)

KOCH G.O.H		
XI	$\alpha_\circ - 2/3k - 60°$	ϕ
XII	$\alpha_\circ - 1/3k - 30°$	ϕ
II	$\alpha_\circ + 1/3k + 30°$	ϕ
III	$\alpha_\circ + 2/3k + 60°$	ϕ
	$k = ARCSIN(SIN\ \alpha_\circ\ TAN\ \phi\ TAN\ \varepsilon)$	

EQUAL "M"		
XI	$\alpha_\circ - 60°$	0
XII	$\alpha_\circ - 30°$	0
I	$\alpha_\circ$	0
II	$\alpha_\circ + 30°$	0
III	$\alpha_\circ + 60°$	0

AZIMUTH		
XI	$\alpha_0 - 90° - \text{ATN}(1/\sqrt{3}\ \text{SIN}\phi)$	$90° - \text{ARCCOS}(1/2\ \text{COS}\phi)$
XII	$\alpha_0 - 90° - \text{ATN}(1/\sqrt{3}\ \text{SIN}\phi)$	$90° - \text{ARCCOS}(\sqrt{3}/2\ \text{COS}\phi)$
II	$\alpha_0 + 90° + \text{ATN}(\sqrt{3}\ \text{SIN}\phi)$	$90° - \text{ARCCOS}(\sqrt{3}/2\ \text{COS}\phi)$
III	$\alpha_0 + 90° + \text{ATN}(1/\sqrt{3}\ \text{SIN}\phi)$	$90° - \text{ARCCOS}(1/2\ \text{COS}\phi)$
Cusp I is the western vertex.		

AZIMUTH CUSPS as defined here divide the Zodiac into twelve equal zones in azimuth. On a regular map the houses will run clockwise; thus the western vertex is the first cusp, and the southern meridian is the tenth.
CAMPANUS CUSPS are calculated by means of the Azimuth cusp formulas, ϕ being replaced by $\phi - 90°$. The cusps will be in the usual counterclockwise order.

Note that to compute Azimuth cusps for southern latitudes one must first follow the table and then change the results as follows:

Cusp III + 180° becomes Cusp XI;
Cusp II + 180° becomes Cusp XII;
Cusp XII + 180° becomes Cusp II;
Cusp XI + 180° becomes Cusp III.

MORINUS CUSPS are related to Equal "M" cusps as follows:

MOR X = EQ.M. I - 90° MOR I = MIDHEAVEN + 90°
MOR XI = EQ.M.II - 90° MOR II = EQ.M.XI + 90°
MOR XII= EQ.M.III- 90° MOR III = EQ.M.XII + 90°

PLACIDUS CUSPS require a more elaborate treatment. Each placidus cusp is the locus of points having equatorial coordinates δ, $f(\delta)$, right ascension being a function of declination as follows:

for cusp XI, $f(\delta) = \alpha_0 + 30° + 1/3\ \text{ARCSIN}(\text{TAN}\,\delta\ \text{TAN}\,\phi)$
for cusp XII, $f(\delta) = \alpha_0 + 60° + 2/3\ \text{ARCSIN}(\text{TAN}\,\delta\ \text{TAN}\,\phi)$
for cusp II, $f(\delta) = \alpha_0 + 120° + 2/3\ \text{ARCSIN}(\text{TAN}\,\delta\ \text{TAN}\,\phi)$
for cusp III, $f(\delta) = \alpha_0 + 150° + 1/3\ \text{ARCSIN}(\text{TAN}\,\delta\ \text{TAN}\,\phi)$

The longitude of a cusp is that of the point common to both the cusp-locus and the ecliptic. In other words it is the longitude of a point δ', $f(\delta')$ such that

$$\text{TAN}\,\delta' = \text{SIN}\,f(\delta')\ \text{TAN}\,\varepsilon$$

By substituting, one can see that this amounts to solving for cusp XI, $\alpha_k = \alpha_0 + 30° + 1/3\ \text{ARCSIN}(\text{SIN}\,\alpha_k\ \text{TAN}\,\phi\ \text{TAN}\,\varepsilon)$ etc.; α_k is the right ascension of the cusp. This is solved recursively. In other words one takes the function

$$\alpha_0 + p + q\ \text{ARCSIN}(\text{SIN}\,\alpha_k\ \text{TAN}\,\phi\ \text{TAN}\,\varepsilon)$$

with p = 30, 60, 120 or 150 degrees and q = 1/3 or 2/3, and inserts any dummy variable for α_k; the resulting value is taken and used as the variable α_k; the new resulting value is inserted in the same way, and so on. Each new value will be closer to the correct one, so the process can be stopped when the difference between successive values is less than an acceptable error, e.g. .00001 degree.

It will usually save a step (out of a dozen or so) if $\alpha_0 + p$ is taken as the first dummy variable.

Having gotten α_k, one can then get its longitude directly through the relationship

$$\lambda = \text{ATN}(\text{TAN}\alpha_k/\text{COS}\varepsilon)$$

but this requires a check for quadrant. An alternative method is to compute the declination

$$\delta_k = \text{ATN}(\text{SIN}\alpha_k\text{TAN}\varepsilon)$$

and to convert α_k, δ_k to their corresponding longitude via the rising function.

A NOTE ON OBLIQUITY. Users of small calculators will be interested to know that mean obliquity is quite well approximated by the fudge formula

$\varepsilon = 23.7 - .00013(\text{YEAR} + \text{MONTH}/12 + \text{DAY}/365 + 5.4)$ degrees.

Without a Julian day routine one can still compute a mean obliquity in this way with an error less than one tenth of an arc second for period from 1700 to 2100. To make the result almost perfect one can use an ephemeris to get the longitudes of the node Ω and Sun $\odot$, and so calculate a rough nutation.

$$.00255833\ \text{COS}\ \Omega + .00015306\ \text{COS}(2\odot)$$

to be added to the mean obliquity.

APPROXIMATE INVERSE INTERPOLATION

by Axel Harvey

It is desired to find the time at which a body, while moving at a variable rate, transits a given point. Four tabulated positions are known, two before and two after the event in question. Let these positions, from the earliest to the latest, be λ_{-1}, λ_0, λ_1 and λ_2; let the transit degree be L. Now let

$$q = (L - \lambda_0)/(\lambda_1 - \lambda_0)$$
$$r = \lambda_0 - \lambda_{-1}$$
$$s = \lambda_1 - \lambda_2.$$

Then $p = q\left[1 - \dfrac{(1 - q)(r + s)}{2(r - s)}\right]$ where p is the fraction of the tabular interval (usually 24 hours) which will have elapsed while the body moved from λ_0 to L. If a midnight ephemeris is used the hour of transit will be 24p.

EXAMPLE. At what hour will the Moon oppose Pluto on July 18, 1987? Using 0h position from the American Ephemeris one has:

17th λ_{-1} 13°33' 56"
18th λ_0 26°43' 23"
19th λ_1 39°31' 08"
20th λ_2 52°01' 16"

Pluto's station at 217 degrees 9 minutes is assumed, for the sake of demonstration, to be as precisely stated as the figures for the Moon. Therefore

L = 37° 09' 00"
Hence q = .8148702920
r = 13°15750
s = -12°502222...
and p = .8129440622
or in hours 19h 30m 38s

The formula can be used with any regular time interval. For example one could have achieved a slightly higher degree of confidence, in the above calculation, by taking both midnight and noon longitudes from the ephemeris and thereby reducing the tabular interval to 12 hours. Thus

18th Midn. 26° 43' 23"
18th Noon 33° 09' 43"
19th Midn. 39° 31' 08"
19th Noon 45° 45' 09"
L 37° 09' 00"

q = .6273541621
r = 6°4388888... S = -6°28361
p = .6259275172

which multiplied by 12 makes 7h 30m 40s after noon.

Moon transits by this method from 24-hour ephemerides have a typical error within +/- 6 seconds of time. On the other hand linear inverse interpolation, using only two table values, can cause errors of up to 6 minutes of time.

MATRIX FORUM: ASTRO-TALK

TOWARDS A DYNAMIC APPROACH TO COMPUTER ASSISTED HOROSCOPE DELINEATION

Editors

This introduction and the following articles represent an attempt to begin to address a subject of great importance to computer oriented astrologers - computer facilitated horoscope interpretation. The very fact that computer generated horoscope delineation is held in such very low esteem by astrologers in general might give us a clue as to its great importance and certain future. There is every reason to believe that computer horoscope delineation is not only going to be in our future but also that it will play a far more significant role than astrologers would care to admit at this time. Astrologers have ever been wary of the computer lest it wrest their function as an interpreter from them. I am sure that's the last thing on the computer's mind but on the theory that 'what you fear shall come upon you' something like this must be part of our future. It is important that astrologers perceive the computer as the friend that is is rather than as a threat to their livlihood. MATRIX readers know this. This issue will introduce what will be a column in future issues of MATRIX on this fascinating subject.

It does not take an abnormal amount of intelligence to perceive the handwriting on the wall. Witness the current interest in astrological techniques the world around. It is as if each of the many techniques of astrology are experiencing a rebirth...even a culmination at this time. To me, a simultaneous completion of technique among the technical streams of astrology can only point to the advent of a new level or age for astrology. In the past, great advances were often heralded by increased activity in the, then known, areas of science. Metaphorically it might be pictured as the emergance of an entire continent when previously only a series of separate islands were perceived. Suddenly the connecting link..the central notion itself is perceived by all. As poetic as the above might appear, it may well be what is happening in the world of astrology today.

In it's subjective and intuitive mode, astrology shares much with other occult sister sciences such as tarot, palm reading, and so forth. However, at this time, astrology is in the process of separating itself from some of the other psychic sciences and entering the establishment via a path similar to that taken by modern Psychology. Even a casual investigation of astrology will show that it is a field or science built around numbers. While it is possible to practice a form of astrology that is purely esoteric or intuitional, there are many other esoteric modes that would be more convenient for this approach. It is difficult to get away from the idea that astrology has to do with positional astronomy and positional astronomy has to do with numbers. It is certainly not everyone who would care to plot and chart the numbers of the celestial sphere as do astrologers. Not everyone would care to be an astrologer.

My point is that astrology, which has catered to the esoteric side of its self for several centuries, is in the process of developing a more practical or scientific side at this point in time. It should not surprise us that as it does so, so does it find increased credibility in the eyes of the establishment. Yes, I expect astrologers to make a half-way decent living (as a group) in the not too distant future. Astrology is in the process of emerging from a more amorphous state and taking on form. Few of us would disagree that the single most important instrumentral event in this process may well turn out to be the advent of the home computer.

Astrology is increasingly becomming a series of techniques that can be communicated, tested and practiced. In this respect, we are becomming very scientific in what we require from a new technique. None of us are particularly impressed by so-and-so's intuitive astrological analysis unless they can teach us how to get the same results. The 'incommunicableness' of a specific technique no longer is considered a recommendation.

Again, what I am saying here is that there is a definite trend among astrologers away from the undefined and amorphous and towards definite and discrete techniques. To the best of my knowledge, the very great majority of modern astrological techniques lend themselves directly to computer implementation. In the past two years, I have had the opportunity to program a wide variety of astrological techniques including many that I have never used in my own practice. These have been implemented in the form of programs for the new home computers. We are fast approaching a point in time when most of the basic astrological programs will be written and generally available. It is at this point that our interest in computer assisted interpretation will become stronger.

This column, which is intended as a regular feature of MATRIX, is dedicated to the theory and implementation of computer delineation. All readers are invited to share ideas and techniques on this very important subject.

To date, most computer generated horoscope interpretations make use of a large storage-bank of written paragraphs. These paragraphs are accessed according to one or another method of natal chart analysis and the appropriate text is printed out. This is the so-called 'cookbook' technique so popular in modern astrological texts. This approach exists in perhaps its finest form in the work of Grant Lewi through such books as ASTROLOGY FOR THE

Another psychological barrier is the idea that a computer is not capable of giving an individual 'personal attention' via a horoscope interpretation. This is the one big myth or bubble that has to pop before too long in the public mind. If I consider for a moment what I have had clients tell me that some so-called astrologers have told them, I welcome the attention of a computer! What we are looking at here is a whole new field that has been all but ignored until now. Teaching a computer how to interpret a chart may not be all that difficult. It will certainly weed out some cruthces that we have sustained too long.

To my mind, the most important task to be faced here is that of achieving a Gestalt or whole picture thru computer use. We can see how the computer can keep in mind thousands of details that an average astrolger could not manage. I believe that most of us have the idea that if these details were to be combined and presented properly, a larger dimension or image could somehow appear. That is: if the details were properly articluated (like the single frames on a movie strip) a moving and life-like image might appear. That image should be the self or inner US that we hope to get a glimpse of as part of a good astrological reading. This self or gestalt is what makes all of the details useful..it is the whole picture or setting in which the details are set. This may well be possible.

I believe that another approach to obtaining a gestalt will be more successful. This approach will make use of some of the new dimensions or ways of looking at a birth or event that have been researched in recent years. In particular I have in mind the Heliocentric perspective as a means to derive a 'larger picture' or gestalt. To my mind, it is easy to obtain a basic gestalt or theme from a dimension such as the heliocentric. This theme then will be used as the background or basic fabric into which more specific details are woven.

There are a variety of dimensions available to us ranging from the very general or broad heliocentric perspective thru the more particular and traditiona geocentric techniques and extending to the ultra-specific details possible thru horizon charts, parans and Local Space techniques. Only a computer will be able to keep track of the significant events in the particular dimensions or charts. Only astrologers will be able to teach the computer how to work this information together and to make use of these different levels of 'reading'.

Eventually the client will interact with the astrologer's computer by means of his own terminal. The client will ask questions or go thru a process of selection to gain the kind or 'tone' or a reading they desire. A massive amount of information will be immediately available at the touch of a button. This informatin will be presented in a meaningful way thru a combination of the astrologer's programming skills and the client's honest questions.

All of this is possible now. All that separates us from the experience is a whole lot of dedicated research and practice. Computer implementation of interpretation techniques is inevitable. I suggest that we begin to build a foundation for these possibilities together. We have much to gain by open discussion and a sharing of ideas and techniques. The following articles by Lee Holt and Roger Elliot are the first of what I hope will be many future articles on this subject from our readers.

We need ideas and thoughts about how all of this can be programmed, what machines and memory will be required, plus new or different approaches and ideas. It is hoped that many of us will begin to create our own versions of ASTRO-TALK. This column is dedicated to a public sharing of information on this subject to aid in furthering this project.

A word about the authors of the following articles.

LEE WAYNE HOLT

Lee Holt is a professional astrologer and film maker. He has worked as a film maker at the University of Arkansas at Little Rock and has been Media Arts Coordinator for the State of Arkansas. He is currently finishing up a film in Little Rock. Holt's book THE ASTROLOGICAL THESAURUS (available from the author) is perhaps the only publication to date to seriously approach the concept of computer astrological articulation. We are planning on Mr. Holt's participation in a computer delineation forum at the A.C.T. conference as part of the AAFA convention in the summer of 1980.

ROGER ELLIOT

Roger Elliot is perhaps England's best known astrologer. Writing for the T.V. TIMES, the British equivalent of our T.V. GUIDE, Elliot is a popular personality. Your editor met Elliot when he was on a tour of the states set up by Charles Jayne. Elliot became interested in the HP-67 programmable calculator...bought one...and was soon deluging us with programs for it. On his next visit to Ann Arbor, Elliot fell in love with our Commodore PET and had to have one of his own. His interest soon blossommed to the tune of an entire Cromemco system complete with multiple disk drives. Roger conceived of the idea for a new kind of computer written horoscope interpretation and wrote the program and the text himself. His BIRTHDAY HOROSCOPE has been more than a little successful.

MILLIONS. In recent years Robert Hand and Robert Pelletier have produced high-quality 'cookbook' astrology textbooks.

Both Hand and Pelletier have been instrumental in writing similar material for Para Research which has been used in their computer generated horoscope interpretation service. Roger Elliot in England has put together one of the most polished and attractive booklets of this type that I have seen. Elliot's YOUR BIRTHDAY HOROSCOPE is based on a harmonic analysis of an individual's Solar Return chart for the current year. In the manner of John Addey, Elliot converts this Solar Return chart into the Harmonic Chart that is equal to your present age and then performs an interpretive analysis of this chart. Putting aside the specific technique Elliot uses, let us take a look at how the interpretation is presented.

Roger Elliot is a master of advertising and promotion. Each copy of YOUR BIRTHDAY HOROSCOPE is attractively bound in a full color cover of heavy textured stock. THe format is carefully trimmed to 7 1/2 by 11 1/2 and bound using one of the new heat binding processes. The most ingeneous part of the whole thing is the way Elliot has made use of the several different type faces available to him on his high-speed dot matrix line printer. Elliot's TALLY printing is capable of printer several different sized type styles ranging from a small 16 characters-per-inch on up to an enchanced bold 3 characters-per-inch. The different type faces are under software control. Elliot varies the type styles in such a way as to add just the right amount of variety to the package. He also weaves the name of the individual along with other more subtle personal references into the text itself. The effect is that of an interpretation created especially for the individual- which in truth is the case.

Elliot's BIRTHDAY HOROSCOPE is, in many ways, a cut above the competition. However, it in no real way breaks from the 'cookbook' tradition of written horosocope interpretation. While your editor and this column are interested in the perfection and further development of the 'cookbook' style of interpretation, we will be more interested in exploring some alternative approaches. In particular, a more dynamic approach is required. Such an approach might require that the computer actually make use of syntax and develop a grammar to create an interpretation. We have termed the process of giving the computer the power of speaking in the astrological tongue- ASTRO-TALK. ASTRO-TALK will be the name of this column in future issues.

ASTRO-TALK

KEYWORDS are as old as modern astrology. There are dozens of books that make use of keywords in teaching astrology. Perhaps the most striking of these books is THE COMBINATION OF STELLAR INFLUENCES by Reinhold Ebertin. It is difficult to become familiar with this book without having the thought "this could be done with the computer". The articulation of midpoint structures using the Ebertin book is about as close to a rudimentary ASTRO-TALK as I have found.

There are many other astrological techniques that lend themselves to computer implementation. Aside from the Ebertin Cosmobiologists, the various forms and techniques of Uranian astrology , Harmonic analysis, Transits, Progressions, Solar Arcs and so on...come to mind. In fact, as we have mentioned earlier, just about all of what we could agree represents modern astrology can be programmed. It is only a matter of time before we will have implemented all major techniques on home computers. Our interest in using the computer will not stop there. We will begin to very carefully work these computers to do more for us. It is at this point that the real meaning and future for the computer in astrology will be perceived.

There are several major psychological barriers that will have to be negotiated before the computer will come into its own. An obvious one is that the computer is out to rob the astrologer of his job. The computer is idealy suited for use by astrologers. It would be better to consider computers not only as tools to 'work for us' but also as instruments that we may play and compose upon. These machines will allow us to maintain control and to use the many powerful astrological techniques that are being developed. THe computer is to the future astrologer as a piano is to a pianist. We will have to learn to consider the computer as a friend.

We still suffer from the shock of the advent of technology...it's newness. Computers and other new-age machinery have practically appeared overnight from an historical perspective. This is responsible for the fact that computers and other new-age developments are almost always associated with 'other' and even non-human or alien consciousness. Man has yet to recognise the computer as his own offspring, an extension of his self and consciousness- a vehicle.

HOW AND WHY I COMPILED AN ASTROLOGICAL THESAURUS: SOME IDEAS ABOUT ELEMENTARY ASTRO-SYNTAX AND ASTRO-SEMANTICS WITH SOME SUGGESTIONS FOR COMPUTER INTERPRETATION

by Lee Wayne Holt

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Although astrology, like music and art, may be understood as a language in itself, it is still the astrologer's job to translate astrological symbols into a spoken language. Horosoope interpretation, whatever else it may be, is the translation of astrological symbols into everyday language. This article explores how we translate from the language of the horoscope into English.

After teaching basic astrology for two or three years, I felt the need for a dictionary or thesaurus that students could use to begin horoscope interpretation. None of the keyword books at that time satisfied me. So in 1972, I began to compile an astrological thesaurus. My intention was to collect and classify the basic astrological meanings according to their use by contemporary astrologers. The major sources I used are listed at the end of this article.

In collecting words and phrases for an astrological thesaurus, or for any thesaurus, the primary concern is to select the proper set of connotations for each symbol. 'To connote' means 'to suggest', 'to imply', 'to be synonomous with', 'to mean'. Connotation differs from denotation. In denotation there is a one-to-one-and-only-one relation between the symbol and it's meaning. In connotation there is a one-to-many relation between the symbol and it's many meanings. Astronomically, the symbol 'the Moon' denotes the major satellite of the Earth. Astrologically, 'the Moon' connotes many things. For example, the moon symbol connotes 'motherhood', 'home', 'family', and 'emotions'. The '4th House' and the sign of 'Cancer' connote the same. All astrologers know connotations for each of the astrological symbols. And as an astrologer gains more experience in interpretation, the number of connotations the astrologer knows increases. In fact, all horosoope interpretation is based on connotative thinking.

Poets think the same way. The word 'rose' connotes 'pretty', 'delicate', and the color 'red'; and 'red' in turn connotes 'blood' and 'life'. So a poet can write 'a rose in bloom' and be referring metaphorically to 'a young woman in early adolescence'. The creation of metaphor is possible only because of the innate connotative logic of our minds. But, whereas a poet through connotative thinking is CREATING reality, an astrologer through connotative thinking is trying to DISCOVER reality. The astrologer like the scientist is searching for truth, but he or she must use the techniques of the poet.

Since connotative logic is the basis of astrological thought, the innate vagueness in connotative thinking produces vagueness in astrological thinking. The connotations of any symbol, astrological or English, are without end; they go on forever like a pebble dropped in a pool whose circular waves gradually fade some distance from the dropping point. An astrological symbol resembles the center point where a pebble drops into a pool. The first circle of waves around the dropping point are the first meanings that we associate with the symbol. For example, the first circle of connotation around the Moon symbol would include 'home', 'mother', 'family', and 'emotions'. The first circle around the Gemini symbol would include 'communication', 'transportation', 'perception', and 'environment'.

In any connotation pool, sooner or later, the waves from one symbolic pebble will meet the waves from other symbolic pebbles. This phenomenon, whether in a real pool or a mind pool, multiplies the vagueness and ambiguities of astrological thought. For example, the Moon connotes 'memory', 'imagination', and 'habit'. Mercury by connoting 'basic mentality' also connotes 'memory', 'imagination', and 'environmental conditioning'. In these meanings, the connotative waves of 'the Moon' and 'Mercury' intersect in a Venn diagram [Figure 1.]. So to decrease ambiguities and avoid out-of-context interpretations, we must continuously keep in mind, while interpreting a horoscope, the central meanings from which each set of connotative waves emanates.

On the other hand, a horoscope interpretation requires us to know where the set of connotations for each symbol intersects with each other set. Then, for example, if two planets are in aspect, we know what qualities the aspect relation will emphasize. From our Moon and Mercury example, we know that an aspect between them will connotate 'mentality', 'memory', 'imagination', and 'conditioning'.

As astrologers, we are stuck with the tools of the poet. Until instruments are developed that can measure astrological quantities, we have only our intuition of astrological qualities. Our historical times may devalue intuition in favor of rationality, and the risks of ambiguity in favor of logical order; but there is no reason why intuition, like rationality, cannot develop into a more precise instrument. In fact, the more it develops, the less ambiguous and more rational we become. Horoscope interpretation, like all living, demands both.

In compiling an astrological thesaurus, I tried to rationally order the connotative logic of astrological intuition. My hopes were to increase not only astrological intuition, but to provide a more rational instrument for interpretation.

In collecting words for each connotative set, I was concerned with collecting a sufficient quantity. THE RULERSHIP BOOK by Rex E. Bills supplies this quantity, but it is difficult to appreciate the concepts behind the words. THE RULERSHIP BOOK does not subdivide the astrological symbols into major headings like a ROGET'S ASTROLOGICAL THESAURUS would. An ideal astrological thesaurus would make the primary connotations of a symbol the major headings under that symbol. For example: 'transportation' and 'communication' are primary connotations and thereby major headings under the 3rd House. 'Buses', 'bikes', 'cars', and 'trains' should be listed under 'transportation'. 'Phones', 'radios', and 'TV' should be listed under 'communication'. Not only does this clarify the concepts behind the connotations; but, since we cannot list all the connotations of each symbol, understanding the concepts behind each symbol enables us to generate unlisted connotations. For example: we could add 'elevators', 'pogo sticks', and 'flying saucers' to the 'transportation' list; and 'radar', 'satellites', and 'hand signals' to the 'communication'.

Unexpectedly, connotations for the Sun and the 1st House were the most difficult sets to collect. Because the Sun and the 1st House are the most existential symbols in the horoscope, they require for their connotative sets the most abstract and ontological terms such as 'being', 'create', and 'self'. Almost every word the Sun connotes is a primary connotation of another planet. The almost complete intersection of the Sun connotations with all other planet connotations shows how important the Sun is in horoscope interpretations.

In classifying contemporary meanings of planets, signs, houses and aspects, I tried to avoid ambiguities due to traditional rulership correspondances. For example, traditionally 'Mars in the 9th House' can be interpreted as meaning the same as 'Sagittarius rising'. Although we know the qualities of these two examples are similar by rulership correspondance, experience tells us they have meanings. 'Mars in the 9th House' implies 'projection in philosophy, education, travel, etc.' while 'Sagittarius rising' implies 'an extroverted and exhuberant personality'. However, according to traditional interpretation, 'Mars' connotes 'outward direction and expression'; and by natural rulership, the '1st House cusp' also connotes 'outward direction and expression. Likewise, 'Sagittarius' and 'the 9th House' both connote 'philosophy, education, and travel'. Thus both 'Mars in the 9th House' and 'Sagittarius rising' can be interpreted as 'an outward direction and expression of philosophy, education and travel'.

As another example, many times we have read interpretations of each planet in each sign, and could not determine the fundamental difference from interpretations of each planet in each house. For instance, 'Saturn in Gemini' might be interpeted as 'a communication career' or 'worry about communicating'; but then 'Saturn in the 3rd House' could be interpreted in the same way.

How can we distinguish, let alone teach, these or similar subtle differences? To some of us this situation may not seem a problem until we try to teach astrology basics, and then the ambiguities arising from traditional rulership correspondances become apparent.

To avoid such ambiguities, I drew inspiration from Margaret Hone and Francis Sakoian. As a beginning astrology student, I was influenced by Margaret Hone's and Jeff Mayo's keyword method where sign connotations are translated as adjectives and adverbs, and house connotations are translated as concrete and abstract nouns. For example, 'the 4th House' connotes 'mother', 'home', 'emotions', and 'memory'; while the sign 'Cancer' connotes repectively 'motherly', 'domestic', 'emotinal', and 'retentive'.

The idea for extending astrology symbols to other parts of speech came from an analogy I believe I read, but cannot find now , in one of Francis Sakoian's books. (My apologies to whomever I owe this idea for not taking better notes at the time.) According to this analogy, a horoscope is like a dramatic play: the planets are the actors; the houses are stages, scenes, and acts in a play; the signs describe the actors' costumes and manners, and also describe the set design of each house. The aspects show the dramatic tension among the actors and outline the plot of the play. From this analogy, we can make another metaphorical leap and associate planets (actors) with verbs, house (scenes) with nouns, sign (designs) with adjectives and adverbs, and aspects (plot relations) with conjunctions. So, for example, in a set of connotations under 'Mercury', we would find VERBS like 'write', 'tell', and 'think'; under 'Pisces', ADJECTIVES like 'sympathetic', 'phony', and 'secretive'; under 'the 3rd House', NOUNS like 'letters', 'gossip', and 'bicycles'.

So that adjectives listed under Virgo and Libra and nouns listed under the 6th and 7th Houses would have corresponding verbs, I included in my thesaurus two additional planet lists: one for Ceres to correspond with Virgo, and one for Persephone to correspond with Libra. Whether Persephone, the trans-Plutonian planet, exists is unimportant in this context. What is important is that we distinguish between verbs associated with Libra from verbs associated with Taurus. (Perhaps the newly discovered Chiron will satisfy the roll of Libra rulership; that is, if rulerships continue in the future to be necessary.)

Let us continue to develop our ideas about astrological semantics and syntax. Let us go from parts of speech analogous to astro-symbols to complete sentences analogous to astro-statements. If an astrologer were interpreting a horoscope, what would be the minimum amount of information the astrologer would need before a statement about the horoscope's subject could be made? 'Mercury' would not be information. 'Pisces' would not be information. Every horoscope has mercury or Pisces in it. However 'Mercury in Pisces' does tell us something specific about the horoscopes subject. So does 'Mercury in the 3rd House'. So does 'Pisces in the 3rd House'. Each of these statements combines two members from the three astrological classes of planets, signs, and houses. Each gives specific information. Let us call this basic semantical unit combining two astrological symbols a 'basic astro-statement'.

In the book NOW THAT I'VE CAST IT, WHAT CAN I DO WITH IT?, Maxine Taylor provides basic sentence forms for translating astro-statements into English statements. A list of similar horoscope sentence forms is included at the end of this article. Using the pronoun 'You' as the subject and parts of speech for the planets, signs, and houses, here are some sample sentences: 'Mercury is Pisces' translates, using sentence form #7, into 'You write sympathetically' or 'You communicate secretively'. 'Mercury in the 3rd' translates, using sentence form #5, into 'You write about bicycles' or 'You circulate gossip'. 'Pisces in the 3rd' translates, using

sentence form #2, into 'You are sympathetic in letters' or 'You are secretive in thought'.

From a previous example, 'Sagittarius rising' (i.e. 'Sagittarius in the 1st House') translates, using sentence form #1, into 'Your personality is EXTROVERTED and EXHUBERANT.' While 'Mars in the 9th House' translates, using sentence form #5, into 'You PROJECT through PHILOSOPHY, EDUCATION, and TRAVEL..' thus the usual ambiguities have disappeared.

To a basic astro-statement, we may add a third variable to produce more descriptive, yet still simple (non-compund) English sentences. For example 'Mercury in Pisces in the 3rd' could translate using sentence form #9, into 'You write sympathetic letters' or 'You tell phony gossip'.

The pronoun 'You' would always be the subject of an English translation of an astrological statement if a horoscope could distinguidh between subject and object. However, astrology is philosophically mystical. The fundamental principle of astrology states that the subject and cosmos are inseparable; The whole lies within the part, and vice versa. This attitude is basic mysticism and contrariwise, philosophies of freedom and determinism, and of cause and effect, assume a separation between actor and object. But if there is no separation, then the subject of any horoscope cannot be said to act upon his/her/its environment, nor vice versa.

On the other hand, the English language, like most European languages, does presuppose cause and effect, creator and creation, subject and object. So to translate from a non-subject-object to a subject-object language such as English, we must keep in mind that the subject 'You' of an English sentence is always interchangable with its object. For example, horoscope interpretation cannot distinguish between 'You write sympathetic letters' and 'Sympathetic letters are written to you'. Or 'You circulate phony gossip' and 'phony gossip circulates about you'.

The interchangeability of subject and object in astrology can lead to nonsense in English. For example: 'Mercury in Pisces in the 3rd' may be translated using sentence form #8 into 'You secretively think about bicycles' which makes sense in English.

Can this last statement possibly make sense even astrologically? If there is no separation between subject and object, then a subject would not distinguish between the Self and environment. Both astrologers and psychotics assume the unity of self and world; In a psychotic's world, as well as the mystic's, bicycles may indeed think of you secretively. The semantics and syntax of astrology could easily tell us more about the logic of paranoia and psychosis.

Another limitation to astrological translation is that nothing in the horoscope is analogous to a preposition. So in sentence forms 2, 4, 5, 6, 8, 9, 12 and 13, when the planet-verb between the subject and the house-noun is intransitive, the preposition is free to float; 'before' will make as much sense as 'under'. 'You think secretively ABOUT bicycles' astrologically equals 'You think secretively ON bicycles'. Unlike English prepositions, the horoscope cannot show simple relations of space and time. Once again because in a indistinguishable universe, there are no such spatial and temporal separations.

If transits are not considered, forms of the verb 'to be' such as 'is', 'was' and 'will be' are equally interchangeable. The horoscope shows us the seeds of possibility. Transits and non-astrological factors, if there are any, determine how much a horoscope can reveal.

Another even more limiting factor to horoscope translation is the subtlety of aspect relations. The English language cannot express this subtlety adequately. English conjunctions such as 'and', 'but', and 'or' are the closest that English can come to astrological 'conjunctions', 'squares', 'oppositions', etc. English is not structured broadly enough to absorb the wide variety of meaning in planetary aspects. Roughly translated, a planetary aspect combines two simple astro-statements into a compound astro-statement. This is analogous to an English conjunction combining two simple sentences into a compound sentence. However, after relating the astrological 'conjunction' to 'and', the 'square' to 'but', the 'opposition' to 'or', the 'trine' to 'if' , and the 'sextile' to 'so', the other innumerable aspects such as the quintile, semi-square, quincunx, and novile become difficult, if not impossible relations to translate. A list of aspects and their translation into English conjunctions is attempted in a list at the end of the article.

While compiling my astrological thesaurus, it dawned on me how a computer might learn the basics of astrological interpretation "from scratch". Each astrological symbol would label a memory bank of primary connotations. Stored under each primary connotation, would be a memory bank of specific connotations. As in an example already given, 'The 3rd House' would label a group of primary connotations such as 'perception', 'environment', 'communication', and 'transportation'. Under 'transportation', 'cars', 'buses', 'bicycles', etc. would be listed. The computer could be programmed with a basic syntax like the twenty horoscope sentence forms included at the end of this article. Given a specific horoscope, the computer could be programmed to randomly select connotations for each simple astro-statement. And also randomly select sentence forms from it's syntactical memory. The computer could be limited to a sample of say six English statements per astro-statement. This would include six statements for each of the traditional ten planets. Without this limitation, each simple astro-statement could generate thousands of English sentences.

The samples of six English sentences for each astro-statement could then be randomly compounded according to aspect relations. For example, the compound astro-statement 'Mars in Pisces in the 8th House conjunct Uranus in the 8th House' might be translated as '(Your SEXUALITY PROJECTS SEDUCTIVELY) WHILE SIMULTANEOUSLY (MASS HYSTERIA NARCOTICALLY FIXATES ON YOU).' Or '(you DEMAND that SHARED FEELINGS be SPIRITUAL) AND LIKEWISE (you DIVINELY TRANSCEND DEATH))'.

After a sufficient sample of simple and compound sentences have been generated, we might be satisfied with the computer's analysis and proceed to sythesize the inforformation ourselves. That is, we could make judgements as to what were the most outstanding traits revealed in the analysis. Or we could program the computer to do horoscope judgements by arranging previously generated sentences in their order of importance. The criteria for such an order may be adapted from the writings of Jones and Rudhyar. Their "focal determinators" are perhaps the contemporary criteria for judging horoscope variables. At the end of this article, you will find a list entitled HIERARCHY IN HOROSCOPE JUDGEMENT. From what I could determine by general survey, imbedded in this list is not only Jone's and Rudhyar's criteria for horoscope judgement, but also the criteria which most contemporary astrologers agree are the most important in horoscope judgement. Although this is not meant to be the last list of this sort, some such list as this is necessary to program a computer to select the most important statements from among the multitudes it could generate. Some astrological Nicaean convention may meet in the near future to decide upon just such criteria.

As a final big step in horoscope synthesis, all astrologers look among important and less important astro-statements to discover thematic repetition. For example: 'Sun in Gemini', 'Moon in the 3rd House', and 'an angular Mercury' are repetitions of the mercury theme. These three astro-statements all have similar qualities according to traditional rulership correspondances. A computer programmed to search for repetition of rulership correspondances among important astro-statements in a horoscope could predict the outstanding traits of the horoscope's subject.

Mathematically, traditional rulership correspondances are an attempt to match the qualities of an astrological symbol in one class, say a planet, with the qualities of a symbol in another class, say a house. Rulership matching is not always in practice one-to-one. For example, the Sun, natural ruler of the 5th House, seems to have as much if not more, in common with the 1st House. To compensate for this imperfection in the rulership system, we say that the Sun is naturally exalted in the 1st House as well as in Aries. Imperfections like this is why we still feel the need for a system of exaltations and detriments. It would be best, however, to learn, and teach the computer in turn, how to discover similar qualities between ANY two symbols, astro-statements, or other horoscope variables; that is the same as learning where each set of connotations intersects with every other. For example, the connotations of Saturn and Pisces have 'guilt', 'humility', and 'isolation' in common. If an astrologer or computer could detect this intersection of qualities, he/she/it could more accurately detect the outstanding themes of a specific horoscope.

The method described above for generating compound sentences from aspect relations applies also to interpreting transits. For example 'Uranus in Leo in the 1st House TRANSITING OPPOSITE Jupiter in Aquarius in the 7th House could be translated as '(your SELF REBELS DRAMATICALLY) CONTRARIWISE (VOYEURISTIC OTHERS ENJOY YOU)'. Simplyfying: ' You rebel

dramatically against voyeurs enjoying you.' Some other translations ' EITHER (you transcend your radiant personality) OR (others heartlessly exploit you).' '(you grandiosely escape from your self) WHILE ON THE OTHER HAND (you delight in an intellectually detatched marriage.)' Simplyfying: ' your grandiose escape from your self goes against your delight in an intellectually detatched marriage.' These conditions prevailed in Marilyn Monroe's horoscope a year to two months before her death on August 5th, 1962.

Conclusion:

The following is a list of previously discussed necessary software to program a computer for horoscope interpretation.

(1) Store a set of connotations for each astrological symbol. (Connotation Memory)
(2) Store specific and secondary connotations under primary connotations within each set. (Partitions of Connotation Memory)
(3) Store transitive and intransitive verbs under planets, nouns under houses, and adjectives under signs. (Included in original partitioning of connotation memory)
(4) Program to add the suffix 'ly' onto an adjective to produce an adverb when needed. (Adverb Program)
(5) Store simple sentence forms with holes for variable planets, houses, and signs. (Sentence memory)
(6) Store a set of prepositions for sentence forms requiring intransitive verbs. (Preposition memory)
(7) Store the set of conjugations for the verb 'to be' for sentence forms requiring a verb. (Conjugation Memory)
(8) Store a set of conjunctions for each major aspect. (Conjunction Memory)
(9) Provide a random number generator to select sample words and sentence forms. (Random Number Program)
(10) Program rules for ordering randomly generated sentences according to importance. (Judgement Program)
(11) Program to emphasize the common connotations of the subset formed by the intersection of two or more connotative sets. (Theme Program)
(12) Program to compound two simple astro-statements into a compound astrostatement. (Aspect and Transit Program) (This may be the most difficult program with which to obtain satisfactory results due to the subtleties of aspect interpretation. As an alternated program, we could translate planets into nouns and aspects into verbs according to rulership correspondances. Thus 'Saturn square the Moon' could translate as 'Reality obstructs the Emotions' or 'Practicality perfects the Soul'.)

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HOROSCOPE SENTENCE FORMS

1. Your (house-noun) is/are (sign-adjective).
2. You are (sign-adjective) (preposition) (house-noun).
3. You are a(n) (sign-adjective) (house-noun).
4. (House-noun) is/are (sign-adjective) (preposition) you.

5. You (planet-verb) (preposition here if verb intransitive) (house-nouns).
6. (House-nouns) (planet-verb) (preposition here if verb intransitive) you.

7. You (planet-verb) (sign-adverbs).

8. You (sign-adverb) (planet-verb) (preposition here if verb intransitive) (house-noun).
9. You (planet-verb) (preposition here if verb intransitive) (sign-adjective) (house-noun)
10. You (planet-verb) that (house-noun) is/are/be (sign-adjective).

11. Your (house-noun) (planet-verb) (sign-adverb).
12. (House-noun) (sign-adverb) (planet-verb) (preposition here if verb intransitive) you.
13. (Sign-adjective) (house-noun) (planet-verb) (preposition here if verb intransitive) you.
14. (House-noun) (planet-verb) that you are/be (sign-adjective).

15. (Planet role-noun) (planet aspect-verb) (planet role-noun).
16. (Planet house-noun) (planet aspect-verb) (planet house-noun).

17. Your actions occupy the area of (house or quadrant-nouns).
18. Your actions avoid the area of (quadrant-nouns).
19. You are (sign, element, or mode-adjectives).
20. You are not (element or mode-adjectives).

PREPOSITIONS

Simple Prepositions: at, but, by, down, ere, for, forth, from, in, like, of, off, on, out, over, per, save, through, till, to, up, via, with.
Compound Prepositions: abaft, aboard, about, above, across, adown, after, against, aloft, along, amid, amidst, among, amongst, anent, around, aslant, athwart, before, behind, below, beneath, beside, besides, between, betwixt, beyond, despite, except, inside, into, onto, outside, since, throughout, toward, towards, under, underneath, until, unto, upon, withal, within, without.
Participal Prepositions: barring, bating, concerning, considering, during, excepting, notwithstanding, past, pending, regarding, respecting, saving, touching.

FORMS OF THE VERB 'TO BE'

am, are, is, was, were, be, being, been, have been, could have been, can be, will be, would be, may be, shall be, must be.

ASPECTS

Aspect's Name, Symbol, Orb, and Type	Conjunctions and Connective Phrases	Principle of Relationship	You Must...	... the actions of the 2 planet or ELSE the 2 planets...
CONJUNCTION ☌ 0° Orb ± 6° weak 7-9° Hard or Soft	and, also, likewise, where, iff and only if; both-and, while simultaneously.	will, concentration, simultaneity, activation.	(Sun verbs) integrate and unify, generate, initiate, and procreate from.	stumble and fumble, stagnate.
SEXTILE ⚹ 60° Orb ± 6° Soft	so, provided, for, because, as-so; while supportively, helpfully and harmoniously.	storage of potentials and talents, support, help, harmony.	(Venus verbs) use, produce with.	remain dormant, inert, and wasted.
SQUARE □ 90° Orb ± 6° weak 7-9° Hard	but, yet, though, however, although, nevertheless; crosswise, while conflictingly.	problems, crises, conflicts, brakes and friction, motor, engine, dynamo.	(Saturn & Mars verbs) discipline, organize, construct with, perfect, activate, externalize.	challenge and battle each other, obstruct inhibit, endure struggle internally.
TRINE △ 120° Orb ± 6° weak 7-9° Soft	if, thus, furthermore, moreover, henceforth, if-then, when-then; consequently.	fluency, acceleration, increase, openness of actions.	(Jupiter verbs) create with, grow socially and mentally through.	go to waste, over-indulge, dissipate, run around in circles.
INCONJUNCT ⚻ 150° Orb ± 3° Hard and Soft	but so, yet whereby; while impersonally, while adjustably, while objectively.	depersonalization social obligations.	(Ceres & Pluto verbs) adjust, polish, correct, objectify, depersonalize, serve, evolve, rework, develop.	malfunction, degenerate, sicken, die.
OPPOSITION ☍ 180° Orb ± 6° weak 7-9° Hard	or, else, unless, otherwise, contrariwise, either-or, neither-nor; while on the other hand, while reactively.	reaction, reflection, awareness, opposition, polarization, confrontation.	(Persephone & Moon verbs) balance, equalize, compromise, complement, reflect upon, objectify.	seesaw, counter, contradict, tug, block, stop, and pull against each other, oppose.

HIERARCHY IN HOROSCOPE JUDGMENT

Statements about:

1. The Sun ☉ — The Sun is the central character in the horoscope drama; and, therefore, is first in importance.
2. The Moon ☽ — The Moon is the main supporting player in the horoscope drama; and, therefore, is almost as important as the Sun.
3. The Ascendent A — The Ascendent is the first scene of the horoscope drama; and, therefore, is more important than any other scene.
4. Rising Planet(s) — A Rising Planet is always the first actor to appear in a horoscope play; and, therefore, is the actor of first importance after the Sun and Moon.
5. Other Angular Planets — Because the four angles (1st, 10th, 7th, and 4th House Cusps) are the key scenes in the horoscope drama, any planet located near an angle becomes a featured player.
6. Hard Major Aspects to the Sun and Moon ☌ □ ☍ — Because the Sun and the Moon are the stars of the horoscope drama, their conflicts with other players comprise the main plot.
7. Hard Major Aspects to Mercury, Venus, and Mars ☌ □ ☍ — Because Mercury, Venus, and Mars are closer to the Sun and Moon than the outer planets, their conflicts amongst themselves and with the other players comprise the horoscope's main sub-plot.
8. Preponderance by Quadrant, House, Sign, Element, or Mode — If the majority of planets act in a particular Quadrant, House, Sign, Element, or Mode; then that area is emphasized.
9. Negative Preponderance by Quadrant, Element, or Mode — If no planets act in a particular Quadrant, Element, or Mode, then that area is de-emphasized, overcompensated for, or unimportant.
10. Preponderance by Element or Mode if Sun, Moon, and Ascendent all in the same Element or Mode — If the Sun, Moon, and Ascendent are all in the same Element or Mode, then that Element or Mode is emphasized.
11. Heaviest and Hardest Aspected Planet — The planet aspected most and hardest is the villain- the central antagonist inciting the major dramatic conflicts. If a planet receives soft aspects only, then it releases, creatively or wastefully, the unresolved tensions amongst the other planet-actors. Our hero!

From ROGER ELLIOT in England

In a famous phrase, an English politician noted for his calm, logical judgment was once derided as a 'desiccated calculating machine'. Today, thirty years later, calculating machines and their bright offspring, computers, are still considered metaphors of abuse. They are seen as faceless creatures, the bureaucrats of our totalitarian world: tedious, blindly obedient, profoundly anti-human.

All of us in astro-computing know the disdain with which we are often treated by other astrologers. How ingenious, how practical! they exclaim, leaving unspoken their central inner conviction that we are somehow cheapening the subtle art of astrology - turning a poem, so to speak, into a series of tabulated statements.

I'm speaking here not about the preparation of astro-data, which our intuitive friends are only too happy to have delivered effortlessly to the portals of their mind, but about these dreadful computerised horoscope interpretations springing up everywhere.

And in truth, the efforts to date have not been nearly as good as the personally written report of a moderately able astrologer. But the fault lies in the programming, not the machines themselves. With a much more subtle use of computer language, we should be able to reproduce the structured ideas of a human astrologer.

Let's look at the various ascending levels of complexity capable of being reached by both human and machine:

1. When first learning astrology, the student analyses the horoscope into large chunks of unrelated ideas. Back in Edwardian days, the English astrologer Alan Leo produced a beginner's book with numbered paragraphs where you could look up Sun in Cancer, Moon in Scorpio, and so on. This is the level at which most astrological interpretations function, with no synthesis at all. In The Key To Your Own Nativity, Alan Leo did at least include two sections where a marriage of concepts too place: comparing first of all the Modes of the Sun and Moon, and then the actual sign-positions.

2. Later on, the apprentice astrologer learns how to marry a good many concepts together. He puts these concepts into hierarchies of importance and then classifies them into appropriate groups. Mercury is less important than the Sun, for instance, unless Mercury is rising; and Mercury in Capricorn is similar to Saturn in Gemini. The astrologer may not consciously realise what he is doing; but in a rough-and-ready way he is echoing the more laboured techniques of planetary weighing, cosmo-psychograms etc practised by his more conscientious colleagues.

A process of structured synthesis is taking place. Having ripped the horoscope to pieces, in other words, the astrologer is putting it meaningfully together again.

To undertake this process, the computer must be able (a) to stitch concepts together, which is easy enough, and (b) which is much harder, to have the language to describe these multiple concepts.

Up to now, the system of storing words in a computer memory has been simple. There has been a Moon-in-Scorpio pigeonhole where the appropriate paragraph is kept. Now it would be possible to use the same database for more complex interpretations, provided the computer had a vastly larger memory storage and the programmer a vastly longer time-span to write the millions of words needed. To fill one page with a Sun-sign interpretation, and another with a Moon-sign one, requires a total storage of only 24 pages. But to fill the same two pages with a Sun-Moon interpretation needs a storage of 2 x 12 x 12 = 288 pages.

Even that takes care of only two astrological factors. Throw in a third, the Ascendant, and the sum grows geometrically to 3 x 12 x 12 x 12 = well, you need a computer to work it out.

So a more efficient database is needed - one which utilises the computer's ability to think rather than simply retrieve information.

Let's eavesdrop on the inner consciousness of our moderately able astrologer as he confronts a horoscope. 'Hm, Mercury rising in Gemini, so a strong extrovert outer personality. But Sun in Cancer and Capricorn Moon suggest a much more reserved inner character. Stresses the dual nature of this chap. On one hand, Cancer-Capricorn is conservative, family-minded; on other, Merc rising and Venus-Uranus conjunction is lively, unconventional, keen on variety. So tricky in some ways, solid in others. What shall I call him? How about the family con-man? Or the home-loving clown?''

And so he might continue, gradually slotting most of the astrological factors into two, three or four main pigeonholes and developing, early on, a kind of nickname or label that characterises the chart as a whole. Such names might be 'melancholic scientist', 'child bride', 'Mack the Knive'. Instantly, I'm sure you are guessing in your own minds what 'Mack' has got going in Scorpio and Capricorn, and what Pluto is doing, and where Mars is!

So the first task of the computer is to judge the weight and significance of the astrological factors and decide on the nickname of the horoscope. There might be 50, 100 or 200 such monickers, depending on the range of computer power available. They would be the end-product of judging how factors inter-react. Pisces and Leo together edge towards Child Bride; Pisces and Capricorn towards 'safe but sorry'; Leo and Capricorn towards King Of The Castle.

The next task is ensuring that every interpretation printed does in some way refer to the nickname. The inefficient way would be to have a separately written paragraph for Mercury in Scorpio for Child Bride, Mercury in Scorpio for Sad Scientist, etc. A cleverer technique is to structure the whole report in such a way that the computer can insert a Child Bride sentence into a Mercury-in-Scorpio paragraph to make the eventual paragraph seem naturally written. And an even cleverer way is to insert parts of sentences into other parts so that the whole report is made up of tiny fragments that have never been assembled in such a way before.

If this sounds bitty and horribly bionic, then I disagree. For this is what sentence structure is about - stitching fragments of ideas together to create a composite whole.

A simple sentence is made of subject-verb-adverb. Translated to an astrological setting, this means that subject = one's personality (or special aspect of one's psyche: eg, sex drive); verb = a planet, say; and adverb = Zodiac sign. Thus 'your libido surges back and forth' could correspond to Mars in Gemini; and this technique of 'keywords' is frequently used in teaching astrology to students.

Now let's look at a more complex sentence, such as 'Although..., you still...." This implies a contrast, a a balancing of opposing factors, with one factor (the main sentence) still more weighty than the other (the subordinate clause). This sentence structure could correspond to a horoscope interpretation balancing Mars in Gemini (subordinate) with Sun-Moon in Cancer-Capricorn (main sentence).

Another structure might be "If,,.., then,,,,.", corresponding with 'If you allow one factor to have the upper hand, then another part of your psyche will be hurt/repressed/sublimated.' Other structures are 'On the one hand...and on the other', 'What's more,...", "Not only....but also" and individual words such as 'however', 'moreover', nonetheless', each of which either reinforces or contrasts an earlier statement.

These can be put together thus: "Although you have Venus-conj-Uranus, you still remain a Sun-Cancer person; moreover, Moon Capricorn reinforces the homely, shy side of your nature. On the other hand, Jupiter on the Midheaven ... '

The factors of a horoscope, in other words, form a definite language. Planets are verbs; houses objects; oppositions and squares are modifiers, trines and sextiles reinforcers. The active mood is signified by Air and Fire; the passive by Fire and Water. The natal chart is the past tense; progressions and transits the future.

At present I'm working on a character assessment program that incorporates this kind of data-base structure. It will try to mirror the kind of report I would write personally for a client. But to do so properly, we would have to reach the further level of complexity.

3. In a face-to-face consultation, the astrologer inter-acts with his client, having a conversation rather than delivering a monologue. Such a dialogue can be reproduced by a client-machine relationship, either through a keyboard, telephone dial or voice. The client could sit at a video unit, writing questions and receiving written answers. Or, as with the English Prestel system now in operation, he could dial the computer and, once connected, have displayed a range of options (0-9) on his TV screen. Each option leads to a further ten sub-options; then a further ten sub-sub-options; and so on. Although this system is mainly financially based at the moment, it could apply to astrology: a modern version of the Delphic oracle, with one question being answered by another.

This kind of interaction with client is possible at quite a simple level. By writing Mr or Mrs on the application form, the client is already giving the computer an important aid to classifying this person. Ask him or her their work, the state of their love life, the size of their bank balance and the computer can reply in a much more specific way.

There's a further refinement which will be much more difficult to computerise. This is strategy. A player of a game like backgammon needs to know the rules, of course; but he must also develop a style of play that can vary according to the state of the game. This kind of judgment, based on experience, is much harder to translate into a series of commands that the computer will understand.

The astute astrologer face to face with his client develops a strategy of interview and comment. He decides when to change the subject, how to raise a tricky point, whether it's wise to mention such-and-such, etc. Even in a written report, the astrologer is making judgments about literary style and content on the basis of the client's letter to him. He might write differently to a teenager than a mature adult. Or he might pick straight away on one crucial question rather than give a general reading.

Even this is not impossible for the computer to tackle, given a little help from the keyboard operator. The operator can pick one of three or four literary styles: jolly, businesslike, sympathetic and way out, man. He can key-in the strategy of the report to be printed: concentrate on the adultery, ignore the hypochrondria, easy on the mayonnaise.

My own belief is that, in five years' time, we could have a situation where a client in New York could dial through to my computer terminal in Somerset, England, key-in birth details plus a series of questions, and receive back on her TV screen a written report on her problems that would be as good as, if not better than, the personally typed, laboriously thought-out efforts of your moderately able astrologer at present.

MATRIX

MATRIX MAGAZINE
1041 N. Main St.
Ann Arbor, MI 48104
(313) 663-6677

COMPUTER SYSTEMS FROM MATRIX

You can buy your Commodore or APPLE computer system directly from MATRIX. We are an authorized Commodore dealer and have APPLE equipment as well. Here are a few reasons why you might want to do business with us as opposed to local stores.

(1) You know who we are and what we stand for. John Townley called recently to tell me that when he took his APPLE II computer back to the store where he bought it for some adjustments, they acted like they didn't even know him. The computer business is a fast-moving and competitive market. We will be there when you need us to make those extra calls and see to it that you get the service you need. I have found that I can get my Commodore customers almost instant service from local repair centers by making a call to Commodore if the local repair center seems reluctant to do warranty work. Here at MATRIX, we have learned that you have to go to bat for your customers. We do just that.
(2) FREE SOFTWARE with a hardware purchase. We do not discount prices, but we don offer free astrological software with each purchase. Buy your machine from us and get a Natal Package as a bonus...or any other program of your choice. The larger the system you purchase, the more free programs you get. Simple enough?
(3)GOOD SERVICE. We have a complete service center here in Ann Arbor for PET and APPLE computer components. If you can't get just what you want done locally, you can UPS it here and I will see to it that you get the finest attention. I am glad to be there when you have questions about your new machine too. Just give me a call.
(4) WE HAVE EXPERIENCE. We have been running these home computers since they first appeared in 1977. We have expanded versions of the PET, APPLE II and TRS-80, complete with floppy disks, modems and line printers. Better yet we have written many of the astrological programs now available for these machines.

Last, but not least, we could use your business! We are trying to grow as a company and are sharing many of the benefits of our growth with readers thru MATRIX Magazine, new programs and various research projects. Right now we are working to make the Neely Vol. XII planet positions for ancient dates available to all. We are astrologers and could use your support.

OUR FULL CATALOG

Our FULL CATALOG is growing everyday. Here is the place to read about varius computer systems, check out the specifications and look at illustrations. Our fall catalog has screen or line-printer output samples for most of our programs. Here is a chance to read about each MATRIX program in detail and to look at a picture of what these programs output to the video screen or line printer. We cannot afford to give these catalogs away but you may deduct their $3.00 cost from your next software order. The FULL SOFTWARE CATALOG is $3.00 ($4.00 FIRSTCLASS) and can be ordered now from MATRIX.

We have dozens of programs for the Commodore PET, APPLE II and TRS-80 computer systems written by some of the world's finest astrological programmers. There is not room in this ad to describe them. Send for our free Software Flyer for a list of the most popular programs.

ASTROLOGICAL PROGRAMMING MANUAL
by Michael Erlewine

Our new BASIC programming manual is finished and at the printers. We have been promised copies by early November. The book is 8 1/2 x 11 and is 220 pages long. It is designed for the beginning programmer with no previous programming experience. However, it also contains an extended section of astrological programs and subroutines of value to the advanced student. Worked examples with intermediate variable listings make the book easy to trouble-shoot. The book is available thru MATRIX for $12.50 POSTPAID

1980 CIRCLE ASTROLOGICAL CALENDAR

This is our 12th year! Our 1980 calendar has complete geocentric and heliocentric ephemerides, Michelsen Aspectarian and many other valuable features. This year's cover is a full color photo of the Earth as taken from the moon. The calendar is put together by Michael, Margaret and Stephen Erlewine. 1980 CIRCLE BOOKS CALENDAR is $3.50 POSTPAID



1979 Summer-Fall

Issue VI

MATRIX MAGAZINE

	1	ACT: ASTROLOGICAL CONFERENCE ON TECHNIQUES
Editors	2	COMPUTER NEWS AND UPDATE
James Neely	6	THE CARPENTER EQUATIONS
Tom P. Santiago	24	ASTRO-COMPUTING IN SOUTH AMERICA
Editors	26	A VISIT WITH NEIL MICHELSEN
David B. Black	28	TECHNICAL PROBLEMS IN SPIRITUAL ASTRONOMY
Buz Overbeck	47	CONVERSATIONAL MATH: BEGINNER'S COLUMN
James Neely	52	ACCURACY IN PLANETARY COMPUTATIONS
David W. Wilson	54	GRAPHIC PLOT ROUTINE
James Neely	55	THE ABERRATION CORRECTION
Robert Hand	57	ASTROGRAPHICS: A NEW SERVICE
	59	LETTERS AND MORE

inside front cover THE 1979 JOHNDRO AWARD

Editors: Michael & Margaret Erlewine

1041 North Main Street ✧ Ann Arbor, Michigan 48104

THE 1979 JOHNDRO AWARD
to

CHARLES A. JAYNE

Commencing in 1978 the Johndro Award for excellence in the technical aspects of Cosmecology is being given to those who have distinguished themselves through some major contribution. Dr. Harlan T. Stetson of M.I.T coined the term COSMECOLOGY many years ago as the study of the Earth's adaptation to its cosmic environment. While this embraces the ancient science of Astrology, it also includes a number of other sciences. The award is named after the famous American Radio Engineer, Mathematician and Astrologer, L. Edward Johndro.

Charles Jayne is the father of modern technical astrology. To my knowledge, no other modern astrologer has labored so persistantly to bring to the attention of the average astrologer the need for a firm grounding in the astronomy and mathematics of astrology. Jayne has been writing highly technical articles and books for the last 40 years. He has been the common denominator linking dozens of research and technical astrologers together. He has been inspirational in establishing many research and communication efforts including the ASTROLOGIC RESEARCH SOCIETY, ASSOCIATION for RESEARCH in COSMECOLOGY (ARC), NCGR, MATRIX Magazine and the newly formed ACT conference. Jayne has been active as an editor and author of publications such as IN SEARCH and COSMECOLOGY BULLETIN plus dozens of books and articles on the technical aspects of astrology.

Charles Jayne is more than an historian or caretaker of these techniques. He practices and uses them. Jayne is a keen student of the entire esoteric tradition and the spiritual heritage of astrology is every bit as important to him as are the technical concerns. Thanks Charles!

- Michael Erlewine

JOURNAL OF GEOCOSMIC RESEARCH -Robert Hand
MATRIX MAGAZINE - Michael & Margaret Erlewine
PHENOMENA -Malcolm Dean
SIRIUS -David Cochrane
MUTABLE DILEMMA -Zip Dobyns

The First ACT

ASTROLOGICAL CONFERENCE ON TECHNIQUES

The first ASTROLOGICAL CONFERENCE ON TECHNIQUES (ACT) will be held in August of 1980 at the AFA convention. As many of you know we have been trying to put this conference together for the last year and a half. Bob Cooper, president of the AFA, has been kind enough to allow us to have our conference along with the AFA's convention next summer. The ACT technical conference will be held at the same time and place as the AFA's convention but will be independently organized.

The ACT conference is non-denomenational in that it will not be sponsored by any single astrological organization. At this point your editor plus Charles Jayne from ARC (Association for Research in Cosmecology) and Robert Hand representing NCGR are working on the general format of the conference. Charles Jayne will spend several days here in Ann Arbor during October and one of the main projects we will tackle will be the schedule of workshops and forums for this conference.

The main purpose of such a conference is to bring together technically oriented astrologers from all over the world. The goals of such a conference will be at least twofold. One goal will be to offer much needed workshops on the technical aspects of astrology. These would include beginning and advanced programming techniques for calculators and computers plus seminars on computer equipment and it's use for astrological practice and research. Beginning and advanced instruction on statistical and research techniques would also be offered. Workshops and forums on major astrological techniques such as Harmonics, Uranian, Cosmobiology and so on would be available.

The second and most important goal of the conference would be to bring many of the leading research and technical astrologers together with an interested and informed audience for a series of open forums and discussions. It is important that we gain some kind of consensus about the kinds of astrological research, what is being done, who is doing it, what should be done and where do we go from here, etc. This could be facilitated by a number of panel discussions with audience participation.

The advantages of holding such a conference at the AFA convention should be obvious. The AFA convention is sure to be well attended. We will not have to worry about finding funds (we dont have) to sponsor such a conference. A large number of non-technical astrologers will be exposed to all of us crazy technicians..with possible beneficial effect.

The AFA does not pay any of it's speakers nor can we. Each of us will have to get to New Orleans under our own steam. In my own case, it will mean a sacrifice in terms of getting that much cash together. I feel it is important that we all make an effort to be there. Bob Cooper has promised us some relief. Invited speakers will have the opportunity to share facilities at a reduced rate. I have set up a fund here in Ann Arbor to aid speakers who cannot afford to attend to be there. Bob Cooper, myself and several other astrologers have pledged a contribution to this relief fund. Any of you willing to help in this regard are welcome to contribute. Please send funds to the MATRIX address for the ACT SPEAKER FUND. Any contribution will be greatly appreciated and Charles Jayne, Robert Hand and myself will decide on the allocation of the monies.

I dont need to tell MATRIX readers that we are having a technical breakthru in astrology at this time. There is much confusion, even among researchers, as to what constitutes valid research..or even what research is. Jayne, Hand and myself have been trying to pull such a conference together for some time now. We plan to work very hard until next summer to see that the conference is a complete success. We need your support if it is going to happen. We need help to advertise the conference. MATRIX, Jayne's COSMECOLOGY BULLETIN, Cochrane's SIRIUS, Dean's PHENOMENA have pledged support. Noel Tyl has offered his support through ASTROLOGY NOW and Robert Hand through NCGR facilities.

Many of you will be asked to participate as speakers. Others of you may wish to lead a workshop or participate in a panel discussion. Let me know if you feel that you could lead a workshop. PLEASE take the time to consider what you would like to see happen at such a conference. Send your suggestions to MATRIX as soon as possible. Please help us to shape and build this conference into a significant event. We need the help of MATRIX readers in this regard, so please show us your support by writing a letter to us with ideas and suggestions as to what you feel would be worthwhile to cover at such a conference, what speakers you would like to see there and so on. Let me know if you feel such a conference would be worthwhile. How about some response from our readers on this subject?

On the personal side, we can look forward to meeting other MATRIX readers in person and sharing some time together. I will be there with as many computers as I can cart to New Orleans. Let's all be there!

- Michael Erlewine
Editor

NEW PROGRAMMABLES

Both Hewlett-Packard and Texas Instruments have new programmable calculators. The Hewlett-Packard HP41C is already available while the TI machine is still in the works. These are 'next generation' machines.

THE HEWLETT-PACKARD HP41C

The HP41C is designed as the main center for a small calculator system. A variety of peripherals are available to fit the machine that include an alphanumeric printer, magnetic card reader and additional memory modules. While the basic HP41C retails at $289.95, the calculator, card reader, printer and memory will cost you a total of $959.65. The minimum configuration of interest to astrologers would include the calculator, card reader and three memory modules. Price: $589.75

The HP41C has a less cluttered keyboard than the earlier HP machines like the HP-67/97. Like the TI-59, the HP41C can trade off program steps against memory registers. The HP41C may have up to 2223 program steps when fully configurated with memory modules but comes stock with 400 lines or 63 data-storage registers. Memory allocation, in terms of register/keystep/programmable keys, is even more complicated than with earlier calculators and approaches the core memory concept found in the microcomputers.

The HP41C has continuous memory and a battery life of about nine months! The many new features of the HP41C would require an article to do them justice (any takers?). We have room here to mention only some highlights.

(1) The portable thermal-printer provides hard-copy records of calculations, high-resolution plots and complete alphanumeric output. (2) programs may be given English names and called up by names. (3) 16 plug in application modules with 4000 steps each are available from HP. (4) The plug-in card reader will also read HP-67/97 magnetic cards. (5) An optical wand will be made available that reads and enters programs or data from printed bar codes. (6)Constants take up only one step of program code rather than the step-for-each-digit of the earlier HPs.

The HP41C is from 50% to 350% faster than the HP-67 depending upon what kind of task is being performed. The user may re-assign the keys on the calculator to produce a custom-tailored keyboard. The HP41C is priced at $289.95, the printer at $329.95, the card reader at $179.95 and the memory modules at $39.95.

NEW TI PROGRAMMABLE

Here is a note from MATRIX reader Joe Gannon. "I still feel the TI-59, at its price, is a worthwhile backup to a main system. The software available (usually with some creative customizing on one's own part) is also cost justifiable. But we are obvipusly talking Chevy (TI) vs. BMW (HP). The new TI will have 1920 steps/240 registers or any combination thereof (it is my understanding they are simply piggybacking two TI-59 chips). But the good news is that it will have continuous memory. Also besides the presently available modules there will be a user programmable module of continuous memory with about 3000 steps(if you REMOVE the module you will lose the programming, otherwise it will be continuous memory). For means of comparison the new TI would have 4000 steps continuous and 100 registers, utilizing the programmable module. The HP41C with printer can only utilize 3 memory modules and would give 1000 steps continuous and 100 registers for twice the price (or maybe even more). The HP has keyboard alpha, addressable alpha, and several other really neat features. (alpha on the TI, as you well know, is a bitch and there are no plans to change it). But I certainly cannot cost justify the HP41C whereas I can the TI."

So, once again we have HP vs TI at the next plateau. HP offers a deluxe machine with super documentation at a high price while TI offer more memory, fair workmanship and average to poor documentation for a much lower price. James Neely will support the HP41C with a series of astrological programs. To my mind, with the price of these new calculator systems approaching that of a micro system, the chief advantage to owning one would be for the astrologer who travels a lot. It is easy to stick a programmable in a suitcase but try getting an APPLE, PET or TRS into one! For most uses, the inexpensive home micro system is by far the more powerful machine and better investment.

NOEL TYL FIGURES IN TELECOMPUTING NETWORK

Telecomputing Corporation of America (TCA) announced at NCC's Personal Computing Conference the opening of its SOURCE telecomputing network, the first nationwide information utility designed expressly for use by the general public. The SOURCE is available, via local telephone call, in over 200 cities across the United States at a cost of $2.75 per hour between 6:00 p.m. and 7:00 a.m. (local time); all day weekends and holidays.

The SOURCE provides over 2,000 programs and data bases, ranging from old favorites such as STARTREK and ADVENTURE, to United Press International's entire daily file of world, regional and local news, sports and financial information as well as a major subset of the New York Times Information Bank. Airline schedules and the ability to make travel reservations and order tickets are also included. Real Estate can be bought and sold through the SOURCE. A large number of sophisticated business application packages, including payroll, accounts receivable and general leger systems are also available. Users can take a course in wine appreciation, prepare their income tax returns or check Ticketron show reviews and schedules at most major cities. Programming languages include FORTRAN, COBAL, Extended BASIC, RPG and assembly language, as well as powerful text editing and correspondance maintenance systems.

Any personal computer equipped with a 300-word per minute telephone interface can gain toll-free access to the system by paying a one-time registration fee of $100. For those not yet equipped with a personal computer, TCA provides a wide variety of low-cost commercial quality SOURCE series TELECOMPUTERS for connecting to the network starting at $595 for a keyboard, modem and video display.

Once granted access to the network, any TCA subscriber can use the mail system to communicate with any other subscriber, regardless of make or model of his termnal or personal computer.

Noel Tyl has been put in charge of the astrological section of the SOURCE network. Operating under a new company called TYL ASSOCIATES, Tyl will offer a large variety of computer based astrological services. These will include everything from choosing astrologically convenient dates for special events to monthly or yearly forecasts.

Certainly, operations like the SOURCE represent the future trend in communication networks. Within not too many years, most of us will do much of our day-to-day business and letter writing thru a national or international computer-based communications network.

JAMES NEELY ON A MICRO!

James Neely is, as we all know, a virtuoso on the programmable hand calculators. Neely also speaks fluent FORTRAN. Until recently, Neely has not had an opportunity to try his hand on the new home microcomputers. Neely now has a Commodore 16K PET.

The 16K PET along with a dual disk drive with 370K of on line storage was sent to Neely compliments of MATRIX Software. The results of putting such a powerful small computer into Neely's hands should be obvious from glancing thru this double issue. The volume XII material as well as the Carpenter equations (both in BASIC) are some of the first fruits of this arrangement. Some comments from Neely about his new PET are in order. "The PET is really GREAT-FABULOUS, FANTASTIC plus all of those other words that are not in my vocabulary but are appropriate!!!!!!! I'm amazed at how many features it has. Whew!!!!! I can sure see how easy it is to get 'hooked' with this device!!!!!"

Neely is engaged on a number of projects that can be implemented on the PET with great benefits to both MATRIX SOFTWARE and MATRIX readers. For one, he is designing a group of programs that will allow us to offer very accurate outer planet positions on disk or cassette for past centuries. As editor of MATRIX MAGAZINE, my goal is to make all of these equations available to our readers. As manager of MATRIX SOFTWARE, my goal is to implement these equations on as many small home computers as possible and make them available in ready-to-run form.

At any rate, you can rest assured that the Neely BASIC programs given in these issues are but the first of many to come from the Neely PET.

TURNKEY SYSTEMS FROM MATRIX SOFTWARE

Some of our own efforts here at MATRIX headquarters are worth a little horn blowing. In the next few months, MATRIX will be offering large disk-based professional astrological business packages. These will be 'turn-key' systems and will be available for the PET, APPLE and TRS-80. Each package is disk-based and line-printer oriented. The operator may select from a large number of astrological options and programs. These will include nine house systems, user-selected planetary accuracy, and a variety of printed output formats (round wheel, rectangular wheel, etc.) Once the selections have been made, the computer takes over to create a hard copy of selected options.

These large disk-based packages will be of interest to the professional astrologer or small business. The package includes a memory bank of client's charts and will also tie in with a Business package that is in the works. Our business package will include clients records, appointment schedules as well as a mailing list, invoice routines and other programs of interest to a small home-based business.

HARDWARE UPDATE

First let me make it clear that a more detailed update and review of computer hardware can be found in our Full Software Catalog. The Catalog is the place to look for in depth specifications, illustrations and the like. This column exists to give you a general update and an idea as to what is happening in the hardware department that might interest astrologers.

LET'S SAY THE NASTY STUFF FIRST

When I first began to review the home computer systems I knew I was in for some tough knocks if I had anything bad to say about a given brand. I have received some real nasty letters from TRS-80 owners who resent my remarks about their machine. The mere fact that TRS-80 has out-advertised and out-sold the competitors is supposed to reflect on it's intrinsic worth. I have a real love for these small computers and I spent months checking out the early versions of these machines before I purchased my first one. I have had about two years of experience with home computers at the time of this writing. I own, operate and have programmed the PET, APPLE II and the TRS-80 (Level II) computers in their original and in expanded form. We have these machines interfaced to disks and printers and to each other. I feel I have more information than your average bear on the relative merits of these machines.

My main objection to the TRS-80 has been and still is the fact that it is a hastily designed and poorly engineered product. In their rush to get their product on the market, Radio Shack produced a machine that has required a variety of factory issued 'fixes' to achieve normal operation. I am not alone in being critical of the TRS. Many readers who own the TRS have written or talked to me about the many and extended problems they have had with their machines. Advanced programmers and hardware designers prominent in the microcomputer field, with whom I have spoken, are in total agreement with me as to the quality of the TRS engineering. I am not alone in my opinion. Our TRS is down for repairs once again and is having a 'fix' being added to a previous Radio Shack fix...if you can believe that !

TI AND ATARI ENTER THE HOME COMPUTER MARKET

The advent of the Texas Instrument's home computer has been long in coming and eagerly awaited. The actual machine which is to be available this fall is anti-climatic.. to say the least. Whereas the APPLE, PET and TRS-80 more or less encourage user programming and provide easy access to all parts of the machine, Texas Instruments does not. For one, they have limited user RAM (program) memory to 16K- unfortunate now that memory has finally become half-way inexpensive. They purposely left the BASIC commands PEEK and POKE out of their BASIC interpreter, which denies the average user access to the internal workings of the machine. They offer lovely color high-resolution graphics but deny the user access to the routines necessary to make use of the graphics in their own programs. Instead their approach is to encourage the user to purchase from TI, programs (at a high price) in the form of ROM-packs that plug into the machine.

TI has been famous for near misses in the past and here is what appears to be their biggest yet. The sad truth is that, because of their reputation, TI is bound to be some kind of a success in the home computer market. It is unfortunate that they have blown the golden opportunity to provide the masses with a really great computer system.

Another giant, ATARI has come forth with their own home computer system. They have managed to come up with a quite attractive system that very much rsembles the APPLE II system. They have a maverick version of BASIC that is bound to caused anyone use to the MICROSOFT BASIC of the PET, APPLE and TRS-80 ... some grief. My only criticism of the ATARI computer is that for the same money you can own an APPLE II system which is far ahead in the way of available software. MATRIX has decided not to purchase either of these systems at this time. Readers owning these systems are welcome to contact me concerning adapting MATRIX software to these new machines.

COMMODORE AND APPLE GROWING FAST

Both Commodore and APPLE are experiencing increased demand for their products. Many APPLE products are already hard to obtain and we can expect to await delivery of both APPLE and PET products in the not-too-distant future. Let me give you a quick run down on what these companies are doing.

APPLE II COMPUTER

APPLE was originally oriented towards the hobbyist computer market but made an abrupt shift in direction over a year ago. Their market now is definitely the small business and mass market. They have accomplished this thru several major additions that really dont come under the category of 'fixes'. The new APPLEs come with APPLESOFT (their floating-point BASIC package) in ROM. Previous to this, APPLESOFT had to be loaded from tape or disk (using up precious memory) or purchased in ROM form for a healthy $200. This is now stock... as is the AUTO START ROM in new APPLES. The AUTO-START ROM provides several new goodies to the APPLE including a slow list of program code, new editing features which amount to another step closer to the 'ON SCREEN' editing of the PET and automatic start-up of their floppy disk when the system is turned on. The most important thing that APPLE has done has been to provide a really nice floppy disk with a DOS (Disk Operating System) that is excellent.

About the only thing that the APPLE lacks at this point, in my opinion, is the lower-case option that would make word processing on the machine practical. APPLES are selling like hotcakes!

COMMODORE IS THE PIONEER

Since you all know how I love the Commodore products, I thought I'd save the best news until last. Commodore has made, by far, the greatest strides in new hardware since our 1st report. The new 16K and 32K PETS with standard sized keyboards have been available, in quantity, for many months now. The Commodore dual drive (370K on-line) disks are also readily available. Commodore did have some initial problems with the software on their new disks (a lousy DOS no less). The new DOS 4.0 has taken care of this and the new disk represents a new concept in small disk systems. The Commodore disk is one of the first really 'intelligent' peripherals and comes with it's own 6502 microprocessor. The disk can read and write data while simultaneously transferring data between it and the PET.

The other new item from Commodore is it's new printer. Complete with it's own microprocessor, the printer is available in both tractor and friction-feed models. The PET printer can, among other things, print the complete set of PET graphics. It can also produce enhanced characters and even outputs a user-programmable character.

The icing on the cake is the new machine-language word processor now available for the PET. The Commodore system is the first low cost complete home system manufactured by a single company. A powerful new business package will soon be available from Commodore. The PET system looks pretty good to me right now as a 'best buy'.

HOW MEASURE THE ECCENTRICITY?

On page 6 of MATRIX TWO Mr. Erlewine states that, "The values for the orbital eccentricities are given in radians". In response, Mr. Pottenger (MATRIX THREE, page 54) admonishes that, "Eccentricity is not measured in radians". "It is a dimensionaless number - a ratio between two distances". Who is correct?

It is true that eccentricity is the ratio between two distances and hence is a dimensionless number, but it is also true that the radian is the ratio between two distances and so it also is a dimensionless quantity. Usually one thinks of the eccentricity as measuring the *shape* of an ellipse or the *elongation* of an elliptical orbit, but not as measuring an angle. Nevertheless, it is not incorrect to measure the eccentricity in degrees which is most certainly an angular measure. How can this be?

In Kepler's equation, $M = E - e \sin E$ (see MATRIX TWO, page 7), sin E is a pure number which ranges between the values of -1 and +1. For Kepler's equation to be meaningful the eccentricity must be measured in the same units as the angles M and E, which are the mean anomaly and eccentric anomaly, respectively. If M and E are measured as the dimensionless radian, then e must also be considered to be measured as the dimensionless radian; this is the usual situation. However, if one is solving Kepler's equation on a computer which operates in the degree mode only then it is convenient to express M and E in degrees, which means that we must also express e in degrees.

This may seem abhorrent to some, but it did not bother Simon Newcomb, the father of our current inner body computations, for on page 9 of the "Tables of the Sun" (*APAE* Vol. VI) he gives the eccentricity of the Earth's orbit as

$$e = 3455".150 - 8".621T - 0".0260T^2.$$

Observe that here the eccentricity is expressed in seconds of arc - an angular measurement.

James Neely

THE CARPENTER EQUATIONS IMPLEMENTED ON THE HOME COMPUTER

BASIC and FORTRAN versions by James Neely

INTRODUCTION by Editors

One of the most important documents in recent years pertaining to planetary positions is NASA TN D-3168. The title is PLANETARY PERTURBATIONS IN CHEBYSHEV SERIES by Lloyd Carpenter of the Goddard Space Flight Center in Greenbelt, MD. The paper contains a program for solving the equations of planetary motion for the five outer bodies using Chebyshev series.

The Chebyshev polynomials or rational polynomial approximations can be used to transform a truncated power series expansion of a function into a more quickly converging polynomial. This process is called economization. Use of Chebyshev polynomials make what would otherwise be very lengthy and time consuming numerical processes practical on a smaller machine.

The Carpenter Equations, as they are called, represent the most exact method for solving the planetary equations for the outer bodies known. Accuracy of 0.001" of arc, in all cases, is possible by means of these equations. That's 1000th of a second of arc! The accuracy is so great that there is no real way of checking this degree of accuracy. The time span in which these equations are operative is from 1800 through the year 2000. James Neely points out that these equations are not good beyond the above limits. One does not extrapolate on a Chebyshev series. It is like walking off a cliff. There is not a tapering off effect when using the equations beyond their particular limits.

Included below are FORTRAN and BASIC versions of the Carpenter equations as programmed by James Neely. The BASIC version was written on a 16K Commodore PET. The REMARK statements given below will help make clear what is happening.

The program will calculate the five outer planets plus the newly discovered body Chiron. The outer planets may be calculated for dates from Sepember 27, 1799 through April 1, 2001. Chiron may be calculated from July 17, 1889 through April 1, 2001. The BASIC version runs in 13,882 bytes on the Commodore PET and takes a long four minutes for the outer planets (Chiron takes an additional 48 seconds).

Output includes 1950.0 Equatorial Coordinates and the Ecliptic Rectangular Coordinates of date. The components of the velocity vector for each planet are also listed. This program plus an accurate inner body routine will be available in ready-to-run form in a variety of MATRIX software for the PET, APPLE II and TRS-80. Below is a sample run.

```
   POSITION          VELOCITY (AU/DAY)
JUPITER
  HELIO: EQUINOX & EQUATOR OF 1950.0
  FOR COMPARISON TO VOL. XII

-4.15988594    -4.82913402E-03
 3.04802629    -5.1180474E-03
 1.4092867     -2.07774167E-03

  HELIO: EQUINOX & ECLIPTIC OF DATE
-4.18404898    -4.78908418E-03
 3.3269322     -5.55695838E-03
 .0803777164    1.29773585E-04
SATURN
  HELIO: EQUINOX & EQUATOR OF 1950.0
  FOR COMPARISON TO VOL. XII

-9.11824743    -1.60123913E-03
 1.87591637    -5.05812625E-03
 1.16989506    -2.0215931E-03

  HELIO: EQUINOX & ECLIPTIC OF DATE
-9.13381927    -1.5618328E-03
 2.12051166    -5.4563108E-03
 .3269995       1.57471624E-04
URANUS
  HELIO: EQUINOX & EQUATOR OF 1950.0
  FOR COMPARISON TO VOL. XII

-12.0284212     2.98001226E-03
-13.18238      -2.46943826E-03
-5.60594484    -1.12431108E-03

  HELIO: EQUINOX & ECLIPTIC OF DATE
-11.9245437     2.99954846E-03
-14.4110984    -2.69127694E-03
 .10087487     -4.91043308E-05
NEPTUNE
  HELIO: EQUINOX & EQUATOR OF 1950.0
  FOR COMPARISON TO VOL. XII

-5.67447488     3.06244017E-03
-27.5742641    -4.99702282E-04
-11.1525604    -2.81774813E-04

  HELIO: EQUINOX & ECLIPTIC OF DATE
-5.45935183     3.06648554E-03
-29.7753409    -5.48398377E-04
 .737469167    -5.97064655E-05
PLUTO
  HELIO: EQUINOX & EQUATOR OF 1950.0
  FOR COMPARISON TO VOL. XII

-27.3925373     1.36944318E-03
-11.9217616    -2.90476431E-03
 4.53385059    -1.33272519E-03

  HELIO: EQUINOX & ECLIPTIC OF DATE
-27.3258426     1.39250859E-03
-9.33193553    -3.18521553E-03
 8.90216855    -6.71463395E-05
CHIRON
  HELIO: EQUINOX & EQUATOR OF 1950.0
  FOR COMPARISON TO VOL. XII

 13.1187688    -3.00027568E-03
 10.3976181     1.91169873E-03
 4.04892855     4.14955727E-04

  HELIO: EQUINOX & ECLIPTIC OF DATE
 13.0378149    -3.01406871E-03
 11.2447351     1.8972501E-03
-.421541325    -3.79824025E-04
```



```
13  PRINT "      HELIOCENTRIC RECTANGULAR
14  PRINT "           COORDINATES
15  PRINT "             OF THE
16  PRINT "           OUTER BODIES
17  PRINT "             AND
18  PRINT "            CHIRON
19  PRINT "
20  PRINT "         BY THE METHOD OF
21  PRINT "        LLOYD CARPENTER
22  PRINT "       NASA TECHNICAL NOTE
23  PRINT "          TN D-3168
24  PRINT "         JANUARY 1966
25  PRINT "
26  PRINT "           PROGRAMMED
27  PRINT "              BY
28  PRINT "          JAMES NEELY
29  FOR I = 1 TO 6000: NEXT I: HOME
30  PRINT : PRINT
31  PRINT "   EPOCH 1950.0 EQUATORIAL COORDINATE
    S
32  PRINT "ARE DISPLAYED FOR COMPARISION TO THOS
    E
33  PRINT "IN APAE VOL. XII. ": PRINT
34  PRINT "    ACCURACY TO 0.001 SECONDS OF ARC
35  PRINT "MAY BE ACHIEVED BY ADDING MORE
36  PRINT "PERTURBATION TERMS AND BY ADDING
37  PRINT "MORE SIGNIFICANT FIGURES TO THOSE
38  PRINT "LISTED (SEE LINES 5000-9999 FOR THE
39  PRINT "OUTER BODIES & LINES 16000 TO 16999
40  PRINT "FOR CHIRON).": PRINT
41  PRINT "    ECLIPTIC RECTANGULAR COORDINATES
42  PRINT "OF DATE ARE ALSO LISTED. ADD THE
43  PRINT "RECTANGULAR COORDINATES OF THE SUN
44  PRINT "TO OBTAIN GEOCENTRIC COORDINATES.
45  PRINT "THE COMPONENTS OF THE VELOCITY VECTOR

46  PRINT "FOR EACH BODY ARE ALSO COMPUTED AND
47  PRINT "PRINTED. USE THESE FOR MOTION
48  PRINT "COMPUTATIONS.
49  FOR I = 1 TO 12000: NEXT I: HOME
50  PRINT "VALID DATES ARE 27 SEPT 1799 TO
51  PRINT "1 APR 2001 FOR THE OUTER BODIES
52  PRINT "AND 17 JULY 1889 TO 1 APR 2001 FOR
53  PRINT "CHIRON.
54  FOR I = 1 TO 4000: NEXT I: HOME
100  DIM XH(3),VH(3),PR(3,3),PV(3),QV(3),RV(3),Y
     C(3),RZ(3),WZ(3),PT(3),PP(3)
105 PI = 3.14159265
109  REM  RADIAN CONVERSIONS. GS IS THE GRAVITAT
     IONAL CONSTANT.
110 TP = PI + PI:RD = PI / 180:SD = RD / 3600:GS
     = 1720209895E - 11
200  PRINT "INPUT JULIAN DAY NUMBER": INPUT JD
205  PRINT "  POSITION          VELOCITY (AU/DAY)

208  REM  LINES 210-290: PRECESSION MATRIX TO RE
     DUCE EPOCH 1950.0 COORDINATES TO
209  REM  EPOCH OF DATE.
210 TJ = (JD - 2415020) / 36525
220 T5 = (JD - 2433282.423) / 36525
230 EP = (((.00181 * TJ - .0059) * TJ - 46.845) *
     TJ + 84428.26) * SD
240 PR(1,1) = T5 * T5 * ( - 13 * T5 - 29696) / 1
    E8 + 1
250 PR(2,1) = ((221 * T5 - 676) * T5 - 2234941) *
    T5 / 1E8:PR(1,2) =  - PR(2,1)
260 PR(3,1) = ((96 * T5 + 207) * T5 - 971690) *
    T5 / 1E8:PR(1,3) =  - PR(3,1)
270 PR(2,2) = T5 * T5 * ( - 15 * T5 - 24975) / 1
    E8 + 1
280 PR(2,3) =  - 10858 * T5 * T5 / 1E8:PR(3,2) =
    PR(2,3)
290 PR(3,3) =  - 4721 * T5 * T5 / 1E8 + 1
300 .337
310  FOR NB = 1 TO 6
314  REM  INPUT: BN$=BODY NAME; NP-N0. OF PERTUR
     BATION TERMS; TE-CENTRAL EPOCH
315  REM  DT=NUMBER OF VALID DATES FOR THE CHEBY
     SHEV EXPANSION;
316  REM  AM=SEMI-MAJOR AXIS; EC=ECCENTRICITY; S
     O=ARGUMENT OF PERIHELION;
317  REM  IC=INCLINATION; BO=LONG. OF THE ASCEND
     ING NODE; SM=RECIPROCAL MASS;
318  REM  GZ=MEAN ANOMALY AT THE EPOCH; AND SZ=M
     ASS OF THE INNER BODIES.
320  READ BN$,NP,TE,DT,AM,EC,SO,IC,BO,SM,GZ,SZ: PRINT
     : PRINT BN$

330 SO = SO * RD:IC = IC * RD:BO = BO * RD:GZ =
     GZ * RD
340 EM = 1 + (1 / SM) + SZ:CG = GS *  SQR (EM):M
    T = CG / (AM *  SQR (AM))
350 DL = JD - TE:XJ = DL / (DT / 2):VF = (2 / DT
    ) / MT
359  REM  IMPOSSIBLE TO CONTINUE OF THE DATE IS
     NOT VALID:
360  IF  ABS (XJ) > 1 THEN  PRINT : PRINT "DATE
     IS OUT OF RANGE. START OVER": GOTO 200
370 E5 = 84404.84 * SD: REM  E5 IS THE OBLIQUITY
     OF THE 1950.0 ECLIPTIC.
378  REM  LINES 380-530: GENERATE EULER MATRIX T
     O CONVERT 1950 ECLIPTIC
379  REM  COORDINATES TO EQUATORIAL.
380 CE =  COS (E5):SE =  SIN (E5):CP =  COS (SO)
    :SP =  SIN (SO)
390 CI =  COS (IC):SI =  SIN (IC):CN =  COS (BO)
    :SN =  SIN (BO)
400 PV(1) =  - CI * SP * SN + CP * CN
410 G1 = CI * SP * CN + CP * SN
420 G2 = SI * SP
430 PV(2) = CE * G1 - SE * G2
440 PV(3) = SE * G1 + CE * G2
450 QV(1) =  - CI * CP * SN - SP * CN
460 G1 = CI * CP * CN - SP * SN
470 G2 = SI * CP
480 QV(2) = CE * G1 - SE * G2
490 QV(3) = SE * G1 + CE * G2
500 RV(1) = SI * SN
510 G1 =  - SI * CN
520 RV(2) = CE * G1 - SE * CI
530 RV(3) = SE * G1 + CE * CI
539  REM  LINES 540-550: AUGMENT EULER MATRIX WI
     TH CONSTANT TERMS AM & FC.
540 FC = AM *  SQR (1 - EC ^ 2)
550  FOR I = 1 TO 3:PV(I) = PV(I) * AM:QV(I) = Q
     V(I) * FC:RV(I) = RV(I) * AM: NEXT I
560  REM  LINES 570-600: SOLVE KEPLER'S EQUATION
     .
570 M = GZ + MT * DL:E = M:SE =  SIN (E):CE =  COS
    (E)
580  FOR I = 1 TO 4:SF = EC * SE:CF = 1 - EC * C
    E:FC = (M - E + SF) / CF
590 E = E + FC - .5 * FC * FC * SF / CF
600 CE =  COS (E):SE =  SIN (E): NEXT I
608  REM  LINES 610-620: RZ=UNPERTURBED POSITION
     COMPONENTS;
609  REM  AND WZ=ANGULAR MOMENTUM VECTOR.
610 C1 = CE - EC:CF = 1 - EC * CE:C2 =  - SE / C
    F:C3 = CE / CF
620  FOR I = 1 TO 3:RZ(I) = PV(I) * C1 + QV(I) *
    SE:WZ(I) = PV(I) * C2 + QV(I) * C3: NEXT I
629  REM  LINES 630-900: EVALUATE POSITION AND V
     ELOCITY PERTURBATION TERMS.
630  FOR I = 1 TO 3:PT(I) = 0:PP(I) = 0: NEXT I:
     REM  INITIALIZE PERTURBATION TERMS TO ZERO

640  IF NP = 0 GOTO 870
650  IF NP <  = 2 THEN  FOR I = 1 TO NP: READ A,
     A,A: NEXT I: GOTO 870: REM  SKIP TOO FEW TE
     RMS
700 EX = XJ + XJ: REM  GENERATION OF PERTURBATIO
    N TERMS FOLLOWS
710  FOR IS = 1 TO 3: READ YC(IS):B2(IS) = 0:B1(
     IS) = YC(IS):A1(IS) = 0
720 A0(IS) = 0:P2(IS) = 0:P1(IS) = 0: NEXT IS:N2
     = NP + NP
730  FOR I = 2 TO NP - 1:N2 = N2 - 2
734 N9 = NP - I
735  PRINT N9
740  FOR IS = 1 TO 3:AZ = N2 * YC(IS) + A1(IS)
750  READ YC(IS)
760 AN(IS) = YC(IS)
770 BZ = EX * B1(IS) - B2(IS) + AN(IS)
780 BP(IS) = EX * P1(IS) - P2(IS) + AZ
790 B2(IS) = B1(IS):B1(IS) = BZ
800 A1(IS) = A0(IS):A0(IS) = AZ
810 P2(IS) = P1(IS):P1(IS) = BP
820  NEXT IS,I
825  PRINT "      "
830  FOR IS = 1 TO 3: READ YC(IS)
840 PT(IS) = .5E - 6 * (EX * B1(IS) - 2 * B2(IS)
     + YC(IS))
850 PP(IS) = .5E - 6 * (EX * P1(IS) - 2 * (P2(IS
    ) - AN(IS)) + A1(IS)) * VF
860  NEXT IS
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870 AL = 1 + PT(1):BE = PT(2):GA = PT(3)
880 P2 =  - C2 / CF:P3 = C3 / CF
890 PA = AL + PP(2) - BE * EC * P2:PB = PP(3):PC
    = BE * P3
900 PD = BE * P2
909  REM  LINES 910-940: XH & VH ARE THE CORRECT
    ED POSITION & VELOCITY VECTORS.
910  FOR I = 1 TO 3:XH(I) = AL * RZ(I) + BE * WZ
    (I) + GA * RV(I)
930 VH(I) = MT * (PA * WZ(I) + PP(1) * RZ(I) + P
    B * RV(I) - PC * PV(I) - PD * QV(I))
940  NEXT I
1000  PRINT "  HELIO: EQUINOX & EQUATOR OF 1950.
    0": PRINT "  FOR COMPARISON TO V3H
1005  FOR I = 1 TO 3: PRINT XH(I),VH(I): NEXT
1008  REM  LINES 1010-1045: PRECESS & ROTATE 195
    0 EQUATORIAL COORDINATES TO
1009  REM  ECLIPTIC COORDINATES OF DATE.
1010  FOR I = 1 TO 3:S8(I) = 0:S9(I) = 0
1020  FOR J = 1 TO 3:S8(I) = S8(I) + PR(J,I) * X
    H(J):S9(I) = S9(I) + PR(J,I) * VH(J): NEXT
    J,I
1030 SE =  SIN (EP):CE =  COS (EP)
1040 XH(1) = S8(1)
1041 XH(2) = S8(2) * CE + S8(3) * SE
1042 XH(3) =  - S8(2) * SE + S8(3) * CE
1043 VH(1) = S9(1)
1044 VH(2) = S9(2) * CE + S9(3) * SE
1045 VH(3) =  - S9(2) * SE + S9(3) * CE
1046  PRINT "  HELIO: EQUINOX & ECLIPTIC OF DATE
    "
1047  FOR I = 1 TO 3: PRINT XH(I),VH(I): NEXT I
2000  NEXT NB: GOTO 200
4000  REM  THE PERTURBATION TERMS ARE LISTED THR
    EE TO EACH DATA STATEMENT. THESE
4010  REM  ARE ALPHA, BETA, AND GAMMA, RESPECTIV
    ELY, EACH SCALED BY 1E6.
4020  REM  ACCURACY CAN BE IMPROVED TO 0.001 SEC
    OND OF ARC BY ADDING ADDITIONAL
4030  REM  SIGNIFICANT FIGURES AND ADDITIONAL PE
    RTURBATION TERMS FROM CARPENTER'S
4040  REM  PAPER. EACH DATA LINE CORRESPONDS TO
    ONE LINE OF CARPENTER'S TERMS.
4050  REM  TO CONVERT A DATA LINE TO A CARPENTER
    TERM, SUBTRACT THE LAST THREE
4060  REM  DIGITS OF THE DATA LINE FROM 999 TO O
    BTAIN THE CARPENTER TERM NUMBER.
4070  REM  FOR EXAMPLE, LINE 5886 CORRESPONDS TO
    PERTURBATION TERM 999-886=113 OF
4080  REN  JUPITER. (SEE PAGE 44 OF CARPENTER'S
    PAPER).
5000  DATA  JUPITER,130: REM  LINES 5000-5999.
    FOR 27 SEPT 1799 THRU 1 APR 2001
5001  DATA  2415200.5,73600
5002  DATA  5.2029737,.048525422,274.169895,1.30
    8122
5003  DATA  99.848097,1047.355,239.954874,5.9768
    2E-6
5870  DATA -2,0,0
5871  DATA 0,-3,0
5872  DATA 3,-1,0
5873  DATA 1,4,0
5874  DATA -4,2,0
5875  DATA -1,-5,0
5876  DATA 4,-1,0
5877  DATA 1,4,0
5878  DATA -3,0,0
5879  DATA 1,-3,0
5880  DATA 2,1,0
5881  DATA -2,1,0
5882  DATA 0,-3,0
5883  DATA 4,1,0
5884  DATA -1,4,0
5885  DATA -4,-2,0
5886  DATA 0,-3,0
5887  DATA 3,-1,0
5888  DATA 3,3,0
5889  DATA -2,4,0
5890  DATA -3,-1,0
5891  DATA 1,-2,0
5892  DATA 0,0,0
5893  DATA 1,-2,0
5894  DATA 3,0,0
5895  DATA 0,4,0
5896  DATA -3,2,0
5897  DATA -2,-2,0
5898  DATA 0,-3,0
5899  DATA 2,-3,0
5900  DATA 4,0,0
5901  DATA 1,9,0
5902  DATA -9,6,0
5903  DATA -6,-14,0
5904  DATA 10,-12,0
5905  DATA 11,15,0
5906  DATA -12,16,0
5907  DATA -11,-19,0
5908  DATA 15,-13,0
5909  DATA 6,21,0
5910  DATA -12,5,0
5911  DATA 0,-7,0
5912  DATA -3,2,0
5913  DATA -2,-14,0
5914  DATA 14,-3,0
5915  DATA 1,17,0
5916  DATA -8,1,0
5917  DATA 0,-4,0
5918  DATA -2,1,0
5919  DATA -1,-7,0
5920  DATA 6,-4,0
5921  DATA 3,8,0
5922  DATA -3,2,0
5923  DATA 1,0,0
5924  DATA -5,13,0
5925  DATA -14,-14,0
5926  DATA 11,-25,-1
5927  DATA 15,14,0
5928  DATA -3,12,0
5929  DATA 3,11,0
5930  DATA -15,21,0
5931  DATA -22,-36,0
5932  DATA 26,-58,0
5933  DATA 46,60,0
5934  DATA -47,120,0
5935  DATA -92,-121,0
5936  DATA 91,-210,0
5937  DATA 141,195,0
5938  DATA -120,265,0
5939  DATA -143,-196,-1
5940  DATA 88,-217,-0
5941  DATA 86,101,1
5942  DATA -18,83,2
5943  DATA -1,30,-2
5944  DATA -49,58,-4
5945  DATA -55,-129,4
5946  DATA 75,-76,4
5947  DATA 12,81,-3
5948  DATA 3,-91,-2
5949  DATA 102,133,-1
5950  DATA -118,246,-4
5951  DATA -114,-231,7
5952  DATA 82,-71,9
5953  DATA -57,19,-9
5954  DATA 63,-236,-6
5955  DATA 131,162,2
5956  DATA -63,68,-4
5957  DATA 86,-19,10
5958  DATA -44,380,12
5959  DATA -206,-105,-8
5960  DATA 31,-260,-3
5961  DATA -10,11,-8
5962  DATA 19,-175,-10
5963  DATA 102,25,8
5964  DATA 2,88,0
5965  DATA 38,-9,10
5966  DATA 12,15,10
5967  DATA 42,86,-3
5968  DATA -41,253,6
5969  DATA -106,-32,-12
5970  DATA -24,-87,-5
5971  DATA -54,-20,-6
5972  DATA -20,-45,-11
5973  DATA -38,-120,7
5974  DATA 36,-123,-5
5975  DATA 15,-125,12
5976  DATA 96,-200,7
5977  DATA 103,56,8
5978  DATA 76,-10,12
5979  DATA 107,151,-1
5980  DATA 23,234,12
5981  DATA 17,203,-10
5982  DATA -43,204,3
5983  DATA -49,129,-14
5984  DATA -79,59,-6
5985  DATA -62,37,-11
5986  DATA -85,-46,-10
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5987  DATA -49,83,-7
5988  DATA -112,-241,-14
5989  DATA 11,-206,-2
5990  DATA -54,47,-12
5991  DATA -2,228,3
5992  DATA -113,-196,-14
5993  DATA 30,-7,6
5994  DATA -118,-213,-14
5995  DATA 56,-254,8
5996  DATA -93,-43,-11
5997  DATA 60,-817,10
5998  DATA -50,-128,-12
5999  DATA 41,-965,10
6000  DATA  SATURN,110: REM  LINES 6000-6999.
    FOR 27 SEPT 1799 THRU 1 APR 2001
6001  DATA  2415200.5,73600
6002  DATA  9.5371950,.054179408,338.991032,2.48
    6946
6003  DATA  113.382301,3501.6,180.374080,5.97682
    E-6
6890  DATA 2,0,0
6891  DATA 0,1,0
6892  DATA 0,0,0
6893  DATA 1,1,0
6894  DATA -2,1,0
6895  DATA -1,-2,0
6896  DATA 2,-1,0
6897  DATA 1,1,0
6898  DATA -1,0,0
6899  DATA 0,1,0
6900  DATA -2,1,0
6901  DATA -2,-4,0
6902  DATA 6,-3,0
6903  DATA 4,6,0
6904  DATA -7,4,0
6905  DATA -6,-6,0
6906  DATA 7,-6,0
6907  DATA 6,7,0
6908  DATA -9,6,0
6909  DATA -4,-7,0
6910  DATA 6,-4,0
6911  DATA 0,1,0
6912  DATA 2,0,0
6913  DATA 5,7,0
6914  DATA -6,1,0
6915  DATA -6,-8,0
6916  DATA 2,0,0
6917  DATA 4,4,0
6918  DATA 3,-4,0
6919  DATA -2,-1,0
6920  DATA -4,4,0
6921  DATA -1,-2,0
6922  DATA 3,-1,0
6923  DATA 0,3,0
6924  DATA 3,-6,0
6925  DATA 4,3,0
6926  DATA -9,10,0
6927  DATA -7,-6,0
6928  DATA 3,-5,0
6929  DATA 3,-2,0
6930  DATA 8,-5,0
6931  DATA 4,6,0
6932  DATA -8,11,0
6933  DATA -13,-8,0
6934  DATA 9,-17,0
6935  DATA 29,20,0
6936  DATA -26,35,0
6937  DATA -44,-36,0
6938  DATA 37,-46,0
6939  DATA 37,31,0
6940  DATA -22,31,0
6941  DATA -17,-12,0
6942  DATA 2,-2,0
6943  DATA -4,-4,-1
6944  DATA 13,-24,-1
6945  DATA 24,24,1
6946  DATA -24,36,1
6947  DATA -23,-29,-2
6948  DATA 11,-20,-2
6949  DATA -12,-2,3
6950  DATA 17,-13,2
6951  DATA 29,20,-2
6952  DATA -12,9,-1
6953  DATA 16,7,0
6954  DATA -18,33,-1
6955  DATA -49,-16,2
6956  DATA 6,-41,0
6957  DATA 26,-16,0
6958  DATA 20,32,1
6959  DATA -29,7,-2
6960  DATA 7,-69,-2
6961  DATA 48,25,1
6962  DATA -15,60,0
6963  DATA 25,-3,2
6964  DATA -34,44,2
6965  DATA -162,-26,-2
6966  DATA 76,-51,1
6967  DATA 232,10,-2
6968  DATA -94,-59,-3
6969  DATA -284,-3,-1
6970  DATA 136,46,0
6971  DATA 296,38,4
6972  DATA -78,12,2
6973  DATA -13,23,-1
6974  DATA -106,-38,-7
6975  DATA -242,-88,5
6976  DATA 136,134,18
6977  DATA -19,163,-12
6978  DATA -88,-211,-21
6979  DATA 395,-210,6
6980  DATA -5,240,-5
6981  DATA -31,-149,16
6982  DATA 81,153,47
6983  DATA -410,368,-28
6984  DATA -129,-376,-29
6985  DATA -186,80,-11
6986  DATA -107,-325,-56
6987  DATA 140,-659,27
6988  DATA 317,579,7
6989  DATA 6,426,31
6990  DATA 42,-294,45
6991  DATA 223,-893,9
6992  DATA 409,512,69
6993  DATA 97,86,-12
6994  DATA 364,485,57
6995  DATA -9,968,-26
6996  DATA 147,-37,34
6997  DATA -11,2395,-32
6998  DATA -118,572,4
6999  DATA 757,2558,-38
7000  DATA  URANUS,58: REM  LINES 7000-7999
    FOR 27 SEPT 1799 THRU 1 APR 2001
7001  DATA  2415200.5,73600
7002  DATA  19.1843420,.047328819,96.312192,.773
    735
7003  DATA  73.745938,22869,76.119648,5.97682E-6

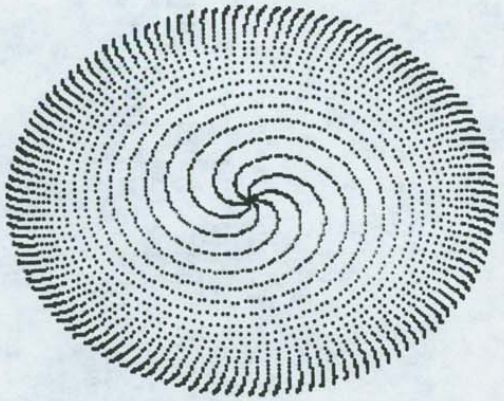
7942  DATA 0,0,0
7943  DATA 0,-2,0
7944  DATA 1,-1,0
7945  DATA -2,3,-1
7946  DATA -1,2,0
7947  DATA 5,-6,1
7948  DATA 1,-7,1
7949  DATA -13,5,-1
7950  DATA -4,21,-1
7951  DATA 32,1,1
7952  DATA 6,-45,0
7953  DATA -61,-9,0
7954  DATA -10,77,0
7955  DATA 92,17,-1
7956  DATA 15,-98,-1
7957  DATA -93,-14,0
7958  DATA -10,70,0
7959  DATA 35,-2,0
7960  DATA -3,11,0
7961  DATA 50,13,0
7962  DATA 13,-76,0
7963  DATA -69,-8,-1
7964  DATA -11,36,-1
7965  DATA -18,-2,0
7966  DATA -6,58,0
7967  DATA 70,5,1
7968  DATA 9,-34,0
7969  DATA 20,5,0
7970  DATA 1,-66,0
7971  DATA -56,-8,-1
7972  DATA 5,12,0
7973  DATA -55,4,-1
7974  DATA -10,59,-1
7975  DATA 28,-4,0
7976  DATA 1,44,0
7977  DATA 64,7,0
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```
7978  DATA 3,-19,-1
7979  DATA 47,1,2
7980  DATA 2,-60,2
7981  DATA -16,1,0
7982  DATA -7,-59,0
7983  DATA -22,-6,-1
7984  DATA 24,-43,-1
7985  DATA -115,-29,1
7986  DATA -37,63,1
7987  DATA 42,16,-1
7988  DATA 42,35,1
7989  DATA -100,11,2
7990  DATA -8,-31,2
7991  DATA -34,-120,-8
7992  DATA 62,229,-2
7993  DATA -119,62,-3
7994  DATA 27,-13,-6
7995  DATA 30,476,24
7996  DATA -223,-287,0
7997  DATA 227,372,19
7998  DATA -325,617,5
7999  DATA 1046,115,19
8000  DATA  NEPTUNE,60: REM  LINES 8000-8999.
    FOR 27 SEPT 1799 THRU 1 APR 2001
8001  DATA  2415200.5,73600
8002  DATA  30.0729814,.008852234,275.039422,1.7
    74465
8003  DATA  131.236967,19314,40.524435,5.97682E-
    6
8940  DATA 0,1,0
8941  DATA 1,0,0
8942  DATA 0,-2,0
8943  DATA -3,1,0
8944  DATA 1,4,0
8945  DATA 7,-2,1
8946  DATA -3,-11,0
8947  DATA -18,4,-1
8948  DATA 5,25,0
8949  DATA 35,-8,1
8950  DATA -11,-43,0
8951  DATA -53,13,-1
8952  DATA 14,59,0
8953  DATA 59,-13,0
8954  DATA -11,-51,0
8955  DATA -32,7,1
8956  DATA 2,7,0
8957  DATA -20,4,0
8958  DATA 9,41,0
8959  DATA 47,-11,-1
8960  DATA -8,-37,0
8961  DATA -11,2,0
8962  DATA -5,-20,0
8963  DATA -40,9,1
8964  DATA 8,39,0
8965  DATA 13,-3,0
8966  DATA 4,21,0
8967  DATA 41,-9,-1
8968  DATA -7,-31,0
8969  DATA 2,0,0
8970  DATA -7,-34,0
8971  DATA -37,8,1
8972  DATA 3,9,0
8973  DATA -27,6,1
8974  DATA 9,38,0
8975  DATA 11,-3,0
8976  DATA 6,29,0
8977  DATA 39,-8,0
8978  DATA 0,-11,-1
8979  DATA 20,-8,-1
8980  DATA -9,-16,1
8981  DATA 35,0,0
8982  DATA -5,-76,0
8983  DATA -64,-2,0
8984  DATA -11,20,0
8985  DATA -3,10,0
8986  DATA -1,-12,0
8987  DATA -12,11,0
8988  DATA 7,-27,1
8989  DATA -54,7,1
8990  DATA 4,9,0
8991  DATA -52,4,1
8992  DATA -6,85,0
8993  DATA -79,-20,1
8994  DATA 13,-109,-1
8995  DATA 150,-13,0
8996  DATA 41,744,0
8997  DATA -314,19,-3
```



```
8998  DATA 30,2909,2
8999  DATA -412,38,-4
9000  DATA  PLUTO,61: REM  LINES 9000-9999.
    FOR 27 SEPT 1799 THRU 1 APR 2001
9001  DATA  2415200.5,73600
9002  DATA 39.4870157,.248266637,113.719012,17.1
    43503
9003  DATA  109.634196,360000,230.365375,5.97682
    E-6
9939  DATA -1,-1,0
9940  DATA 0,2,-1
9941  DATA 2,1,1
9942  DATA -1,-5,2
9943  DATA -3,-2,-2
9944  DATA 3,12,-4
9945  DATA 10,3,4
9946  DATA -5,-25,7
9947  DATA -20,-3,-6
9948  DATA 8,40,-10
9949  DATA 32,-1,7
9950  DATA -9,-51,9
9951  DATA -40,6,-5
9952  DATA 6,43,-3
9953  DATA 29,-10,-1
9954  DATA 2,-8,-6
9955  DATA 5,4,6
9956  DATA -10,-31,7
9957  DATA -32,9,-3
9958  DATA 7,32,1
9959  DATA 20,-10,-4
9960  DATA 7,9,-7
9961  DATA 21,-6,4
9962  DATA -11,-31,0
9963  DATA -25,12,4
9964  DATA -6,-6,7
9965  DATA -31,7,-3
9966  DATA 11,28,2
9967  DATA 20,-11,-5
9968  DATA 9,14,-5
9969  DATA 28,-12,0
9970  DATA -8,-18,-6
9971  DATA -3,3,4
9972  DATA -14,-24,0
9973  DATA -28,16,4
9974  DATA -4,-5,7
9975  DATA -24,9,-1
9976  DATA 11,23,3
9977  DATA 9,4,-2
9978  DATA 16,8,8
9979  DATA 10,-23,-7
9980  DATA 9,41,-12
9981  DATA 57,-7,-1
9982  DATA 1,-42,-3
9983  DATA -9,-10,0
9984  DATA -17,-6,0
9985  DATA -4,-6,1
9986  DATA -13,4,-6
9987  DATA 17,1,3
9988  DATA -11,-25,-9
9989  DATA -8,13,6
9990  DATA -17,-45,-1
9991  DATA -39,17,5
9992  DATA -10,-21,1
9993  DATA -47,18,10
9994  DATA 10,-76,10
9995  DATA 34,46,-2
9996  DATA 2,719,8
9997  DATA -787,104,3
9998  DATA -21,2323,-30
9999  DATA -1356,137,14
```

```
16000  DATA  CHIRON,80: REM  LINES 16000-16999.
    FOR 17 JULY 1889 THRU 1 APR 2001
16001  DATA  2431600.5,40800
16002  DATA  13.7342411011,.3838168359,338.82830
    63946,6.9225246891
16003  DATA  208.76913180007,35000000,358.178236
    8507,5.97682E-6
16920  DATA -1,0,0
16921  DATA -1,0,0
16922  DATA 1,-1,0
16923  DATA 2,0,0
16924  DATA -1,1,0
16925  DATA -2,-1,0
16926  DATA 1,-1,0
16927  DATA 2,1,0
16928  DATA -2,1,0
16929  DATA -2,-1,0
16930  DATA 2,-1,0
16931  DATA 3,1,0
16932  DATA -2,1,0
16933  DATA -4,-1,0
16934  DATA 2,-2,0
16935  DATA 4,1,-1
16936  DATA -2,2,0
16937  DATA -5,-1,1
16938  DATA 3,-2,0
16939  DATA 6,1,-1
16940  DATA -3,1,-1
16941  DATA -6,0,1
16942  DATA 3,-2,1
16943  DATA 6,1,-1
16944  DATA -3,2,0
16945  DATA -8,-2,1
16946  DATA 4,-5,1
16947  DATA 7,2,-1
16948  DATA -3,8,-1
16949  DATA -8,-4,1
16950  DATA 3,-9,0
16951  DATA 12,4,-1
16952  DATA -5,9,0
16953  DATA -15,-2,1
16954  DATA 6,-8,2
16955  DATA 18,2,-2
16956  DATA -6,8,-1
16957  DATA -25,-4,2
16958  DATA 8,-12,0
16959  DATA 27,4,-1
16960  DATA -8,17,-2
16961  DATA -28,-5,3
16962  DATA 8,-17,2
16963  DATA 37,6,-4
16964  DATA -9,22,2
16965  DATA -47,-6,0
16966  DATA 12,-42,0
16967  DATA 57,9,1
16968  DATA -11,72,1
16969  DATA -63,-18,0
16970  DATA 6,-109,-14
16971  DATA 78,22,10
16972  DATA -12,139,15
16973  DATA -150,-14,-11
16974  DATA 25,-89,2
16975  DATA 175,4,-13
16976  DATA -19,-69,-6
16977  DATA -228,22,19
16978  DATA 22,121,4
16979  DATA 474,-43,3
16980  DATA -41,108,-17
16981  DATA -296,-13,14
16982  DATA 1,-306,-4
16983  DATA 19,26,-29
16984  DATA 89,335,22
16985  DATA -820,129,-18
16986  DATA -51,-635,52
16987  DATA 731,-20,-34
16988  DATA -77,728,-22
16989  DATA 153,-59,68
16990  DATA -407,-1141,-94
16991  DATA 2395,-1164,68
16992  DATA 725,4900,-169
16993  DATA -2793,812,208
16994  DATA 785,-1397,-89
16995  DATA -4006,-1977,135
16996  DATA 2756,-6790,332
16997  DATA -5211,-5727,-315
16998  DATA 5429,74502,392
16999  DATA -19231,-3562,-303
```



```
      ELONG = LMP
      DBPP = 0.029CO *DCOS(GMV     + 5.166174586DO)
     1     + 0.002DO *DCOS(-(GPV  ) + 4.269075351DO)
     2     + C.067DO *DCOS(-(GPV2) + 4.272566309DO)
     3     + 0.21DO *DCOS(-(GPV3) + 4.267330021DO)
     4     + 0.031DO *DCOS(-(GPV4) + 1.141445331DO)
     5     + 0.166CO *DCOS(-(G-J2) + 4.687954371DO)
      DBPL = 0.6576DO*DSIN(F) - 0.047DO*DSIN(F-GL)
      ELAT = (DBPP + DBPL) * STRAD
      ELONG = DMOD(ELONG,TWOPI)
      IF (ELONG .LT. 0.DO) ELONG = ELONG + TWOPI
      CL = DCOS (ELAT)
C     LONGITUDE, LATITUDE AND RADIUS VECTOR:
C     WRITE(6,2000) ELONG,ELAT,RVEC
 2000 FORMAT(10X,3(3X,F20.15))
C     RECTANGULAR COORDINATES OF THE SUN:
      XYZS(1) = RVEC*CL*DCOS(ELONG)
      XYZS(2) = RVEC*CL*DSIN(ELONG)
      XYZS(3) = RVEC*DSIN(ELAT)
      RETURN
      END
C*********************************************************************
      SUBROUTINE GEQEQU(ELONG,ELAT,RA,DECL)
C
C     CONVERT ECLIPTIC COORDINATES TO EQUATORIAL COORDINATES
C
      IMPLICIT REAL*8(A-Z)
      COMMON /EPS$/EPS,SEPS,CEPS,TEPS
      COMMON /PI$/RAD,PI,PI02,TWOPI,PI04,STRAD
      SLON = DSIN(ELONG)
      CLON = DCOS(ELONG)
      SLAT = DSIN(ELAT)
      CLAT = DCOS(ELAT)
      CDCA = CLAT*CLON
      CDSA = CLAT*SLON*CEPS - SLAT*SEPS
      SD   = CLAT*SLON*SEPS + SLAT*CEPS
      DECL = DARSIN(SD)*RAD
      RA = SATAN2(CDSA,CDCA)*RAD/15.DO
      RETURN
      END
C*********************************************************************
      SUBROUTINE SETCON
C
C     GENERATE AND SET UP CONSTANTS
C
      IMPLICIT REAL*8 (A-Z)
      COMMON /PI$/RAD,PI,PI02,TWOPI,PI04,STRAD
      PIC4 = DATAN(1.DO)
      PI02 = PI04 + PI04
      PI   = PI02 + PI02
      TWOPI = PI + PI
      RAD = 45.DO/PI04
      STRAD = 1.DO/(3600.DO * RAD)
      GAUSS = 0.0172020989500
      EMU = 1.DO + 1.DC/329390.DC
      RETURN
      END
C*********************************************************************
      SUBROUTINE INPCHB
C
C     INPUT CHEBYSHEV DATA FOR THE BODY
C
      IMPLICIT REAL*8(A-H,O-Z)
      REAL*8 YC(730,3),MOTION,MOTR
      COMMON/MOT$/MOTION,MOTR
      COMMON/NSYM$/NSYM(18)
      COMMON /PI$/RAD,PI,PI02,TWOPI,PIC4,STRAD
      COMMON /CHEB$/YC,NFIRST,NPTS
      COMMON /EPS$/EPS,SEPS,CEPS,TEPS
      COMMON/GAUSS$/GAUSS,TEPOCH,DTCHEB,SA,SE,SO2,SI2,CO2,SM,SGZ2,SMINNR
      INFILE = 5
      INFILE = 10
C     INPUT CENTRAL EPOCH, DAYS OF VALIDITY, MEAN ORBITAL ELEMENTS
C     AND MASSES:
      READ(INFILE,999,END=40)NSYM,TEPOCH,DTCHEB,SA,SE,SO2,SI2,CO2,SM,
     1   SGZ2,SMINNR
  999 FORMAT(19A4/2F15.7/(4F18.11))
      EMU = 1.DO + SMINNR + SM
      CAPGAU = GAUSS*DSQRT(EMU)
      MOTR = CAPGAU/(SA*DSQRT(SA))
      MOTION = RAD*MOTR
      II = 1
      NFIRST = 11
      NF = -2
   10 CONTINUE
      NP = NP + 2
      I2 = II + 1
C     INPUT PERTURBATION COEFFICIENTS
      READ(INFILE,1010,END=30) K,((YC(I,J),J=1,3),I=I1,I2)
 1000 FORMAT(I8,6F12.4)
      II = I1 + 2
      IF (K .LT. 1000) GO TO 10
      I1 = I1 - 2
      NPTS = NP
   20 CONTINUE
      RETURN
   30 WRITE(6,2000)
 2000 FORMAT('0PREMATURE END OF DATA IN INPCHB. STOP'//)
   40 STOP
      END
C*********************************************************************
      SUBROUTINE PQRGEN
C
C     CONVERT MEAN ORBITAL (ECLIPTIC) ELEMENTS TO MODIFIED DIRECTION
C     COSINE MATRIX TO GENERATE 1950.0 EQUATORIAL POSITIONS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON /PQR$/PQR(3,3)
      COMMON /PI$/RAD,PI,PI02,TWOPI,PIC4,STRAD
      COMMON/GAUSS$/GAUSS,TEPOCH,DTCHEB,SA,EC,SO2,SI2,CO2,SM,SGZ2,SMINNR
      EPI950 = 84404.84D0/3600.DO
      EP50R = EPI950/RAD
      CE = DCOS(EP50R)
      SE = DSIN(EP50R)
      PERI = SO2/RAD
      AINCL = SI2/RAD
      ANODE = CO2/RAD
      CP = DCOS(PERI)
      SP = DSIN(PERI)
      CI = DCOS(AINCL)
      SI = DSIN(AINCL)
      CN = DCOS(ANODE)
      SN = DSIN(ANODE)
      PQR(1,1) = -CI*SP*SN + CP*CN
      A1       =  CI*SP*CN + CP*SN
      A2       =  SI*SP
      PQR(2,1) =  CE*A1 - SE*A2
      PQR(3,1) =  SE*A1 + CE*A2
      PQR(1,2) = -CI*CP*SN - SP*CN
      A1       =  CI*CP*CN - SP*SN
      A2       =  SI*CP
      PQR(2,2) =  CE*A1 - SE*A2
      PQR(3,2) =  SE*A1 + CE*A2
      PQR(1,3) =  SI*SN
      A1       = -SI*CN
      PQR(2,3) =  CE*A1 - SE*CI
      PQR(3,3) =  SE*A1 + CE*CI
      AMAJOR = SA
      FAC = AMAJOR*DSQRT(1.DO - EC**2)
      DO 10 I = 1,3
```



```
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION N1(3),N2(3),N3(3),N4(3),N5(3),N6(3)
      COMMON /PI$/RAD,PI,PI02,TWOPI,PIC4,STRAD
      COMMON /RECT$/XYZS(3)
      COMMON /BODY$/XYZH(3),XYZG(3)
      COMMON /JULYN$/DAYJ
      COMMON/GAUSS$/GALSS,TEPOCH,DTCHEB,SA,SE,SO2,SI2,CO2,SM,SGZ2,SMINNR
      GAUSS = 0.0172020989500
      JDFIN = 1
      JSTART = 1
      JDINC = 1
      CALL SETCON
      CALL INPCHB
      CALL PQRGEN
    5 CONTINUE
C     WRITE(6,1234)
C1234 FORMAT('0READ JSTART,JDFIN,JDINC'/1X,'XXXXXXX XXXXXXX XX')
C
C     JSTART = STARTING JULIAN DAY NUMBER
C     JD = FINAL JULIAN DAY NUMBER
C     JDINC = THE NUMBER OF DAYS TO BE INCREMENTED (STEPSIZE).
C
      READ(5,1235,END=9999)JSTART,JDFIN,JDINC
 1235 FORMAT(I7,1X,I7,1X,I2)
      JD = JSTART
      WRITE(6,2005)
 2005 FORMAT(///)
      JDTOT = (JDFIN-JSTART)/JDINC + 1
      DO 50 JJJ = 1,JDTOT
C     WRITE(6,8000)
 8000 FORMAT(//)
      DAYJ = DFLOAT(JD) + 0.5DO
      CALL TIME(DAYJ)
      CALL FUNARG
      CALL SUN
C     WRITE(6,8001)XYZS
      CALL OUTER
C     WRITE(6,8001)XYZH
      CALL PRECES(XYZH,XYZH)
C     WRITE(6,8001)XYZH
 8001 FORMAT(10X,3(3X,F20.15))
      DO 10 I = 1,3
      XYZG(I) = XYZH(I) + XYZS(I)
   10 CONTINUE
      CALL LONG(XYZG,ELONG,ELAT)
      CALL GEQEQU(ELONG,ELAT,RA,DECL)
      CALL LONG(XYZH,HLONG,HLAT)
      ELONG = ELONG*RAD
      ELAT = ELAT*RAD
      HLONG = HLONG*RAD
      HLAT = HLAT*RAD
      CALL JDATE(DAYJ,ND,MO,NYR)
      CALL DMS(ELONG,N1,NS1)
      CALL DMS(ELAT,N2,NS2)
      CALL DMS(RA,N3,NS3)
      CALL DMS(DECL,N4,NS4)
      CALL DMS(HLONG,N5,NS5)
      CALL DMS(HLAT,N6,NS6)
      RV = DSQRT(XYZH(1)**2 + XYZH(2)**2 + XYZH(3)**2)
      WRITE(6,2000)DAYJ,MO,ND,NYR,N1,NS2,N2,N3,NS4,N4,N5,NS6,N6,RV
 2000 FORMAT(1X,F9.1,3X,I2,'-',I2,'-',I4,3(3X,3I3,2X,A1),(2,2(3),3X,F09.4
     1 )
      JD = JD + JDINC
   50 CONTINUE
      GO TO 5
 9999 STOP
      END
C*********************************************************************
      SUBROUTINE TIME(DJN)
C     DJ = THE NUMBER OF DAYS FROM JAN 0.5, 1900. OTHER VARIABLES
C     ARE USED BY FUNARG.
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON /TIME$/DJ,T,BD,BD2
      DJ = DJN - 2415020.0DO
      BD = DJ/10000.DO
      T = DJ/36525.DO
      BD2 = BD * BD
      RETURN
      END
C*********************************************************************
      SUBROUTINE LONG(VEC,ELONG,ELAT)
C
C     CONVERT RECTANGULAR COORDINATES TO SPHERICAL
C
      IMPLICIT REAL*8(A-Z)
      DIMENSION VEC(3),VECR(3)
      COMMON /PI$/RAD,PI,PI02,TWOPI,PIC4,STRAD
      ELONG = DATAN2(VEC(2),VEC(1))
      IF (ELONG .LT. 0.DO) ELONG = ELONG + TWOPI
      ELAT = DARSIN(VEC(3)/DSQRT(VEC(1)**2+VEC(2)**2+VEC(3)**2))
      RETURN
      END
C*********************************************************************
      FUNCTION SATAN2(X,Y)
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON /PI$/RAD,PI,PI02,TWOPI,PIC4,STRAD
      SATAN2 = DATAN2(X,Y)
      IF (SATAN2 .LT. 0.DO) SATAN2 = SATAN2 + TWOPI
      RETURN
      END
C*********************************************************************
      SUBROUTINE FUNARG
C
C     COMPUTE THE FUNDAMENTAL ARGUMENTS OF THE SUN, MOON, MERCURY,
C     VENUS, MARS, JUPITER AND SATURN
C
      IMPLICIT REAL*8(A-Z)
      INTEGER*4 I
      COMMON /PI$/RAD,PI,PI02,TWOPI,PIC4,STRAD
      COMMON /TIME$/DJ,T,BD,BD2
      COMMON /FARG$/LL,D,LS,O,V,J,M,SN,TE,LO,GL,GS,F,U
      GS = 358.475845DC + 0.985600267DO*DJ - BD2*(1.12C-5 + 7.C-8*BD)
     1     + 2.99D-7 * BD)
      LL=(C.751206DC8DDO + DJ*(0.03660110143633600 + DJ*(-235980.C-20
     1    + DJ*1077.D-25)))
      LL = DMOD(LL,1.D0) * TWOPI
      D = (0.7199535416700 + DJ*(-147094228332.D-15 + DJ*(432630.D-20
     1    + DJ*1266.D-25)))
      O  = DMOD(O,1.DO) * TWOPI
      LS = (0.7709352126C5DO + DJ*(2737909264963.D-15 + DJ*83044.D-20))
      LS = DMOD(LS,1.D0) * TWOPI
      O = (0.4930032021600 + DJ*113676C7782806.D-15)
      O = DMOD(O,1.D0) * TWOPI
      V = (0.9501920216000 + DJ*4453362451095.D-15)
      V = DMOD(V,1.DO) * TWOPI
      J = (0.6593119984500 + DJ*230808970898.D-15)
      J = DMOD(J,1.DO) * TWOPI
      M = (0.8140268750000 + DJ*1455647068607.D-15)
      M = DMOD(M,1.D0) * TWOPI
      SN = (0.7385264120300 + DJ*92943729984.D-15)
      SN = DMOD(SN,1.DO) * TWOPI
      TE = (0.2749563549DO + DJ*2737803094025.D-15)
      TE = DMOD(TE,1.DO) * TWOPI
      LO = (0.7492673304DO + DJ*3660099529218.D-15)
      LO = DMOD(LO,1.DO) * TWOPI
      GL = GL/RAD
      GS = GS/RAD
```

```
      F   = (0.0312524691400 + DJ*(3674819569168.D-15 + DJ*(-668609.D-20
     1    + DJ* 190.D-25)))
      F = DMOD(F,1.D0) * TWOPI
      D   = (0.9742379475D0 + DJ*(3386319219833D-15 + DJ*(-299023.D-20
     1    + DJ*1077.D-25)))
      D = DMOD(D,1.D0) * TWOPI
C     WRITE(6,2000)LL,Q,LS,Q,V,J,M,SN,TE,LC,GL,GS,F,D
 2000 FORMAT(5(2X,F20.15))
      RETURN
      END
C*****************************************************************
      SUBROUTINE SUN
C
C     THIS IS AN EXTREMELY ACCURATE ROUTINE FOR COMPUTING THE
C     SOLAR POSITION. IT AGREES TO WITHIN TWO PLACES OF THE LEAST
C     SIGNIFICANT FIGURE WITH THE APAE VOL. XIV.
C
      IMPLICIT REAL*8(A-Z)
      COMMON /PI$/RAD,PI,PI02,TWOPI,PI04,STRAD
      COMMON /TIME$/DJ,T,T0,T02
      COMMON /FARG$/LL,Q,LS,Q,V,J,M,SN,TE,LO,GL,GS,F,D
      COMMON /RECT$/XYZ$(3)
      COMMON /COORD$/ELONG,ELAT,RA,DECL
      COMMON /VEL$/VELVEC(3,10)
      DLS = (6.400D0   * DSIN((231.19D0 + 20.20D0 * T)/RAD)
     1    + (1.882D0 - 16.4D-3*T)*DSIN((57.24D0 + 150.27D0*T)/RAD)
     2    + 0.266DC * DSIN((31.8D0 + 119.0D0 * T)/RAD)
     3    + 0.202D0 * DSIN((315.6D0 + 893.3D0 * T)/RAD) ) * STRAD
      LSC = LS + DLS
      G   = GS + DLS
      G2 = G  + G
      G3 = G  + G2
      RI = 1.00014033D0 - 70.D-8*T
     1    + (-0.0167492ED0 + T*(4179.D-8 + T*126.D-8)) * DCOS(G)
     2    + (-0.00014027D0 + T*70.D-8) * DCOS(G2)
     3    + (-0.00000176D0 + T*1.D-8) * DCOS(G3)
      TV  = TE - V
      V2 = TV  + TV
      V3 = TV  + V2
      V4 =  V2 + V2
      V5 =  V3 + V2
      GMV = G  - TV
      GMV2 = G  - V2
      GPV = G  + TV
      GPV2 = G  +  V2
      GPV3 = G  +  V3
      GPV4 = G  +  V4
      CRP =      543.2D-8 *DCOS(-(TV) +  3.141592654D0)
     1    +     1575.4D-8 *DCOS(-(V2) +  2.094395103D-3)
     2    +      204.6D-8 *DCOS(-(V3) +  4.71238898ED-3)
     3    +       86.6D-8 *DCOS(-(V4) -  1.919862177D-3)
     4    +       37.5D-8 *DCOS(-(V5))
     5    +       21.6D-8 *DCOS(GMV + 3.070034154D0)
     6    +       36.8D-8 *DCOS(GMV2 + 3.490658504D-3)
     7    +      200.1D-8 *DCOS(-(GPV2) + 2.940879790D0)
     8    +      344.7D-8 *DCOS(-(GPV3) +  2.93128047900)
     9    +       45.1D-8 *DCOS(-(GPV4) + 6.087708431D0)
      CRP = DRP + 44.7D-8 *DCOS(-(G2+V3) +  5.623456850C)
     1    +       21.6D-8 *DCOS(-(G2+V4) + 2.415535685D0)
     2    +       32.5D-8 *DCOS(-(G2+V5) +  5.583308277D0)
      TM = TE - M
      M2 = TM + TM
      M3 = TM + M2
      M4 = M2 + M2
      M5 = M2 + M3
      M6 = M3 + M3
      M7 = M3 + M4
      DRP = DRP +  34.5D-8 *DCOS(  TM   + 0.010471975500)
     1    +      473.6E-8 *DCOS( M2 - 5.235987756D-3 )
     2.   +       38.7D-8 *DCOS( M3 + 3.181735227D0)
     3    +       34.8D-8 *DCOS( -(G-M2) + 0.713839664100)
     4    +       49.5D-8 *DCOS( -(G-M3) +  3.975866C360D)
     5    +      110.1C-8 *DCOS( -(G-M4) +  3.960501139C0)
     6    +       24.6D-8 *DCOS( -(G-M5) +  0.860447321300)
     7    +       24.2C-8 *DCOS( -(G2-M4) +  4.845034004D0)
     8    +       20.5D-8 *DCOS( -(G2-M5) +  1.070240094D0)
     9    +       32.0D-8 *DCOS(-(G2-M6) +  1.6563174600)
      TJ = TE - J
      J2 = TJ + TJ
      J3 = TJ + J2
      J4 = J2 + J2
      DRP = DRP +  1627.3D-8 *DCOS( TJ +  0.01919862170D0)
     1    +       927.0D-8 *DCOS( J2 +  3.145432378D0)
     2    +        64.7D-8 *DCOS( J3 +  3.070034154D0)
     3    +        47.9D-8 *DCOS( J4 + TJ +  0.411897703500)
     4    +        23.7D-8 *DCOS(G+J2 +  3.029891582D0)
     5    +        56.2D-8 *DCOS(-(G-TJ) +  4.366813789D0)
     6    +       336.0D-8 *DCOS(-(G-J2) +  3.535668755D0)
     7    +       184.9D-8 *DCOS(-(G-J3) +  1.522490707D0)
     8    +        40.1D-8 *DCOS(-(G2-J3) +  1.802925117D0)
     9    +        26.0D-8 *DCOS(-(G2-J4) +  6.176720223D0)
      TS = TE - SN
      S2 = TS + TS
      DRP = DRP +  98.8E-8 *DCOS(TS +  6.283185308D0-3)
     1    +       37.3D-8 *DCOS( S2 +  3.143333798D0)
     2    +       25.8D-8 *DCOS(-(G-S2) +  3.186971214D0)
      DRL = 3076.2D-8*DCOS(D) + 85.D-8*DCOS(D+GL)
     1    - 306.D-8*DCOS(D-GL) - 32.D-8*DCOS(D+G) + 83.E-8*DCOS(D-G)
      RVEC = RO * (1.D0 + DRP + DRL)
      C  = (6910.057D0 + T*(-17.240D0) - T*0.052D0))*DSIN(G)
     1  + (72.338D0 - T*0.361D0)*DSIN(G2)
     2  + (1.054D0  -T*1.D-3)*DSIN(G3)
      DLP = 4.858D0 *DCOS(-TV + 4.7123889810D0)
     1    + 5.526D0 *DCOS(-V2 +  1.572890722D0)
     2    + 0.666D0 *DCOS(-V3 +  1.577952177D0)
     3    + 0.210D0 *DCOS(-V4 +  1.567305668D0)
     4    + 0.116D0 *DCOS(+GMV2 +  1.583013632D0)
     5    + 2.497D0 *DCOS(-(GPV2) +  4.498586147D0)
     6    + 1.559D0 *DCOS(-(GPV3) +  4.502251339D0)
     7    + 0.144D0 *DCOS(-(GPV4) +  1.378810109D0)
     8    + 1.024D0 *DCOS(-(G2+V3) +  4.029092578D0)
     9    + 0.152D0 *DCOS(-(G2+V4) +  3.968878719D0)
      DLP = DLP + 0.423D0 *DCOS(-(G2+V5) +  0.869173967500)
     1    + 0.154D0 *DCOS(-(G3+V5) +  3.736749229D0)
      DLP = DLP + 0.273D0 *DCOS(TM +  1.581268302D0)
     1    + 2.043D0 *DCOS(M2 +  1.566607537D0)
     2    + 0.129D0 *DCOS(M3 +  4.764748858D0)
     3    + 1.770D0 *DCOS(-(G-M2) +  5.345411990D0)
     4    + 0.425D0 *DCOS(-(G-M3) +  5.544911034D0)
     5    + 0.500D0 *DCOS(-(G-M4) +  5.531646532D0)
     6    + 0.585D0 *DCOS(-(G2-M4) +  3.243170816D0)
     7    + 0.204D0 *DCOS(-(G2-M5) +  3.237585763D0)
     8    + 0.154D0 *DCOS(-(G2-M6) +  3.228859116D0)
     9    + 0.101D0 *DCOS(-(G3-M6) +  0.940732466D0)
      DLP = DLP + 0.101D0 *DCOS(-(G3-M7) +  0.930260491400)
      DLP = DLP + 7.208D0 * DCOS(TJ + 1.589820416D0)
     1    + 2.731D0 *DCOS(J2 +  4.716752304D0)
     2    + 0.164D0 *DCOS(J3 +  4.628613177D0)
     3    + 0.163D0 *DCOS(J4 + TJ +  1.923352836D0)
     4    + 2.600D0 *DCOS(-(G-TJ) +  3.050311934D0)
     5    + 1.610D0 *DCOS(-(G-J2) +  5.106833992D0)
     6    + 0.556D0 *DCOS(-(G-J3) +  3.094643297D0)
     7    + 0.210D0 *DCOS(-(G2-J3) +  3.371576115D0)
      DLP = DLP + 0.419D0 *DCOS(TS +  1.576730446D0)
     1    + 0.108D0 *DCOS(S2 +  4.714134310D0)
     2    + 0.320D0 *DCOS(-(G-TS) +  4.524242487D0)
     3    + 0.112D0 *DCOS(-(G-S2) +  4.766494187D0)
      DLL = 0.454D0*SIN(D) + 0.177D0*DSIN(D+GL) - 0.424D0*DSIN(D-GL)
     1    + 0.172D0*DSIN(D-G)
      LMP = LSC + (C+DLP + DLL)*STRAD
```



```
      PQR(I,1) = AMAJOR*PQR(I,1)
      PQR(I,2) =    FAC*PQR(I,2)
      PQR(I,3) = AMAJOR*PQR(I,3)
   10 CONTINUE
      KK=1
   20 CONTINUE
C     WRITE(6,3000)PQR
 3000 FORMAT('0PQR  '/(1X,3F20.15))
      RETURN
      END
C*****************************************************************
      SUBROUTINE OUTER
C
C     EVALUATE PERTURBATIONS AND CORRECT THE MEAN POSITION TO THE
C     TRUE POSITION BY THE METHOD OF CARPENTER
C
      IMPLICIT REAL*8(A-H,O-Z)
      REAL*8 YC(730,3),MOTION,MOTR
      REAL*8 RZ(3),WZ(3),PERT(3),PRTP(3)
      COMMON/MOT$/MOTION,MOTR
      COMMON /CHEB$/YC,NFIRST,NPTS
      COMMON/BODY$/XYZH(3),XYZG(3)
      COMMON /PQR$/PQR(3,3)
      COMMON /PI$/RAD,PI,PI02,TWOPI,PI04,STRAD
      COMMON /JULYN$/DAYJ
      COMMON/GAUSS$/GAUSS,TEPOCH,DTCHEB,SA,EC,SO2,SI2,CO2,SM,SGZ2,SMINNR
      NAMELIST/GAU$/GAUSS,TEPOCH,DTCHEB,SA,EC,SO2,SI2,CO2,SM,SGZ2,SMINNR
      NAMELIST/MOT$$/MOTION,MOTR
C     WRITE(6,GAU$)
C     WRITE(6,MOT$$)
C     WRITE(6,3003)((YC(I,J),J=1,3),I=1,10)
 3003 FORMAT('   YC   '/(1X,3F20.4))
      DELT = DAYJ - TEPOCH
      XJ = DELT/(DTCHEB/2.D0)
      IF (DABS(XJ) .GT. 1.D0) GO TO 70
      EM = (SGZ2 + MOTION*DELT)/RAD
      E = EM
      SE = DSIN(E)
      CE = DCOS(E)
      ECC = EC
C     SOLVE KEPLER'S EQUATION:
      DO 10 I = 1,3
      ESE = ECC*SE
      ECE = 1.DO - ECC*CE
      FAC = (EM-E+ESE)/ECE
      E = E + FAC - 0.5DO*FAC*FAC*ESE/ECE
      CE = DCOS(E)
      SE = DSIN(E)
   10 CONTINUE
      CK1 = CE - ECC
      ECE = 1.DO - ECC*CE
      CK2 = -SE/ECE
      CK3 = CE/ECE
C     UNPERTURBED POSITIONAL AND ANGULAR MOMENTUM VECTORS:
      DO 20 I = 1,3
      RZ(I) = PQR(I,1)*CK1 + PQR(I,2)*SE
      WZ(I) = PQR(I,1)*CK2 + PQR(I,2)*CK3
   20 CONTINUE
C     WRITE(6,3002)RZ,WZ
 3002 FORMAT('   RZ   ',3E25.15/
     1       '   WZ   ',3E25.15)
      EX = XJ + XJ
      NTPM = NPTS
      NSTRT = NFIRST
      NTP = NSTRT + NTPM - 1
      NTPM1 = NTPM - 1
C     ACCUMULATE PERTURBATIONS:
      DO 40 IS = 1,3
      B2 = 0.D0
      B1 = 0.D0
      DO 30 I = 1,NTPM1
      II = NTP - I + 1
      B2 = EX*B1 - B2 + YC(II,IS)
      B1 = B2
   30 CONTINUE
      PERT(IS) = 0.5D-6*(EX*B1 - 2.D0*B2 + YC(NSTRT,IS))
   40 CONTINUE
C     WRITE(6,3001)PERT
 3001 FORMAT(' PERT ',3E25.15)
      ALPHA1 = 1.D0 + PERT(1)
      BETA = PERT(2)
      GAMMA = PERT(3)
C     COMPUTE TRUE 1950.0 HELIOCENTRIC EQUATORIAL COORDINATES
      DO 50 I = 1,3
      XYZH(I) = ALPHA1*RZ(I) + BETA*WZ(I) + GAMMA*PQR(I,3)
   50 CONTINUE
      RETURN
   70 CONTINUE
C     WRITE(6,2000) DAYJ
 2000 FORMAT('0JULIAN DAY NUMBER IS OUTSIDE THE RANGE OF CONVERGENCE'/
     1  '  ..............JOB TERMINATED.............'/
     2  '  FAULTY DAY NUMBER = ',F20.3////)
      STOP
      END
C*****************************************************************
      SUBROUTINE PRECES(XYZI,XYZO)
C
C     CONVERT HELIOCENTRIC EQUATORIAL COORDINATES OF EPOCH 1950.0 TO
C     HELIOCCENTRIC ECLIPTIC COORDINATES OF EPOCH OF DATE.
C
      IMPLICIT REAL*8(A-H,O-Z)
      REAL*8 TEMP(3),XYZI(3),XYZO(3)
      COMMON /EPS$/EPS,SEPS,CEPS,TEPS
      COMMON /PI$/RAD,PI,PI02,TWOPI,PI04,STRAD
      COMMON /PREC$/PREC(3,3)
      COMMON /JULYN$/DAYJ
      TZ = 0.5DO
      T = (DAYJ - 2415020.31DO - 36524.21879D0*TZ)/36524.21987D0
      X1 = (((0.018D0*T+0.302D0)*T+2304.25D0+1.396D0*TZ)*TZ)*STRAD
      Z = X1 + ((T*(0.791D0 + T*0.001D0))*STRAD
      THETA = (T*((2004.682D0-0.853D0*TZ)-T*(0.462D0+T*0.042D0)))*STRAD
      CX = DCOS(X1)
      SX = DSIN(X1)
      CZ = DCOS(Z)
      SZ = DSIN(Z)
      CT = DCOS(THETA)
      ST = DSIN(THETA)
      CC = CT*CX
      CS = CT*SX
      TU = (DAYJ - 2415020.D0)/36525.D0
      EPS = (((0.001D0*TU-0.0059D0)*TU-46.845D0)*TU+84428.26D0)*STRAD
      CEPS = DCOS(EPS)
      SEPS = DSIN(EPS)
      PREC(1,1) =  CZ*CC - SZ*SX
      PREC(2,1) =  SZ*CC + CZ*SX
      PREC(3,1) =  ST*CX
      PREC(1,2) = -CZ*CS - SZ*CX
      PREC(2,2) = -SZ*CS + CZ*CX
      PREC(3,2) = -ST*SX
      PREC(1,3) = -CZ*ST
      PREC(2,3) = -SZ*ST
      PREC(3,3) =  CT
      DO 20 I = 1,3
      TEMP(I) = 0.DO
      DO 10 J = 1,3
      TEMP(I) = TEMP(I) + PREC(I,J)*XYZI(J)
   10 CONTINUE
   20 CONTINUE
```

```
      XYZ(1) =  TEMP(1)
      XYZ(2) =  CEPS*TEMP(2) + SEPS*TEMP(3)
      XYZ(3) = -SEPS*TEMP(2) + CEPS*TEMP(3)
      RETURN
      END
C*****************************************************************
      SUBROUTINE JDATE(DJ,D,M,Y)
C
C     DECODE JULIAN DAY NUMBER INTO DAY, MONTH AND YEAR
C           (MODIFIED VAN FLANDERN & FLIEGL ALGORITHM)
C
      INTEGER*4 D,Y
      REAL*8 DJ
      J = DJ + 0.5000CC00001D0
      IF (J .LT. 2298814) GO TO 20
      JJ=J - 1721119
      Y=(4*JJ-1)/146097
      JJ=4*JJ-1- 146097*Y
    5 D=JJ/4
      JJ=(4*D+3)/1461
      E=4*D+3 - 1461*JJ
      D=(D+4)/4
      M=(5*D-3)/153
      E=5*E-3 - 153*M
      D=(D+5)/5
      Y=100*Y + JJ
      IF ( M. LT. 10) GO TO 10
      M=M-9
      Y=Y+1
      RETURN
   10 M=M+3
      RETURN
   20 JJ = J - 1721117
      Y = (4*JJ - 1)/146100
      IF (JJ .LT. 0) Y = Y - 1
      JJ = 4*JJ - 1 - 146100*Y
      GO TO 5
      END
      END
C*****************************************************************
      SUBROUTINE DMS(A,N,NS)
C
C     CONVERT DECIMAL DEGREES TO DEGREES, MINUTES AND SECONDS
C
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION N(3)
      DATA NB/' '/,NM/'-'/
      NS = NB
      IF (A .LT. 0.D0) NS = NM
      AUX = DABS(A) + (1.D0/7200.D0)
      N(1) = AUX
      AUX = (AUX - N(1))*60.D0
      N(2) = AUX
      N(3) = (AUX - N(2))*60.D0
      RETURN
      END
```

```
 JUPITER ELEMENTS
  5.2029737          0.0484525422          274.169895          1.308122
 99.848097           0.0C0954786I          237.954874          0.000005976B2

  0    41.0068    -964.6742    10.3494    -50.3624    -127.7253    -11.9375
  2    60.0357    -817.3009     9.6772    -92.9013     -43.4CC0    -11.4463
  4    56.1745    -254.3264     8.3875   -117.8735    -213.1945    -13.5034
  6    30.4887      -6.5151     6.0424   -113.3665    -196.1025    -14.0284
  8    -1.7558     227.6389     2.8009    -54.3652      46.5609    -11.6129
 10    10.9379    -205.5816    -1.7433   -112.2293    -240.7871    -13.8698
 12   -48.6814      83.3622    -6.9742    -84.6521     -45.6533    -10.1755
 14   -62.4461      36.7154   -11.3516    -78.5943      58.8386     -5.9003
 16   -49.1141     129.6287   -13.5748    -42.5846     203.7166      2.6959
 18    16.7849     233.1693   -10.3020     23.2458     234.2435     12.1237
 20   106.8185     150.8379    -0.7376     76.2245      -9.8271     11.6506
 22   102.5929      55.8459     7.8830     95.7224    -200.2563      6.6656
 24    15.3416    -124.6497    12.3684     36.0233    -122.5103     -5.4167
 26   -37.5174    -119.7082     6.5005    -20.3804     -45.2421    -11.4359
 28   -54.1821     -19.5208    -5.5719    -23.7197     -86.6018     -5.4267
 30  -105.8205     -31.5345   -12.2501    -41.2316     253.1597      5.9139
 32    41.8078      86.2014    -3.2118     12.0688      14.5463     10.0773
 34    38.0307      -9.2830     9.8041      2.1234      87.6261      0.0915
 36   101.9230      25.2031     7.9056     18.8944    -175.1915    -10.3064
 38   -10.0253      11.1649    -8.0801     30.7530    -259.7033     -2.5678
 40  -206.2312    -105.0949    -8.0610    -43.5636     379.8159     11.5993
 42    85.6049     -19.4592    10.1534    -63.3686      68.1574     -4.3768
 44   131.4694     161.9853     1.5852     63.3558    -235.4212     -5.5795
 46   -56.5534      19.2558    -8.8873     82.2052     -71.1815      8.7577
 48  -113.9580    -231.7505     6.9647   -118.1470     245.5480     -3.5167
 50   101.9795     132.6225    -1.2767      3.2562     -91.4539     -2.3500
 52    12.3426      81.4299    -3.1731     74.5184     -76.4076      4.2822
 54   -54.6286    -128.8878     3.7752    -48.8866      57.4334     -3.5556
 56    -0.8246      33.2461    -2.1172    -18.3160      82.8196      1.6722
 58    85.8566     101.3808     1.1932     87.6661    -217.4124     -0.1243
 60  -142.5251    -196.3644    -0.9016   -119.6170     264.3143      0.0001
 62   140.6076     195.3193     0.3045     91.2678    -210.3814     -0.0810
 64   -92.1606    -120.8940    -0.0573    -46.5239     119.7310     -0.2769
 66    46.0670      60.4510     0.2609     26.1330     -58.1662      0.2122
 68   -22.4135     -36.2147    -0.1282    -15.0708      20.8873     -0.0047
 70     2.5940      11.3696    -0.2539     -2.6360      11.7641      0.3271
 72    15.1087      13.6367     0.4072     11.4880     -25.1688     -0.5801
 74   -14.0073     -14.2821    -0.4180     -4.8539      12.6865      0.2467
 76     1.4038       0.0326     0.3743     -3.4566       1.3202      0.1181
 78     3.1821       8.1046    -0.0560      6.0530      -3.7889     -0.0575
 80    -0.7673      -4.5837    -0.3939     -2.2715       1.6458     -0.0593
 82     0.0172      -4.0928     0.4837     -8.0865       1.1556     -0.1304
 84     0.5087      17.0122    -0.2533     13.8119      -3.2505      0.3655
 86    -2.1887     -13.7247     0.1356     -3.4056       1.8081     -0.2664
 88     0.2199      -6.5770    -0.1433    -11.8829       5.2707     -0.0735
 90     6.1467      20.6774     0.0854     15.4927     -13.0274      0.2348
 92   -11.1558     -19.3067    -0.0377    -11.5334      15.5736     -0.2057
 94    10.8666      15.1854     0.0437     10.0323     -12.1095     -0.0115
 96    -6.3916     -13.7407     0.0010     -8.8053       5.6693      0.1593
 98     1.0327       9.4454    -0.0497      4.4335       0.6581     -0.1407
100     2.2057      -2.7382     0.0309     -0.0066      -2.5806      0.0330
102    -2.0042      -1.9774    -0.0418     -2.5266       1.7663      0.0514
104    -0.0494       3.8788    -0.0931     -0.1186      -0.0081      0.1054
106     0.8534      -2.2503     0.0042     -3.3024      -1.4600     -0.0803
108     0.5323      -2.2460     0.0560      2.7004       2.7967      0.0280
110    -2.3731       4.1177    -0.0774      0.4261      -3.4803      0.0333
112     3.4051      -6.9590    -0.0990     -1.2100       3.1220     -0.0027
114    -3.8685      -2.0228     0.0937     -2.3980      -3.0528     -0.0046
116     3.6756       1.1441     0.0476      1.7274       1.3798      0.0084
118    -2.4109       1.1631    -0.0061     -2.6468       0.3242     -0.0052
120     0.6711      -2.7535    -0.0082      3.6265      -1.3755     -0.0089
122     0.6635       4.0900    -0.0032      0.0024       1.6504      0.0140
124    -1.3730      -4.8812     0.0088     -3.7969      -1.6504     -0.0023
126     1.2817       4.4583     0.0005      3.0393       1.1252      0.0022
128    -0.4162      -3.3282    -0.0100     -1.9887       0.1276     -0.0114
130    -0.2551       1.7352    -0.0014      0.5624       0.2150      0.0093
132     0.0355       0.2884     0.0249      0.8631       0.1367     -0.0068
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134    0.3423    -1.4341    -0.7342    -1.0503    -0.1397     0.0115
136   -0.1529     0.7835     0.0297     0.1027    -C.1931    -0.0116
138   -0.1815     0.3688    -0.0229     0.4995     0.3459     0.0071
140    0.0629    -0.5500     0.0091    -0.2530    -0.2560    -0.0057
142   -0.3337     0.0129    -0.0126    -0.1820     C.2925     C.0042
144    0.4715     0.4591    -0.0281     3.4404    -0.3788    -0.0022
146   -0.5058    -0.6300     0.0312    -0.4813     0.4040     0.0069
148    0.4128     0.3937    -0.0270     0.1455    -0.4157    -0.0117
150   -0.4003     0.2255     0.0172     0.4385     0.2578     0.0056
152    0.0809    -0.8682    -0.0046    -0.9423     0.C717     0.0032
154    0.1667     1.3272    -0.0027     1.2859    -0.0133    -0.0033
156    0.0095    -1.6225     0.0023    -1.4177    -0.1877    -0.0007
158   -0.2786     1.5311    -0.0005     1.0732     C.3036     0.0017
160    0.1962    -0.8649     0.0014    -0.3293    -0.0731    -0.0019
162    0.0931     0.0247    -0.0049    -0.2287    -0.1160     0.0016
164   -0.1374     0.4142     0.0105     0.4364     0.0923     0.0012
166    0.0855    -0.3752    -0.0156    -0.2837     0.0055    -0.0023
168    0.0029     0.1531     0.0150     0.0949     C.         C.
170   -0.0967     0.0089    -0.0077    -0.0064     0.1358     0.0014
172    0.1016    -0.C105    -0.0019     0.0556    -0.0536    -0.0019
174   -0.3420    -0.1180     0.0089    -0.1780     0.C065     0.0051
176    0.0856     0.2246    -0.0118     0.2303    -0.1036    -0.0082
178   -0.1857    -0.2114     0.0106    -0.1592     C.1635     0.0068
180    0.1470     0.0869    -0.0066     0.0100    -0.0768    -0.0028
182   -0.0381     0.1647     0.0023     0.1933     0.0338     C.
184    0.0268    -0.3450     0.0002    -0.4121     0.1450     C.0014
186   -0.1852     0.5422    -0.0009     0.5241     0.2580    -0.0013
188    0.2411    -0.5626     C.0006    -0.4424    -0.2469    -0.0004
190   -0.1827     0.3908    -0.0001     0.2257     0.1394     0.0013
192    0.0919    -0.1513     0.0003    -0.0387    -0.0032     0.0001
194    0.0514    -0.0295    -0.0022    -0.0769    -0.0744    -0.0015
196   -0.0775     0.1050     0.0048     0.1015     0.0377     0.0016
198    0.0158    -0.0881    -C.0059    -0.0578     0.0305    -0.0016
200    0.0210     0.0301     0.0045     0.0065    -0.C266     0.0013
202    0.         0.0016    -0.0016    -0.0047    -0.0040     0.0005
204    0.0045     C.C206    -0.0013     0.C414    -0.0165    -0.0028
206   -0.0091    -0.0664     0.0033    -0.0901     0.C471     0.0042
208    0.0604     0.0952    -0.0035     0.1020    -0.0321    -0.0042
210   -0.0293    -0.0851     0.0025    -0.0668     0.C071     0.0031
212    0.0150     0.0245    -0.0015    -0.0170    -0.0231    -0.0010
214   -0.0044     0.C717     0.0007     0.1165    -0.C799    -0.0006
216    0.1014    -0.1520     0.        -0.1630    -0.1450     C.C007
218   -0.1496     0.1760    -0.0002     0.1557     0.1692    -0.0001
220    0.1389    -0.1501     C.0001    -0.1131    -0.1184    -0.0001
222   -0.0675     0.0965     0.0002     0.0598     0.0333     C.
224   -0.0014    -0.0303     C.0005    -0.0002     0.0143     0.0003
226    0.0223    -0.0227    -0.0015    -0.0321    -0.C164    -C.0010
228   -0.0189     0.0174     0.0021     0.0274     0.0124     0.0015
230    0.0187    -0.0224    -0.0020    -0.0056    -0.C122    -0.0013
232   -0.0128     0.0064     0.0012     0.0025     0.C027     0.0005
234    0.0043    -0.0054    -0.0001    -0.0126     0.0107     0.0007
236   -0.0067     0.0204    -0.0006     0.0353    -0.C139    -0.0018
238    0.0148    -0.0412     0.0007    -0.0525     0.0049     0.0023
240   -0.0035     0.0465    -C.0007     0.0432    -0.0069    -0.0020
242    0.0041    -0.0255     0.0006    -0.0125     C.0040     0.0010
244   -0.0090     0.0053    -0.0003     0.0157    -0.0067    -0.0002
246   -0.0055     0.C270     0.         0.C326     0.C692    -0.0002
248    0.0080    -0.0403    -0.         0.0430    -0.CE67     0.0003
250   -0.0054     0.0469     C.0001     0.0435     0.0736    -0.0001
252    0.0050    -0.0398    -C.0001    -0.0252    -0.C427    -0.0001
254   -0.0020     0.0200    -0.0001     0.0087     0.0151     0.0001
256    0.0020    -0.C001     0.0004     0.0058     0.0039     0.0005
258   -0.0019     0.0105    -0.0007    -0.0097    -0.C132    -C.C008
260    0.0163    -0.0099     0.0008     0.0044     0.0127     0.0009
262   -0.0113     0.0028    -0.0005     0.0014    -0.C059    -0.0006
264    0.0025    -0.0004     0.0002     0.0035    -0.C019     0.0001
266   -0.0043     0.0041    -0.0001     0.0165     0.0050     0.0006
268    0.0043    -0.0193     0.         0.C235    -0.0001    -C.0010
270   -0.0025     0.0196     0.        -0.0192    -0.0084     0.0010
272   -0.0006.    0.0126     C.         0.0112     0.C087    -0.0008

274    0.0026    -0.0062     0.        -0.0045     0.C047     0.0004
276    0.0141     0.0013              -0.0010    -0.C035
278   -0.0303     0.0039              -0.0064     0.0371    -0.0041
280    0.0377    -0.0082    -0.0001    -0.0053    -0.C390     0.0031
282   -0.0346     0.0095     0.0001    -0.0085    -0.0309
284    0.0225    -0.C068    -0.0001    -0.0040     0.0171    -0.0031
286   -0.0090     0.0009    -0.0001    -0.CC15     0.C033    -C.0002
288   -0.0027     0.0034     0.0002     0.0026     0.0054     0.0004
290    0.0081    -0.0029    -C.0002    -0.0011    -0.C079    -0.0005
292   -0.0015     0.0001     0.0001    -0.0025     0.C054     0.0004
294    0.0006    -0.0001    -0.0001    -0.0011    -0.C012    -0.0002
296    0.0001     0.0043     0.0001     0.CCE7    -0.C009    -0.0001
298   -0.0032    -0.0078    -0.0001    -0.0013    -0.0012     0.0003
300    0.0012     0.0077     C.0001     0.0083     0.0051    -0.0003
302    0.0059    -0.0059    -0.0001    -0.0063    -0.C066     0.0004
304   -0.0045     0.0042     0.0001     0.0047     0.0022    -0.0003
306   -0.0011     0.C036     0.0001    -0.CC38     0.C050     0.0001
308    0.0006    -0.0034              -0.0028    -0.C127
310   -0.0151    -0.0021     0.0001    -0.0010     0.0174
312    0.0175     0.0006    -0.0001     0.C0C3    -0.C169
314   -0.0144    -0.0007     0.0001    -0.0013     0.0117
316    0.0079     0.0020               0.0020    -0.0048     0.0001
318   -0.0014    -0.0017              -0.0005    -0.CC07    -0.0001
320   -0.0027    -0.0006              -0.0019     0.0034     0.0002
322    0.0037     0.0019               0.0024    -0.C031    -0.0002
324   -0.0025    -0.0012              -3.0006     0.C016     0.0002
326    0.0011     0.0010              -0.0019    -0.0007    -0.0001
328   -0.0010     0.0029               0.0025     0.C035     0.0001
330    0.0020    -0.0032    -0.0001    -0.0034    -0.0025     0.0002
332   -0.0031     0.0024     C.0001     0.0026     0.0033    -0.0002
334    0.0035    -0.0018    -0.0001    -0.0024    -0.C029     0.0001
336    0.0021     0.0001     0.0001     0.0020     0.0007    -0.0001
338   -0.0010    -0.0026              -0.CC26     0.C031
340    0.0048     0.0026               0.0024    -0.C064
342   -0.0072    -0.0026              -0.0026     0.0076
344    0.0029     0.0017              -0.0025    -0.C063
346   -0.0049    -0.0028              -0.0022     0.0036
348    0.0020     0.0017               0.0007    -0.0008
350    0.0003                          0.0009    -0.CC08    -C.0001
352    0.0001    -0.0012              -0.0016     0.0012     0.0001
354    0.0011     0.0012               0.0011    -C.C010    -0.0001
356   -0.0010    -0.0003               0.0001     0.CC09     0.0001
358    0.0005    -C.0008              -0.0010     0.C009
360   -0.0011     0.0011               0.CC12     0.0011
362    0.0012    -0.C009    -0.0001    -0.0010    -0.C017     0.0001
364   -0.0021     0.0007     C.0001     0.0009     0.0020    -0.0001
366    0.0007    -0.0001    -0.0001    -0.0010    -0.CC15
368   -0.0009     0.0010               0.0012
370   -0.0008    -0.0014              -0.CC16     0.C017
372    0.0023     0.0020               0.0022    -0.C028
374   -0.0025     0.0024               0.0024     0.0027
376    0.0023     0.0023               0.0020    -C.C018
378   -0.0013    -0.0016              -0.0010     0.0008
380    0.0004     C.0005              -0.0001     0.C001
382    0.0001     0.0004               0.0008    -C.CCC2
384   -0.0003    -C.0008              -0.0009     0.0005     0.0001
386   -0.0005     0.0005               0.0004    -C.C005
388   -0.0001     0.0001                         -0.0004
390    0.0005    -C.C002              -0.0003    -0.0005
392   -0.0008     0.0003               0.0003     0.CCC8
394    0.0011    -0.0002              -0.0002    -0.0011
396   -0.0013     0.0001               0.0001     0.CC11
398    0.0010    -0.0001              -0.0003    -0.C006
400   -0.0003     0.0005               0.0007    -0.0002
402   -0.0008    -0.0010              -0.CC12     0.C007
404    0.0008     0.0014               0.0015    -0.C008
406   -0.0008    -0.0015              -0.0014     0.0007
408    0.0005     0.0012               0.0CC5    -0.0004
410   -0.0004    -0.0007              -0.0003     0.0002
412    0.0001     C.0001              -0.0CC2
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414		0.0003		0. 0005	-0. 0001
416	-0.0001	-0.0004		-0.0004	0.0002
418	0.0001	0.0003		0.0002	-0.0002
420	-0.0002	-0.0001			0.0002
422	0.0003				-0.0004
424	-0.0005				0.0005
426	0.0007	0.0001		0.0001	-0. 0006
428	-0.0006	-0.0001		-0.0001	0.0004
430	0.0003			-0.0002	-0.0002
432	-0.0001	0.0003		0.0005	
434	-0.0001	-0.0006		-0.0007	0.0001
436	0.0001	0.0008		0.0008	-0. 0001
438	-0.0001	-0.0007		-0.0007	0.0001
440	0.0001	0. 0005		0.0004	-0.0001
442	-0.0001	-0.0002		-0. 0001	
444		-0.0001		-0.0002	
446		0.0002		0.0003	
448		-0.0002		-0.0002	
450		0.0001		0.0001	-0.0001
452	-0.0001				0.0001
454	0.0002	0.0001		0.0001	-0. 0002
456	-0.0003	-0.0001		-0.0001	0.0003
458	0.0003	0.0001		0.0001	-0. 0002
460	-0.0002	-0.0001			0.0002
462	0.0001			-0.0001	-0.0001
464	-0.0001	0.0002		0.0003	0. 0001
466	0.0001	-0.0003		-0.0004	-0.0001
468	-0.0001	0.0004		0.0004	0. 0001
470		-0.0003		-0. 0003	
472		0.0002		0.0001	
474					
476		-0.0001		-0.0001	
478	-0.0001	0.0001		0.0001	
480	0.0001	-0.0001		-0.0001	
482				0.0001	
484	-0.0001	0. 0001		-0.0001	0. 0001
486	0.0001	0.0001		0.0001	-0. 0001
488	-0.0001	-0.0001		-0.0001	0.0001
490	0.0001	0.0001		0.0001	-0. 0001
492	-0.0001				0. 0001
494	0.0001			-0.0001	-0.0001
496	-0.0001	0.0001		0. 0001	0.0001
498	0.0001	-0.0002		-0.0002	-0.0001
500	-0.0001	0. 0002		0.0002	0.0001
502	0.0001	-0.0001		-0.0001	
504		0.0001			
506					
508					
510					
512					
514					
516				-0.0001	
518		0.0001		0.0001	
520		-0.0001		-0.0001	
522		0.0001			
524					
526					
528	-0.0001			0.0001	0. 0001
530	0.0001	-0. 0001		-0.0001	-0.0001
532	-0.0001	0. 0001		0.0001	
1004					

SATURN ELEMENTS

9.5371950	0.054179408	338.991032	2.486946	
113.382301	0.000285584	180.374080	0 00000597682	
0	757.4862	2557.6035	-374.6214	-117.5646
2	-11.2971	2395.4467	-31.9203	146.5709
4	-9.0744	967.6583	-26.0238	364.2359
6	97.2528	86.2457	-11.7247	408.9010
8	223.2753	-492.9087	9.2092	41.5352
10	6.3576	426.4257	31.1112	317.0505

12	140.3357	-659.3633	26.9513	-107.3764	-324.9522	-55.9981
14	-186.8598	80.1544	-11.2740	-129.0829	-175.5183	-28.7434
16	-413.6345	367.7741	-28.0946	80.8977	152.8467	41.8188
18	-30.8178	-149.5045	15.9630	-5.1778	240.2706	-4.9858
20	394.7312	-210.2148	5.7539	-88.2616	-211.3451	-21.0426
22	-15.2782	163.2504	-11.2151	135.9595	134.0736	18.1213
24	-242.1472	-88.6429	5.2517	-105.5253	-37.5114	-6.9453
26	-13.0341	23.2219	-0.8876	-77.9813	11.5231	2.3811
28	255.7081	38.3075	3.7553	136.2915	46.6929	9.1210
30	-284.2382	-6.5616	-0.6444	-94.4764	-59.1773	-5.0597
32	231.5779	9.8748	-1.5604	72.7000	-51.0938	0.9746
34	-162.0822	-26.1567	-1.9357	-34.4429	44.0833	2.0353
36	94.6246	-3.0089	1.8724	-14.6653	66.1371	-0.3547
38	-49.3761	24.5922	1.1826	7.0355	-68.9855	-1.8325
40	29.2013	6.5140	-1.7666	19.7551	32.3549	1.4425
42	26.3300	-15.9477	-0.2820	6.2526	-41.3253	0.1882
44	-48.7061	-15.7794	1.5766	-18.1907	33.4259	-0.7201
46	54.1266	7.3700	-0.4698	11.6462	-5.1741	-0.6533
48	29.2244	20.1881	-1.4199	16.7389	-12.5975	1.8763
50	-12.2890	-2.3707	2.8350	11.2729	-20.1820	-1.5989
52	-23.1361	-29.3539	-2.0184	-24.1111	35.6666	2.5456
54	23.3740	29.2111	1.2514	12.7304	-23.9561	-0.7208
56	-3.9919	-3.9732	-1.0072	2.0572	-1.7880	0.4760
58	-16.6763	-11.7436	0.4265	-22.0305	31.4243	-0.2407
60	37.3560	30.6574	0.0894	36.7463	-46.3659	0.2173
62	-34.5746	-36.2562	0.0902	-26.3659	35.3281	-0.1330
64	28.9982	26.4505	-0.2405	8.7824	-17.8349	0.0161
66	-12.6758	-7.5062	-0.0995	-7.5743	10.7821	-0.0218
68	2.1002	6.3830	0.2153	8.3252	-4.5285	0.0576
70	2.6652	-1.7969	0.0688	2.9347	-5.1309	-0.0708
72	-6.9978	-5.2285	-0.2437	-9.3866	10.4452	0.1419
74	4.4825	2.9059	0.2768	5.9564	-2.2324	-0.1353
76	0.1268	2.5660	-0.2611	-2.9690	-0.5725	0.0591
78	-0.8255	-2.0872	-0.0004	-3.6468	4.0157	0.1054
80	-1.4029	-0.8942	0.3626	2.4900	-3.3743	-0.1940
82	4.3205	4.0762	-0.4191	1.5548	0.4065	0.1188
84	-6.1160	-8.0351	0.2659	-5.9128	1.2572	-0.0980
86	4.5631	6.8963	-0.2062	1.3882	0.4170	0.0454
88	-0.0447	1.2737	0.1573	6.7922	-3.6853	-0.0491
90	-4.1323	-7.3972	-0.0157	-8.8812	5.5740	-0.0115
92	5.8276	7.2140	-0.0581	6.9931	-5.5484	0.0727
94	-5.5047	-6.1004	0.0148	-6.7534	4.4543	-0.0837
96	4.0818	6.0151	0.0165	5.6603	-2.8439	0.0380
98	-2.0513	-3.8348	-0.0219	-2.0149	1.1394	0.0398
100	1.0232	0.5117	0.0229	-0.8356	0.4913	-0.0375
102	1.2575	1.4280	0.0472	1.7708	-1.0949	-0.0645
104	-1.1830	-2.0885	-0.1442	-1.7865	0.7006	0.0669
106	0.5003	1.2593	0.1283	0.2621	-0.1419	-0.0329
108	-0.1554	-0.8993	-0.0198	1.6435	0.0316	-0.0118
110	0.1502	-1.6445	-0.0598	-0.9022	-0.6442	0.0231
112	-0.1904	-0.3751	0.0971	-1.5290	0.1587	-0.0265
114	0.4344	2.0622	-0.1227	2.1012	-0.4429	0.0138
116	-0.6967	-1.3041	0.1131	-0.7209	0.4852	-0.0049
118	0.4079	-0.2729	-0.0685	-0.6351	-0.0133	0.0116
120	-0.2644	1.2930	0.0277	1.7362	-0.5106	-0.0222
122	-0.7395	-2.0701	0.0032	-2.7487	0.7636	0.0322
124	0.9583	2.5113	-0.0245	2.9920	-0.8422	-0.0069
126	-0.9155	-2.3212	0.0129	-2.4404	0.4220	-0.0083
128	0.4321	1.8264	0.0172	1.5097	-0.1201	0.0217
130	0.0851	-1.0286	-0.0169	-0.2540	-0.1264	-0.0387
132	-0.1090	-0.1552	-0.0151	-0.9513	0.0003	-0.0064
134	-0.0138	0.8364	0.0188	1.0608	-0.0177	0.0346
136	-0.1981	-0.3774	-0.0390	-0.1966	0.2303	0.
138	0.2969	-0.3570	0.0246	-0.3457	-0.2247	-0.0021
140	-0.1541	0.4136	0.0003	0.1190	0.0506	0.0079
142	0.0452	-0.0070	-0.0272	0.2457	-0.1064	-0.0090
144	-0.0840	-0.3258	0.0417	-0.5162	0.0412	0.0061
146	0.0960	0.4321	-0.0425	0.4874	-0.0702	-0.0106
148	-0.1228	-0.2534	0.0356	-0.1253	0.1185	0.0155
150	0.1650	-0.1591	-0.0208	-0.3783	-0.1124	-0.0367

152	-0.0406	0.5451	0.0029	0.7608	-0.0574	-0.0047
154	-0.1078	-0.8031	0.0058	-1.0183	0.0803	0.0026
156	-0.0035	0.9918	-0.0022	1.1302	0.1138	0.0050
158	0.1905	-0.9594	-0.0037	-0.8109	-0.1819	-0.0368
160	-0.2514	0.5544	0.0043	0.2900	0.2310	0.0648
162	-0.0506	-0.0312	0.0004	0.1309	0.0763	-0.0008
164	0.0762	-0.2342	-0.0017	-0.2840	-0.0370	-0.0047
166	-0.0139	0.1983	0.0145	0.1524	-0.0836	0.0095
168	-0.0434	-0.0540	-0.0135	-0.0020	0.0883	-0.0008
170	0.0912	-0.0439	0.0067	-0.0515	-0.0936	-0.0020
172	-0.0652	0.0311	0.0032	-0.0213	0.0138	0.0027
174	-0.0170	0.0696	-0.0116	0.1428	0.0395	-0.0175
176	0.0063	-0.1416	0.0160	-0.1903	0.2256	0.0129
178	0.0760	0.1293	-0.0153	0.1324	-0.0774	-0.0114
180	-0.0669	-0.0508	0.0101	-0.0056	0.0301	0.0051
182	0.0063	-0.0692	-0.0036	-0.1604	-0.0132	-0.0002
184	-0.0458	0.2260	-0.0006	0.3438	0.1007	-0.0019
186	0.1579	-0.3598	0.0016	-0.4389	-0.1805	0.0009
188	-0.1938	0.3764	-0.0011	0.3737	0.1697	0.0020
190	0.1403	-0.2614	0.0002	-0.1959	-0.1952	-0.0027
192	-0.0451	0.0987	-0.	0.0303	0.0630	0.
194	-0.0435	0.0238	0.0016	0.0670	0.0482	0.0023
196	0.0582	-0.0731	-0.0043	-0.0834	-0.0178	-0.0023
198	-0.0008	0.0593	0.0057	0.0455	-0.0325	0.0022
200	-0.0306	-0.0185	-0.0043	-0.0041	0.0249	-0.0021
202	0.0049	-0.0038	0.0012	0.0020	0.0091	-0.0003
204	0.0052	-0.0105	-0.0020	-0.0342	-0.0037	0.0042
206	0.0168	0.0406	-0.0044	0.0668	-0.0223	-0.0068
208	-0.0184	-0.0600	0.0048	-0.0766	0.0103	0.0071
210	-0.0035	0.0549	-0.0036	0.0513	0.0050	-0.0051
212	0.0159	-0.0159	0.0021	0.0138	0.0113	0.0017
214	0.0346	-0.0499	-0.0009	-0.0916	-0.0558	0.0006
216	-0.0903	0.1068	-0.0003	0.1310	0.1054	-0.0306
218	0.1328	-0.1245	0.0009	-0.1344	-0.1238	0.0003
220	-0.1230	0.1064	-0.0004	0.1001	0.0861	0.0005
222	0.0599	-0.0683	-0.0001	-0.0493	-0.0234	-0.0001
224	-0.	0.0208	-0.0004	-0.0023	-0.0099	-0.0003
226	-0.0176	0.0126	0.0013	0.0299	0.0091	0.0010
228	0.0131	-0.0281	-0.0020	-0.0260	-0.0054	-0.0018
230	-0.0117	0.0168	0.0020	0.0106	0.0062	0.0018
232	0.0074	-0.0049	-0.0011	-0.0033	-0.0009	-0.0007
234	0.0033	0.0032	-0.0001	0.0007	-0.0071	-0.0011
236	-0.0086	-0.0125	0.0008	-0.0243	0.0076	0.0029
238	0.0031	0.0270	-0.0008	0.0377	-0.0001	-0.0038
240	0.0072	-0.0313	0.0008	-0.0317	-0.0087	0.0031
242	-0.0118	0.0167	-0.0009	0.0081	0.0059	-0.0017
244	-0.0036	0.0050	0.0005	0.0148	0.0183	0.0004
246	0.0390	-0.0202	0.	-0.0293	-0.0815	0.0001
248	-0.0690	0.0297	-0.0002	0.0383	0.0666	-0.0002
250	0.3704	-0.0349	0.0001	-0.0384	-0.5548	0.0001
252	-0.0484	0.0297	0.	0.0254	0.0314	0.0001
254	0.0222	-0.0147	0.0001	-0.0072	-0.0110	-0.
256	-0.0020	-0.0004	-0.0004	-0.0055	-0.0027	-0.0004
258	-0.0102	0.0085	0.0007	0.0094	0.0093	0.0039
260	0.0130	-0.0082	-0.0008	-0.0055	-0.0088	-0.0011
262	-0.0086	0.0026	0.0004	0.0038	0.0038	0.0008
264	0.0017	-0.0002	-0.0001	-0.0026	0.0017	-0.
266	0.0029	0.0061	0.0001	0.0118	-0.0037	-0.0009
268	-0.0015	-0.0135	-0.0002	-0.0168	-0.0005	-0.0016
270	-0.0058	0.0134	0.0001	0.0132	0.0074	-0.0016
272	0.0108	-0.0081	-0.	-0.0074	-0.0076	0.0012
274	-0.0046	0.0038	-0.	0.0029	-0.0031	-0.0006
276	-0.0114	-0.0007	-0.	0.0017	0.0183	0.0001
278	0.0269	-0.0030	0.	-0.0060	-0.0286	0.0002
280	-0.0338	0.0062	-0.	0.0082	0.0301	-0.0001
282	0.0309	-0.0073	-0.0001	-0.0075	-0.0233	-0.
284	-0.0207	0.0051	0.	0.0036	0.0131	-0.
286	0.0078	-0.0007	0.0001	0.0012	-0.0025	0.0001
288	-0.0024	-0.0028	-0.0003	-0.0025	-0.0041	-0.0004
290	-0.0071	0.0018	0.0002	-0.0003	0.0060	0.0005

292	0.0066	0.0009	-0.0001	0.0017	-0.0040	-0.0005
294	-0.0030	-0.0003	0.	0.0012	0.0007	0.0003
296	-0.0002	-0.0033	-0.0001	-0.0052	0.0009	0.0001
298	-0.	0.0057	0.0002	0.0066	0.0010	-0.0005
300	0.0034	-0.0055	-0.0003	-0.0056	-0.0041	0.0007
302	-0.0061	0.0039	0.0002	0.0040	0.0049	-0.0007
304	0.0048	-0.0027	-0.0002	-0.0029	-0.0019	0.0004
306	0.0035	0.0025	0.0001	0.0027	-0.0039	-0.0002
308	-0.0077	-0.0026	-0.0001	-0.0022	0.0100	-0.
310	0.0137	0.0017	-0.	0.0010	-0.0138	0.
312	-0.0156	-0.0005	0.0001	-0.0003	0.0134	
314	0.0134	0.0006		0.0011	-0.0093	
316	-0.0077	-0.0016		-0.0016	0.0038	
318	0.0013	0.0014	0.0001	0.0004	0.0006	0.0001
320	0.0034	0.0002	-0.0001	0.0015	-0.0027	-0.0002
322	-0.0034	-0.0014		-0.0018	0.0025	0.0003
324	0.0022	0.0008		0.0003	-0.0012	-0.0002
326	-0.0009	0.0009		0.0016	0.0005	0.0001
328	0.0008	-0.0023	-0.0001	-0.0026	-0.0010	0.0001
330	-0.0018	0.0024	0.0002	0.0023	0.0019	-0.0002
332	0.0029	-0.0016	-0.0002	-0.0015	-0.0026	0.0003
334	-0.0032	0.0011	0.0002	0.0014	0.0024	-0.0002
336	0.0020	-0.0009	-0.0002	-0.0018	-0.0005	0.0001
338	0.0009	0.0020	0.0001	0.0021	-0.0025	
340	-0.0044	-0.0020		-0.0022	0.0052	
342	0.0066	0.0021		0.0034	-0.0061	
344	-0.0065	-0.0024		-0.0026	0.0051	
346	0.0045	0.0023		0.0020	-0.0029	
348	-0.0018	-0.0014		-0.0006	0.0006	-0.0001
350	-0.0002			-0.0008	0.0007	0.0001
352	0.0021	0.0009		0.0014	-0.0010	-0.0001
354	-0.0011	-0.0009		-0.0009	0.0008	0.0001
356	0.0009	0.0002		-0.0002	-0.0007	-0.0001
358	-0.0007	-0.0006		0.0008	-0.0007	
360	0.0009	-0.0009	-0.0001	-0.0008	-0.0009	0.0001
362	-0.0013	0.0006	0.0001	0.0006	0.0014	-0.0001
364	0.0018	-0.0004	-0.0001	-0.0005	-0.0016	0.0001
366	-0.0018	0.0005	0.0001	0.0006	0.0012	-0.0001
368	0.0007	-0.0007	-0.0001	-0.0009		
370	0.0008	0.0011		0.0014	-0.0014	
372	-0.0022	-0.0016		-0.0016	0.0023	
374	0.0026	0.0020		0.0022	-0.0022	
376	-0.0021	-0.0019		-0.0018	0.0015	
378	0.0012	0.0013		0.0005	-0.0007	
380	-0.0004	-0.0004		0.0001	-0.0001	
382	-0.0001	-0.0003		-0.0007	0.0002	
384	0.0003	0.0006		0.0007	-0.0004	-0.0001
386	-0.0004	-0.0004		-0.0003	0.0004	0.0001
388	0.0004				-0.0004	
390	-0.0004	0.0002		0.0002	0.0004	
392	0.0006	-0.0002		-0.0002	-0.0007	
394	-0.0009	0.0001	0.0001		0.0009	
396	0.0011		-0.0001		-0.0009	
398	-0.0008	0.0001	0.0001	0.0002	0.0005	
400	0.0002	-0.0004		-0.0006	0.0002	
402	0.0005	0.0008		0.0011	-0.0006	
404	-0.0008	-0.0011		-0.0014	0.0007	
406	0.0007	0.0013		0.0013	-0.0005	
408	-0.0005	-0.0010		-0.0009	0.0003	
410	0.0003	0.0005		0.0003	-0.0002	
412	-0.0001			0.0002		
414		-0.0003		-0.0004	0.0001	
416	0.0001	0.0003		0.0004	-0.0001	
418	-0.0001	-0.0002		-0.0002	0.0001	
420	0.0002	0.0001			-0.0002	
422	-0.0003			0.0003		
424	0.0004			-0.0001	0.0004	
426	-0.0005	-0.0001		-0.0002	0.0005	
428	0.0005	0.0001		0.0001	-0.0004	
430	-0.0003			0.0001	0.0001	

432		-C. 0003	-0.0004		
434	0.0001	0.0005	0.0007	-C. CCC1	
436	-0.0001	-C. 0007	-0.0007	0.0001	
438	0.0001	0.0006	0. 0006	-0. C001	
440	-0.0001	-0.0004	-0.0003	0. C001	
442	0. 0001	0.0002	0.0001		
444			C. CCC2		
446		-0.0002	-0.0002		
448		0. 0002	0.0002		
450		-0.0001	-0.0001		
452	0.0001			-0.0001	
454	-0.0002		-0.0001	0.0002	
456	0.0002	0.0001	0.0001	-0. CCC2	
458	-0.0002	-C. 0001	-0.0001	0.0002	
460	0.0002	0.0001		-0. C001	
462	-0.0001		0.0001	0.0001	
464	0.0001	-0.0002	-0.0001	-0.0001	
466		0.0003	0. CCC3	0.0001	
468		-0.0003	-0.0003		
470		0. 0003	0.0003		
472		-0.0002	-0.0001		
474	0.				
476		0. 0001	0.0001		
478	0.0001	-0.0001	-0. CCC1		
480		0.0001	0.0001		
482	0.				
484	0.0001		0.0001	-0.0001	
486	-0.0001	-0.0001	-0.0001	0.0001	
488	0.0001	C. 0001	0.0001	-0.0001	
490	-0.0001	-0.0001	-0.0001	0. CCC1	
492	0.0001			-0.0001	
494	-0.0001		0.0001	C. 0001	
496	0.0001	-0.0001	-0.0001	-0.0001	
498	-0.0001	0. 0001	0.0002	0.0001	
500	0.0001	-0.0001	-0. CCC1	-0. CCC1	
502	-0.0001	0.0001	0.0001		
504	0.				
506	0.				
508	-0.				
510	0.				
512	-0.				
514	-0.				
516			0.0001		
518		-0.0001	-0.0001		
520		0.0001	0.0001		
522	-0.				
524	0.				
526	-0.				
528	0.0001		-0.0001	-0.0001	
530	-0.0001	0.0001	0.0001	0. C001	
532	0.0001	-0.0001			
1001					

URANIC ELEMENTS

19.1843426	0.647328819	96.312192	0.773735	
73.745938	0.000043727	76.119648	0. 000005 97682	

0	1046.2359	114.9270	18.9247	-324.6979	617.3822	5.1954
2	226.6035	372.3200	19.0866	-222.8549	-287.1911	0.2276
4	29.9345	475.5590	23.6937	27.0461	-12.5666	-6.0900
6	-119.2144	61.7762	-2.7651	61.9505	229.2651	-2.0008
8	-33.9696	-120.3346	-7.9512	-7.6579	30.9209	2.2295
10	-100.0789	10.7094	1.8721	41.3225	34.5611	C.5537
12	42.2824	15.5561	-0.9432	-36.8013	62.8249	0.7729
14	-114.7817	-29.2419	0.8517	23.9723	-43.1379	-1.0549
16	-21.6738	-6.0101	-0.5538	-6.6364	-58.5533	0.1706
18	-10.3457	1.3378	-0.4365	2.2163	-59.8947	1.4796
20	47.0741	0.6814	1.6342	2.7549	-19.1529	-1.3637
22	63.8854	7.3115	-0.1042	0.7623	44.4596	0.0587
24	27.5321	-4.3427	0.2121	-10.1897	58.6414	-0.5821
26	-55.0482	3.6993	-0.5295	4.6910	12.1505	0.0551
28	-56.3164	-8.4237	-0.5503	1.4721	-65.7747	0.4155

30	20.0343	4.5307	0.0416	8.5906	-34.1075	0.2487
32	69.8262	5.3215	0.5563	-5.5134	58.4358	-0.0630
34	-17.8565	-1.7887	0.3579	10.17579	35.1151	0.5546
36	-69.0427	-8.6662	-C.5102	13.2614	-75.6061	0.0780
38	50.2281	12.6758	-0.4265	-3.0135	11.4073	0.4193
40	35.3541	-2.2451	0.4906	-9.9331	70.0625	-0.0253
42	-92.6815	-14.3570	0.1888	14.6578	-98.0510	-0.5027
44	91.7728	17.3031	-0.7487	-9.9251	77.C110	C.4298
46	-61.3134	-8.6986	0.1674	6.3961	-44.9900	0.1228
48	32.1787	0.9289	0.6034	-3.7910	2C.6017	0.5630
50	-13.4623	5.1197	-0.9312	0.5815	-6.9423	C.1102
52	4.6220	-6.1284	C.8076	-1.0443	2.4794	-0.4638
54	-1.6530	2.9332	-0.5143	0.4863	-1.2561	C.2715
56	0.2968	-2.1088	0.2656	0.4782	-0.3602	-0.1070
58	0.0225	1.8881	-0.1199	-0.2032	0.3292	0.3383
60	0.3238	0.3054	0.0514	-1.0421	0.6225	-0.0227
62	-0.0633	-0.5152	-0.1240	-0.1228	-0.0217	0.0078
64	-0.3701	-1.0610	0.0101	0.7836	-0.5975	0.0120
66	0.0366	0.4962	-0.0012	0.5901	-0.2446	0.0113
68	0.3176	0.9420	C.0006	-0.8977	0.6664	-0.0141
70	0.1491	-0.2709	-0.0028	0.5158	0.1274	-0.0157
72	-0.5384	-1.0900	0.3033	0.8607	-0.4863	0.0340
74	0.0378	0.5460	-0.0036	0.5153	-0.C568	0.0130
76	0.5035	0.9592	0.0037	-1.1360	0.3582	-0.0012
78	-0.1965	-0.8785	-0.0032	0.1257	-0.1414	0.0151
80	-0.4837	-0.5634	0.0015	1.3466	-0.2246	0.0059
82	0.5815	1.1359	0.0018	-0.8817	0.2533	0.0123
84	0.0413	-0.1763	-0.0021	-0.5410	0.6491	-0.0102
86	-0.6877	-1.0182	-0.0021	1.3901	-0.2237	-C.0065
88	0.7842	1.2434	0.0042	-1.0340	-0.C076	0.0142
90	-0.4007	-0.3809	-C.0019	-0.1325	C.3631	-0.0036
92	-0.1293	-0.8638	-0.0030	1.2343	-0.5633	-0.0114
94	0.5689	1.6506	0.0028	-1.6640	0.6495	0.0152
96	-0.6842	-1.7151	-0.0032	1.5C63	-0.C599	-0.0055
98	0.5466	1.3690	0.0013	-1.1434	0.5484	-0.0090
100	0.3423	0.9232	-0.0013	0.7606	-0.3763	0.0192
102	0.2207	0.4948	-0.0020	-0.4113	0.2479	-0.0218
104	-0.1482	-0.1946	0.0016	0.1483	-0.1629	0.0192
106	0.0532	0.0854	-0.0016	-0.1C67	C.0867	-0.0143
108	0.0254	-0.0626	0.0014	0.0659	-0.C3CE	C.0095
110	-0.0129	0.0108	-0.0007	-0.0205	0.0210	-0.0043
112	-0.0424	0.0390	0.0004	-0.0046	-0.C093	C.0022
114	0.0325	-0.0187	-0.0002	-0.0046	0.0070	C.0012
116	0.0245	-0.0317	0.0006	0.0119	0.0070	0.0003
118	-0.0312	0.0331	-0.0001	0.0052	0.C052	C.0003
120	-0.0135	0.0123	-0.0001	-0.0199	-0.0163	-0.0002
122	0.0365	-0.0399	0.0003	-0.0052	C.C102	-0.0002
124	-0.0153	0.0223	0.0003	0.0465	0.C260	0.0003
126	-0.0133	0.0062	C.0001	-0.0496	-0.0285	0.0001
128	0.0238	-0.0093	-0.0004	0.CC16	-0.0068	-C.0004
130	-0.0199	-0.0083	0.0002	0.0365	0.0151	0.0003
132	0.0160	0.0182	C.0003	-0.0436	-0.0621	-0.0001
134	-0.0251	-0.0061	-0.0004	0.0143	0.C328	-C.
136	0.0409	-0.0181	-0.	0.0196	0.0046	0.
138	-0.0480	0.0350	C.0006	-0.C32C	-0.C186	-0.
140	0.0395	-0.0313	-0.0007	0.0202	0.C082	0.0001
142	-0.0183	0.0080	C.0004	-0.0031	0.0093	-0.0002
144	-0.0090	0.0017	0.0002	-0.0027	-0.C240	C.0003
146	0.0306	-0.0419	-0.0004	0.0407	0.0350	-C.0003
148	-0.0342	0.0468	0.0003	-0.0455	-0.0381	0.0003
150	0.0295	-0.0414	0.	0.0401	0.C302	-C.0001
152	0.0233	0.0333	C.0004	-0.0276	-0.0193	-0.0003
154	0.0182	-0.0256	C.0006	0.0148	0.C057	C.0003
156	-0.0148	0.0179	-0.0007	-0.0075	-0.0058	-0.0003
158	0.0041	C.0100	C.0006	0.0056	0.C010	0.0002
160	-0.0033	0.0034	-0.0004	-0.0058	-0.CCCE	-0.0002
162	0.0004	0.0002	0.0003	0.0041	0.0003	0.0001
164	-0.0011	-0.0003	0.0002	-0.0001	-0.CCC7	-0.0001
166	0.0029	-0.0020	-0.0003	0.0043	0.0002	0.
168	-0.0030	0.0043	-0.0001	0.0062	0.0020	0.

170	0.0009	-0.0047	0.	-0.0044	-0.0021	-0.
172	0.0023	0.0026	-0.	0.0010	-0. CC10	-C.
174	-0.0044	0.0005	0.	0.0014	0.0047	0.
176	0.0046	-0. C024	-0.	-0. C022	-0.0061	-0.0001
178	-0.0041	0.0026	-0.	0.0025	0. CC45	C.
180	0.0046	-0. 0018	-0.	-0.0021	-0.0030	0.
182	-0.0056	0.0010	0.	0.0015	0. C018	-0.
184	0.0050	-0.0033	-0.0001	-0.0003	-0.0012	0.0001
186	-0.0026	0. 0005	-0.	0.0009	0.0013	-0.
188	-0.	0.0009	-0.	0.0014	-0. CC15	-C.
190	0.0014	-0. 0006	0.	-0.0010	0.0021	-0.
192	-0.0013	-0.0001	-0.	0.0002	-0. C015	-0.
194	0.0004	0.0003	0.	0.0002	C. C001	-0.
196	0.0007	0. 0001	-0.	0.	0.0012	-0.
198	-0.0017	-0. 0007	0.	-0. 0004	-0. C021	-0.
200	0.0021	0. 0008	-0.	0.0004	0.0023	0.
202	-0.0021	-0. 0004	C.	0.0002	-0. C022	-0.
204	0.0018	-0.0002	0.	-0.0005	0. C017	-0.
206	-0.0014	0. 0005	-0.	0.0010	-0. C012	0.
208	0.0010	-0. 0004	-0.	-0. C013	0. C009	-0.
210	-0.0004	-0. 0002	-0.	-0.0007	-0.0007	-0.
212	0.	0. 0008	0.	0.0011	0.0005	-0.
214	-0.0001	-0. 0009	-0.	-0. 0008	-0. C001	-0.
216	0.0004	0. 0006	0.	0.0003	-0. C002	-0.
218	-0.0006	-0. 0001	-0.	0.0001	0. C005	-0.
220	0.0007	-0. 0003	0.	-0.0004	-0. C006	-0.
222	-0.0008	0. 0005	0.	0.0005	0.0007	-0.
224	0.0008	-0. 0005	-0.	-0. 0005	-0. C007	-0.
226	-0.0008	0.0004	-0.	0.0004	0.0006	-0.
228	0.0003	-0. C001	-0.	-0.0001	-0. C005	0.
230	-0.0005	-0. 0001	0.	0.0002	-0. C004	-C.
232	0. 0003	0. 0002	-0.	0.0003	-0. C002	-0.
234	-0.0002	-0. 0001	0.	-0. 0002	0. C001	-0.
236	0.0001	0.	-0.	0.0001	-0. C001	-0.
238	-0.	0.	0.	0.	0.	-0.
240	0.	0. 0001	-0.	-0.	0.	-0.
242	-0.0001	-0. 0002	0.	-0. 0001	-0.	-0.
244	0.	0. 0002	-0.	0. 0001	0.	-0.
246	0.	-0. 0001	0.	0.	0.	-0.
248	-0.	-0. 0001	-0.	-0. 0001	0.	-0.
250	0.0001	0. 0002	0.	0. 0001	-0.	-0.
252	-0.0001	-0. 0002	-0.	0. 0001	0.	-0.
254	0. 0001	0.	-0.	-0. 0002	-0.	-0.
256	-0.0001	0. 0001	0.	0. 0003	-0.	0.
258	0.	-0. 0001	-0.	-0. 0003	0. 0001	-0.
260	0.	0. 0001	0.	0. 0002	-0. 0001	-0.
262	-0.0001	-0.	0.	-0. 0001	0. C001	-0.
264	0. 0001	-0.	0.	-0.	-0. 0001	-0.
266	-0.0001	0. 0001	0.	0. 0001	0. C001	-0.
268	0. 0001	-0. 0001	-0.	-0. 0001	-0. C001	-0.
270	-0. 0001	0. 0001	0.	0. 0001	0. 0001	-0.
272	0. 0001	-0. 0001	-0.	-0.	-0. 0001	-0.
274	-0. 0001	-0.	0.	-0.	0. 0001	-0.
276	0. 0001	0.	-0.	0. 0001	-0. 0001	-0.
278	-0. 0001	-0.	0.	-0.	0.	-0.
1001						

NEPTUNIC ELEMENTS

3C.072 5814	3.008852234	275.039422	1.774464	
131.23 4567	0. 0CC051 776	40.524435	0. 000005 97682	

0	-411.3061	38.4491	-4.4161	30. 3706	2905.4704	1.9610
2	-314.3147	19.1038	-2.7387	41.3092	744.1504	-0.4436
4	150.1879	-13.1648	-0.0337	13.4863	-109.3482	-0.7171
6	-78.8924	-19.8492	0.7382	-6.0134	85.4033	-C.1208
8	-52.0265	4.3401	0.5648	4.0535	9.3467	0.1294
10	-54.1633	7.0986	0.7918	6.9822	-26.7325	0.6222
12	-11.9778	10.9094	0.4336	-0.9346	-11.6434	0.3330
14	-22.5515	10.0030	0.1630	-10.6279	19.9793	-0.3597
16	-64.4477	-1.7952	0.0343	-4.6072	-76.C089	-0.1326
18	35.0031	0.3213	-0.2140	-8.7546	-15.7353	0.7920
20	21.7988	-7. 8641	-0.7558	-0.3055	-10.5149	-0.5906

22	39.0558	-8.2485	-0.1973	6.3522	28.5877	0.1142
24	10.7753	-2.7034	-0.0655	8.9178	38.4163	-C.2327
26	-27.1551	5.7870	0.3057	2.6302	8.6632	0.0355
28	-37.4213	8.6528	0.5645	-6.9138	-33.7877	0.1297
30	7.4931	0.3931	-0.0088	-1.1445	-31.5725	0.1205
32	46.9017	-8.5455	-0.6152	4.1445	20.7807	-0.0849
34	12.6500	-2.6388	-0.3554	8.3732	39.1482	-C.1358
36	-40.3302	9.1504	0.5101	-5.1685	-20.3646	0.0838
38	-10.5962	1.6560	0.5789	-8.2984	-36.0087	0.1519
40	47.2941	-10.8787	-0.5386	9.0517	46.C530	-0.0175
42	-20.0523	4.0783	-0.3597	2.4648	7.1019	-0.1809
44	-42.5117	7.2589	0.7497	-11.2516	-50.2464	0.1292
46	59.0342	-12.9363	-0.1838	13.5971	58.6632	0.0600
48	-52.9570	12.8341	-0.6162	-10.5550	-43.2969	-0.1241
50	34.6347	-8.2015	0.0525	5.3232	25.C3C5	0.2254
52	-19.3278	3.9720	-0.2242	-2.7263	-11.4613	-C.1605
54	7.1232	-2.3862	0.5391	1.4499	3.5695	0.0834
56	-2.7924	0.7096	-0.2741	0.1178	-1.E8E5	-C.C45C
58	1.3108	0.2392	0.1111	0.0018	0.5253	0.0189
60	0.4398	0.4518	-0.0499	-0.5422	0.3443	0.0320
62	-0.1158	-0.2491	0.0179	-0.2422	0.2444	0.0024
64	-0.4662	-0.5204	0.0035	0.4083	-0.3971	-0.0064
66	-0.0063	-0.0108	0.0023	0.4136	-0.3624	-0.0071
68	0.4723	0.9165	-0.0079	-0.2952	0.2742	0.0024
70	0.1193	0.1338	-C.0040	-0.4574	0.4554	0.0083
72	-0.4439	-0.5080	0.0067	0.2666	-0.2485	-C.0011
74	-0.1566	-0.1425	0.0055	-0.4707	0.4542	-0.0083
76	0.4854	0.5513	-0.0064	-0.3548	0.3053	0.0039
78	0.0650	0.0533	-0.0054	-0.4211	0.3758	0.0089
80	-0.4986	-0.6118	0.0072	0.5207	-0.4387	-0.0027
82	0.1835	0.1815	-0.0035	0.4566	-0.1702	-0.0068
84	0.4481	0.5267	-0.0085	-0.6267	0.5676	0.0063
86	-0.4530	-0.5077	0.0006	0.2526	-0.2515	0.0056
88	-0.1089	-0.1085	0.0085	0.3900	-0.3722	-C.0056
90	0.5801	0.6069	-0.0069	-0.6653	0.6258	0.0020
92	-0.5084	-0.5705	-0.0030	0.3765	-0.3323	0.0077
94	0.0263	0.0557	0.0100	0.2278	-0.1964	-0.0107
96	0.4958	0.5366	-0.0080	-0.7027	0.6174	0.0047
98	-0.7753	-0.8259	0.0001	0.E3C5	-0.7156	0.0053
100	0.7905	0.7961	0.0079	-0.7304	0.6997	-0.0121
102	-0.6222	-0.6392	-0.0123	0.5565	-0.4996	0.0125
104	0.4001	0.4474	0.0124	-0.3536	0.3059	-0.0118
106	-0.2367	-0.2475	-0.0096	0.1763	-0.1720	0.0089
108	0.1244	0.1130	0.0063	-0.0505	0.0838	-0.0055
110	-0.0508	-0.0715	-0.0037	0.0672	-0.0265	0.0027
112	0.0148	0.0527	0.0020	-0.0333	0.0058	-0.0016
114	-0.0078	-0.0106	-0.0008	0.0615	-0.C052	C.0011
116	0.0093	-0.0157	0.0002	-0.0093	0.0068	-C.0004
118	0.0108	-0.0015	-0.0002	0.0044	-0.0044	0.0002
120	-0.0076	0.0222	0.0001	-0.0183	-0.CC6C	0.0001
122	0.0008	-0.0084	0.	-0.0081	-0.0028	0.0003
124	0.0075	-0.0179	-0.0001	0.0222	C.0073	-C.0003
126	-0.0053	0.0175	-0.	-0.0044	-0.0022	C.0002
128	-0.0036	0. 0075	0.0001	-0.0196	-0.0054	0.0003
130	0.0087	-0.0226	-0.0001	0.0192	0.C0EE	-C.
132	-0.0043	0.0096	-0.	0.0045	-0.0002	-0.0003
134	0.0056	0.0152	0.0001	-0.0246	-0.C070	0.0003
136	0.0101	-0.0242	-0.	0.0263	C.C060	C.0001
138	-0.0039	0.0093	-C.0001	0.0033	0.0019	-0.0004
140	-0.0059	0.0143	0.0001	-0.0246	-0.0074	C.0003
142	0.0101	-0.0268	-0.	0.0284	0.0063	-0.0001
144	-0.0077	0.0210	-C.0001	-0.0146	-0.0015	-0.0004
146	0.0026	-0.0024	0.0001	-0.0067	-C.CC3E	C.0004
148	0.0031	-0.0141	-0.0001	0.0230	0.0088	-0.0002
150	-0.0083	0.0316	-0.	-0.C341	-0.C117	-0.0012
152	0.0104	-0.0352	0.0001	0.0340	0.0108	0.0004
154	-0.0088	0.0311	-0.0002	-0.0279	-0.0077	-0.0006
156	0.0068	-0.0215	0.0002	0.C155	0.C056	0.0002
158	-0.0052	0.0161	-0.0001	-0.0129	-0.0048	-0.0004
160	0.0044	-0.0101	0.0001	0.0077	0.0037	0.0003

162	-0.0028	0.0056	-C.0001	-0.0042	-0.C016	-0.0002
164	0.0010	-0.0026	0.0001	0.0020	0.0003	C.0001
166	-C.0004	0.0012	-0.	-0.0009	-0.0005	-0.0001
168	0.0008	-0.0007	0.	0.	0.0011	0.
170	-0.0010	0.0005	-0.	-0.0001	-0.0009	0.
172	0.0003	-0.0001	0.	-0.0001	-0.0003	0.
174	0.0007	-0.0002	-0.	0.0001	C.CCC9	-0.
176	-0.0007	0.0002	0.	0.	-0.0004	-0.
178	-0.0002	-0.0001	0.	-0. CCC1	-0.C006	0.
180	0.0009	-0.0002	-0.	0.	0.CC1C	-0.
182	-0.0006	0.0003	0.	0.0001	-0.0004	-0.
184	-0.0003	-0.0001	0.	-0.0002	-C.CC6	0.
186	0.0010	-0.0002	-0.	0.0002	0.0009	-0.
188	-0.0005	0. C003	-0.	-0.0001	-0.0006	-0.
190	0.0001	-0.0001	0.	-0.0002	0.C03	-0.
192	0.0005	-0.0001	-0.	0.0004	0.0009	-0.
194	-0.0013	0.0002	0.	-0.0004	-0.C010	-0.
196	0.0011	-0.0001	0.	0.0003	C.CCC5	0.
198	-0.0004	0.	-0.	-0.	-0.0003	-0.
200	-0.0004	0.0001	0.	-0. CCC2	-0.0009	0.
202	0.0010	-0.0003	-0.	0.0003	0.0013	-0.
204	-0.0013	0.0004	-0.	-0.0004	-0.0014	-0.
206	0.0013	-0.0004	0.	0.0003	0.0013	0.
208	-0.0011	0.0003	-0.	-0.0002	-0.0010	-0.
210	0.0005	-0.0002	0.	0. CCC1	0.0007	0.
212	-0.0006	0.0001	-0.	-0.0001	-0.CC5	-0.
214	0.0004	-0.0001	0.	0.	0.0003	0.
216	-0.0002	0.	-0.	0.	-C.C002	-0.
218	0.0001	0.	-0.	-0.	0.0001	0.
220	-0.0001	-0.	-0.	0.	-0.0001	-0.
1001						

PLLID ELEMENTS

39.4870157 0.248266637 113.71901Z 17.143503

109.634196 0.0000028 230.365315 0.00000587682

C	-1350.4805	137.2600	13.7957	-20.5252	2323.0315	-29.7122
2	-786.8813	104.3215	3.1866	1.8C86	718.7075	7.7612
4	33.6053	46.2568	-2.2112	9.6316	-74.4655	5.7533
6	-46.8526	17.7760	9.8055	-9.9343	-20.6760	0.8086
8	-38.5459	17.1075	4.8078	-16.6588	-44.5250	-1.4881
10	-7.9913	12.7964	5.8275	-11.4801	-25.4650	-8.5257
12	17.1255	1.3457	2.6179	-12.8121	-5.2068	-6.4041
14	-3.6400	-5.8537	0.5422	-16.6435	4.2124	-0.2549
16	-8.3665	-10.3037	0.4756	0.9194	-41.5368	-2.9302
18	57.0588	-7.4921	-C.9755	8.7232	41.3920	-11.6437
20	10.0370	-23.0816	-6.8766	15.5710	8.0754	2.5727
22	8.3368	3.9419	-2.4730	11.4677	23.2704	2.6564
24	-24.0420	9.0218	-0.7115	-3.8443	-4.6200	6.7260
26	-28.4152	15.9175	3.3995	-14.1639	-23.7016	0.4020
28	-2.8746	3.1190	4.4312	-7.9682	17.9171	-5.5097
30	28.2263	-12.4906	0.0679	8.6156	13.5739	-5.3640
32	19.9103	-10.9930	-4.6647	11.0463	27.6193	2.3236
34	-21.1341	7.1247	-2.7161	-5.7658	-5.6023	6.8764
36	-25.1419	11.8971	3.8666	-10.7807	-30.5878	-0.2089
38	21.3229	-6.1771	3.5694	7.2115	9.0028	-7.1302
40	20.2084	-9.7995	-4.2024	1.6107	31.5554	1.0210
42	-32.4938	8.5704	-2.8346	-9.8840	-30.8191	7.1650
44	4.7307	3.9612	5.8178	2.3855	-8.3005	-5.8522
46	28.5907	-9.6662	-1.3034	5.7622	43.4454	-2.5336
48	-39.5254	6.2578	-4.6585	-9.4379	-51.0422	8.9817
50	31.8367	-0.8494	7.3142	7.7627	4C.1179	-9.6082
52	-19.9073	-2.6694	-6.4331	-4.7254	-24.5721	7.1400
54	9.5974	2.9632	4.0460	2.8862	11.5953	-4.1812
56	-3.4806	-1.6542	-2.0991	-1.1122	-4.5557	1.8040
58	1.6920	1.1132	0.9617	0.1066	2.3039	-0.7441
60	-0.8675	-0.6471	-0.2951	-0.4028	-0.3986	0.4035
62	-0.3055	-0.1027	0.2086	0.2052	-0.C994	-0.0237
64	-0.0744	-0.0072	-0.0934	0.3465	-0.4466	-0.0441
66	0.4361	0.3349	-0.0039	-0.CC17	0.1382	-0.1242
68	0.1974	0.0652	0.0519	-0.3590	0.4365	0.0461
70	-0.3669	-0.3139	0.0325	-0.0689	-0.0192	0.1334

72	-0.2666	-0.1269	-C.0453	0.3553	-0.4526	-0.0147
74	0.3477	0.3368	-0.0365	0.0650	0.CC13	-C.1354
76	0.2476	0.1322	0.0458	-0.3925	0.4554	0.0227
78	-0.3806	-0.3691	0.0361	0.0157	-0.C876	0.1419
80	-0.1387	-0.0669	-0.0569	0.4232	-0.4215	-0.0407
82	0.4212	0.4665	-0.0282	-0.1655	0.2463	-0.1319
84	-0.0614	-0.1499	0.0717	-0.3330	C.2948	0.0953
86	-0.3864	-0.4118	-0.0117	0.3876	-0.4426	0.0845
88	0.3367	0.4269	-0.0669	0.0114	0.0956	-0.1539
90	0.0993	0.0554	0.0471	-0.3876	0.3542	0.1356
92	-0.4208	-0.5214	0.0215	0.4283	-0.4648	0.1247
94	0.3367	0.5939	-0.0769	-0.1113	C.1503	-0.1684
96	-0.0451	-0.0995	0.0615	0.3033	-0.2555	0.0721
98	-0.3025	-0.4543	0.0023	0.5389	-0.5107	0.0775
100	0.4970	0.7752	-0.0676	-0.5420	C.5576	-0.1458
102	-0.5910	-0.8254	0.0923	0.4453	-0.4613	0.2165
104	0.3921	0.7097	-0.0867	-0.3233	0.3081	-0.1893
106	-0.2624	-0.5131	0.0728	0.1861	-0.1720	0.1366
108	0.1556	0.3021	-0.0516	-0.0825	0.0874	-0.0840
110	-0.0780	-0.1608	0.0266	0.0483	-0.C494	0.0454
112	0.0300	0.0995	-0.0130	-0.0405	0.0383	-0.0226
114	-0.0120	-0.0569	0.0117	0.0139	-0.0034	0.0103
116	0.0099	0.0384	-0.0084	0.C115	0.C013	-C.C036
118	-0.0041	0.0080	-0.0002	-0.0039	-0.0035	0.0011
120	-0.0043	0.0084	0.0031	-0.0154	-0.C024	-0.0011
122	0.0043	-0.0183	0.0020	0.0110	0.C050	0.0005
124	C.0038	0.0047	-0.0047	-0.0097	0.0002	-0.0005
126	-0.0053	0.0168	0.0001	-0.0157	-0.C056	-0.0001
128	0.	-0.0108	0.0046	-0.0001	0.0036	0.0005
130	0.0050	0.0101	-0.0028	0.0155	0.0039	0.
132	-0.0044	0.0185	-0.0028	-0.0119	-0.C075	-0.0005
134	-0.0012	-0.0044	0.0049	-0.0058	0.0018	0.0002
136	0.0040	-0.0157	-0.0012	0.C177	0.0068	0.0003
138	-0.0044	-0.0199	-0.0041	-0.0120	-0.C080	-C.0001
140	-0.0021	-0.0051	0.0052	-0.0047	0.0039	0.0004
142	0.0066	-0.0142	-0.0012	0.C175	C.C071	0.0001
144	-0.0055	0.0229	-0.0039	-0.0178	-0.0097	-0.0005
146	0.0044	-0.0168	0.0060	0.0075	0.0066	0.0008
148	0.0026	0.0012	-0.0043	-0.0065	-0.C062	-0.0006
150	-0.0060	0.0155	0.0002	-0.0177	-0.0084	-0.0002
152	-0.0073	-0.0263	0.0041	0.0228	0.C142	0.0006
154	0.0071	0.0288	-0.0069	-0.0218	-0.C152	-C.0007
156	0.0049	-0.0252	0.0076	0.0173	0.0111	0.0008
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160	0.0028	-0.0132	0.0049	0.0080	0.0083	0.0006
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204	-0.0009	0.0001	0.0001	-0.0002	-0.0006	0.0002
206	0.0009	-0.0001	-0.0001	0. CCC1	0.0006	-0.0001
208	-0.0008	0.0001	-0.0002	-0.0002	-0.C012	-0.0002
210	0.0007	0.	0.0002	0.0001	0.0013	0.0002
212	-0.0005	-0.0001	-C.0001	-0.0001	-0.0007	0.0002
214	0.0004	0.0001	0.0001	0.0001	C.CCC5	-0.0001
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CHIRON EXPANSION

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26	-149.2026	-14.2012	-11.3176	-11.7067	139.1178	15.2607
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212	-0.0008	0.0006	-0. C002	0.0015	0. C003	-0.0003
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COSMOBIOLOGY AND ASTROCOMPUTATION IN SOUTH AMERICA: A BRIEF REPORT

by Tom P. Santiago

[EDITOR'S NOTE This article on some of the technical activity in South American countries is the first in a series of reports. It is hoped that MATRIX readers in other parts of the world will provide similar reports for their regions. It is important for those of us interested in astrological technique to develop an awareness of research activity underway in different parts of the globe. Articles such as this one will make this possible.]

In recent decades, much stimulating and awe inspiring talk has been centered on the idea of East meeting West, on almost every level and within every discipline. Our readers will no doubt agree, however, that when we speak of "West" we are committing ourselves to a very large hemisphere within which many cultures, ideosynchrasies, and languages reside, lamentably not always in an intercommunicative manner. Up here in the North, for example, we are all experiencing the recent upsurge of electronic calculator and computer technology as nothing short of euphoria, and we all see it as coinciding in diverse ways with the inception of a new, fresh, and precise science of the stars and of man.

Well, (and the readers of the alive and responsive MATRIX please take note) we are not alone. When many in the East speak of the West, they are also and in some instances especially referring to the South-West. It is with great pleasure that the author sees in many respects how we "up-here" are carving out the same and at times arrid paths as are many of our star-honoring people of the South; relative not only to values of astrological applications and practice but also to those of raw investigation. I have both corresponded and spoken to Michael Erlewine (our ED) about astrological research in South America, and of the quite striking parallels that can be noted between our respective interests within the annals of astrology and of an astrology-science. I have also mentioned the unfortunate existence of a language barrier, and how it has sustained the lack of information flow within the Americas; of a communication which in the future will prove fundamental to an all out flourishing of a never-before-seen science of astrology. It is then with relevance to astrology, astronomy, mathematics, and especially computer applications that our kind Editor(s) has agreed that MATRIX should instrument what it could of an informational bridge between the North and South.

It was in 1948 when a certain French Scientist and psychologist (as well as MASTER astrologer) first stepped foot in Caracas, Venezuela. At the time of his arrival, Dr. Serge Raynaud de la Ferriere was already held in high esteem in Paris for the "caliber" of the astrology which he practiced and advocated (he was also the President of L'GROUPMENT MONDIALE D'COSMOBIOLOGI and of L'FEDERATION INTERNATIONALE DES SOCIETES SCIENTIFIQUES). His knowledge of over 27 languages facilitated the conveyance of his ideas throughout Venezuela, from where a myriad of students were immediately aroused by this man's broad, epistemological way of focusing on human problems and their solutions. More than 100 titles bear his name (written in French, translated into Spanish, and soon into the English language), wherein were expressed ideas dealing from the most infinitely spiritual to the most concretely mathematical.

The term "astrology", as conventionally used, was discarded by him so as to leave room for the creation of an all-encompassing model of knowledge within which astrology still had a very important place, albeit in a partial sense. After the manner then of the Swiss statistician and astrologer K. Krafft, probably the first person in the modern world to speak of a "cosmobiology" in an astrological sense, Dr. de la Ferriere adopted this term and taught under a system that, though rooted in a firm and solid mathematical/astronomical foundation, had startling implications for an objective knowledge of man's inner being and its outer determinants. Michel Gauquelin has also recommended that the term "astrology" be supplanted and that "astrobiology" or "cosmobiology" be used in its place. But this only changes the name, not the methodology, and hence in the long run offers little hope of not having it misused and prostituted all over again. We won't stop to etymologically analyze the terms in this brief inquiry, but upon doing so the reader will immediately conceive Reinhold Ebertin's propensity for fragmentation in using "cosmobiology" to represent among other things, a system of half-sums, solar arc directions, etc., with only theoretical recourse to the "natural sciences" as Krafft and Ebertin himself has prided on saying. This of course is not meant as a minimization of the most able Ebertin and his orthodox cosmobiologists, a school which has definately introduced much innovation into our science. But again I repeat: THE COSMOBIOLOGY OF EBERTIN IS NOT THE COSMOBIOLOGY OF DR. S.R. DE LA FERRIERE AND OF PRESENT DAY SOUTH AMERICA.

To make a long, interesting, and even historical story short, Dr. de la Ferriere succeeded in bringing together a large group of disciple/students and in 1962, the year of his death, left one as prepresentative of his system, Dr. David Ferriz.

Today Dr. Ferriz is residing in Caracas, Venezuala, and is heading a considerable group of enthusiastic researchers through the labyrinth of a very, very Uranian science of Cosmobiology. In 1970 he presided over the inauguration of the FACULTAD DE COSMOBIOLOGIA (Faculty of Cosmobiology) with main headquarters in the most studious city of Lima, Peru. The faculty is a sort of "pilot" organsim, a school which has as its main objective the extension of this "ciencia sintesis" to a level of academic application, and is represented in many countries and cities of S.A. via its subordinate ESCUELA SUPERIORES DE COSMOBIOLOGIA (Schools for Higher Studies in Cosmobiology: see Spanish listing in the Naso International Astrological Directory published by the NASO School of Astrology/127 Madison Ave. NYC). In recent years, as have we in the states, the Faculty (and its schools) has rsponded and strongly felt the implications of the genesis and advent of astrocomputation, from the level of sophisticated programmables and micros, all the way on up to the massive computers.

For example, the office of the Faculty in Caracas opened over a year ago a professional counseling service and is using a disk based APPLE II micro-computer system for its clients datum. The response I am told is endless: swarms clients; phones ringing, ringing, ringing: astrology's public image progressively redefined and resituated; higher aspirational levels of research and practice; ... it's great! The air is so intense, and the clients so exigient, that the system is in the process of being expanded: BASIC floating point ROM card, 2 more disks (!!), expansion memory modules, Interface Cards, the works! Previous to these activities and even to date, the HP and TI line of programmable calcultors were used. Every day more and more individuals are constructively responding to what will prove to be not only the trend of the day, but also that of the future.

The development of Cosmobiology in South America in general, and in countries like Venezuela, Peru and Columbia in particular, has followed lines pretty much in contrast with the developmental process of astrology in the U.S. Whereas much value is placed on formality of theory and applicational methods in S.A., astrology (and the majority of "astrologers") in the U.S. has, with many eminent exceptions, a marked tendancy towards an almost simplistic conformism, or shall we call it an exagerated domesticity (?). The conquest of University accreditation and recognition is of prime concern to researchers in S.A., and many public and prestigious educational institutions have already made patent their openmindedness and even support of interdisciplinary investigations along cosmobiological lines.

Examplary of this was the PRIMER SIMPOSIUM INTERNACIONAL DE COSMOBIOLOGIA (First International Symposium on Cosmobiology) which was held in the Forum of the University of Medellin, Columbia and at the National University of Columbia during the week extending from the 1st to the 7th of September 1975. At this convention were to be found representatives of University's, private and public institutions, etc., all of whom sat and listened in awe to the expositions which Dr. Ferriz, students, and other researchers orgranized for this large event. It was during the opening addresses that the monumental title, the TEORIA CIENTIFICA DE COSMOBIOLOGIA by Dr. Ferris (Scientific Theory of Cosmobiology), was presented to the convention with written support (in preface) by the Director of the University of Trujillo, Peru. This 1,062 page text (!!) outlines the principles upon which Dr. de la Ferriere's Cosmobiology rests (in its formal, scientific aspect), to wit:

1) The Dialectical Principles of Cosmobiology (among many other things), for our present purposes can be summed up as follows.
a) thesis---astronomy
b) antithesis---astrology
c) synthesis---astrosophy
d) mathesis---archeometry

2) Principle of Orientation with the Biocenter (topocentric coordinates on biosphere)

3) Principle of Causality (the investigation of by statistical relation)

The four derivative principles are:
4) sinergy
5) synchronicity
6) isomorphy
7) diversified interpretation (delineation)

The present brief report is just that, a brief report, and hence does not permit a much needed elaboration on the above points. Perhaps at a later date. Dr. Ferriz has also and interestingly presented the model of Cosmobiology in the form of a temple, the base and foundation of which turn out to be the mathematical sciences. The columns of the temple are on the one hand, the SUPPORTIVE astronomical (positional astronomy for example) and astrophysical science and on the other, the DEMONSTRATIVE applied sciences, i.e. psychology, medicine, history, etc. To give a general outline of what the aforementioned book covers in terms of chapters, etc., the following should give us some idea:

1) Cosmobiology's social function and its multiple structure
2) the biomedical sciences
3) the cosmobiological interaction among human beings
4) the Precessional Ages: the transcendental research of Dr. S.R. de la Ferriere
5) planes and conicity of time: Cycloidal Theory of Scipion Llona
6) the mathematical foundation

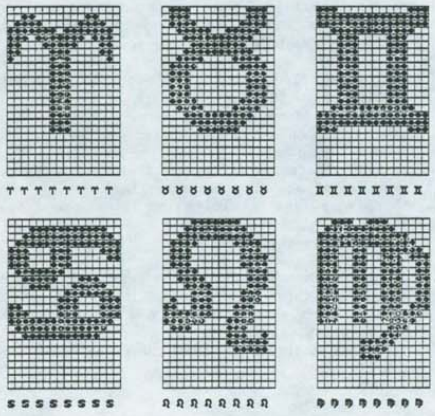
The technical enthusiasts will be glad to know that they dont have to read Spanish to benefit from this book, as the 1st chapter on the tecnica matematica of Cosmobiology (all numbers!) includes a fairly hard-to-come-across compilation of various

astronomical/astrological procedures used by many astrologers past and present. Here are some of the techniques outlined:

1) a mathematical synthesis of the formulae used by the topocentric school in Argentina after Polich and Page.
2) formulae used by Dr. Adolf Weiss (German author of the 846 page "Astrologia Racional" and of the English "Cornerstones of Astrology")
3) formulae for domification used by Zariel
4) formulae for Primary Directions used by Hierotz-Bonatis
5) formulae for the Prime Vertical primary directions (Campanus)
6) techniques used by Ebertin and more

A fellow researcher and friend has recently finalized a 55 page booklet dealing with the mathematical and astronomical models of computation as they pertain to astrology. The title: COSMOBIOLOGIA DE PRECISION (Cosmobiology of Precision) by Mario Flores, contains many interesting diagrams, algorithms, and flowcharts (these last are in English) which are readily implementable on any capable computer system or calculator. I'll try to get all these things down to "Matrix Headquarters" as soon as possible, and maybe our Editors will learn to read Spanish in the process.

It seems that individuals all over are favorably answering to the informational flow with which our universe is persistently pulsating. And the advent of astrocomputation we feel has to catagorically be seen within this context. Computers are here to stay, and the "astrologer" who stubbornly disagrees and takes pride in some nebulous resistance had better direct his or her mind to the real, authentic cosmos, and not some subjective fabrication of his or her own. There is nothing wrong or distorted with using machines to do what they were intended for unless the human being which does so ceases to be human and becomes an organic machine himself in the process.



A VISIT WITH NEIL MICHELSEN

Editors

We had the pleasure of a visit from Neil and Rosemary Michelsen of ASTRO COMPUTING SERVICES during the month of August. The Michelsens spent the night in Ann Arbor on their way to an astrological and healing conference in northern Michigan. As you might expect, we talked about computers... past, present and future. There was a good exchange of information which prompts the following report on what is happening at the new location of ASTROCOMPUTING SERVICES in San Diego.

As we know Michelsen has been one of the pioneers in the field of astrological computing. He worked at IBM for many years before launching into his own computing firm. At first, ASTRO COMPUTING SERVICES was built in and operated from a basement in Pelham, New York. The center has recently relocated to sunny San Diego California. There is an in-depth interview of Michelsen in a forthcoming issue of ASTROLOGY NOW that you wont want to miss. Here I would like to mention something about the computer system Michelsen is using.

As most of us know, perhaps the single most revolutionary component in Michelsen's set up is his Versatec 1200A printer/plotter. He tells a wonderful story about how he aquired the Versatec. After a large investment in a basic computer system, he had ordered a much less sophisticated kind of printer to handle his output. When he saw an announcement for the new Versatec 1200A he immediately called and changed his order to this machine. He was pledging some $8000 he didn't have at the time on an intuition that he had to have this machine. As we know, the rest his history.

The Michelsen printout has set the standard for our times in output and changed the course of astrological history. The AMERICAN EPHEMERIDES published by Michelsen may be (aside from being the finest ephemerides the astrological world has ever seen) the first large book to be publised that has been completely typeset by the computer- camera ready output.

What is it about the Versatec printer, aside from it's $10,000 cost, that makes the Michelsen print-out unique? The Versatec is a dot-matrix printer that uses special paper and a fluid 'toner' to bring out the type. In some ways it operates much like the old Spirit duplicators- remember the purple print? It's major difference from other dot-matrix printers has to do with the size of the matrix that is used. While most dot-matrix printers use a character matrix of 5x7 or 7x9 (seven dots across by nine dots high), the Versatec has a much finer character matrix of 16x24 dots. This finer matrix results in the ability to control the shape of each character to a greater degree than conventional dot-matrix printers. Of course, the individual characters are user programmable on the Versatec. We thank Neil for the opportunity to publish some of the special 16x24 character matrices that are used by ASTRO COMPUTING SERVICES. These enlarged character matrices were themselves created on the Versatec.

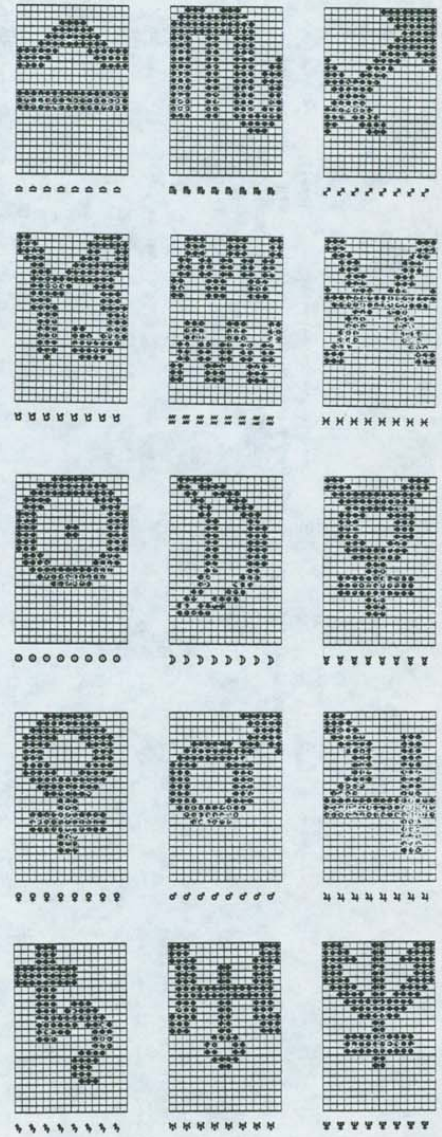
Michelsen has been using an Interdata mini-computer with an internal RAM capacity of 64-kilobytes along with a 10-megabyte hard disk for additional storage. The Interdata is a mini-computer as opposed to the micro-computers used for most home computing. The difference between a mini and a micro computer grows fuzzier all the time. In the past the mini-computer has used a 16-bit processor while the micro has an 8-bit CPU. The 16 bit machines can process 16 bits of information at once while the 8 bit can handle 8 at a time.

The quality of Michelsen's work and the volume of the output from ASTRO COMPUTING SERVICES gives one the impression that a huge mainframe computer must be at the center of the system. But as Michelsen kept having to point out to me during his visit, 64K RAM is not a large computer. The TRS-80 is capable of addressing 64k too.

The 10-Megabyte hard disk is something special, at least at this time. Hard disks differ from soft or floppy disks in several respects. FOr one, the hard disk can hold a very great deal more information than can the floppy. The chief reason for this is that hard disks are designed so that the read/write heads never come in contact with the disk surface. They are controlled so that they 'float' above the surface. This is not true of floppy disks. The controlled floating read/write heads on a hard disk can read and write much more informations in the same area than can the floppies. During the next year we will see many hard disks become available for the micro systems -at a reasonable price. Until recently, the most inexpensive hard disk has sold for from $6000-$10,000! We should see hard disks with from 10 to 50 megabytes (million bytes) during the coming year selling for between $2-$3000. Some difference.

Michelsen is planning to purchase another (and larger) computer in the near future. He mentioned something on the order of the Prime Computer which would allow time sharing. At this point Michelsen and the rest of his employees must really share the time on their Interdata- through proper scheduling. A real time-sharing system would allow many emplyees to use the machine simultaneously.

This timesharing capability is important, among other things, to facilitate the very important research that is underway at ASTRO COMPUTING SERVICES headquarters. One of the Michelsen staff is Thomas Shanks who, along with Neil Michelsen, has done outstanding and pioneer work in astrological research. We will have a separate article in the near future to detail some of these research activities. Thanks again to the Michelsens for permission to publish these lovely characters.



Technical Problems in Spiritual Astronomy

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In astrology, one starts with data provided by a purely materialistic science (astronomy) and attempts to go beyond the data into a realm which modern science stoutly maintains does not exist. Astronomy (= names of the stars) remains at the surface of what one sees in the sky; astrology (= knowledge of the stars) goes below the surface and seeks meanings. Although astrologers would rarely have occasion to contradict an astronomical observation, their acquaintance with phenomena ignored by astronomers might well lead them to understand astronomical observations in new ways. In particular, there are large collections of astronomical data, the differences among which are purely utilitarian in the eyes of astronomers, but which might well be the result of qualitative distinctions in astrological terms. For example, The American Ephemeris and Nautical Almanac gives positions of planets heliocentrically and geocentrically, and in terms of right ascension/declination and longitude/latitude; but if you apply standard conversion formulae and reduce these numbers to a uniform coordinate system, you will find that they do not agree. Furthermore, none of them will consistantly agree with the positions of the planets observed telecopically (assuming a further conversion to the coordinates of the location of the telescope). How do these discrepancies arise? What significance do they have for astrology? Which set of numbers is the "right" one for astrological purposes? In this article, I will answer only the first of these questions, but perhaps shed a little light on the latter two, which for me remain active and open. Should someone be

interested in pursuing these questions further than what is presented here, I would suggest consulting W.M. Smart: Textbook on Spherical Astronomy, Cambridge 1977 for basic information, and the American Ephemeris for numerical data. (These are the sources I have used, unless noted otherwise.)

First, however, I should make my prejudices explicit, because there is more than one direction to go in studying astrological phenomena, and one's direction influences the questions one asks and the results one can obtain. The bias I will express here is based on realizing that the phenomena of astrology are incompatible with materialist theories of astronomy; these theories might have virtues, but concordance with easily demonstratable astrological phenomena is not among them. One can construct arbitrarily many theories of astronomical data, and arrange them in myriad ways (e.g., a Phobos-centric, geometrical coordinate system) - the significant question for me is: which of the theories and arrangements (if any) is the legitimate expression of which spiritual reality? In my investigations, I have found the work of Rudolf Steiner to be a fruitful source of guidance in understanding the spiritual realities involved. Such detailed spiritual results as I have been able to obtain are described in my forthcoming book Spiritual Scientific Astrology; here, I will concentrate on the technical aspect.

We will start with definitions of the common coordinate systems. The geocentric coordinate system (see figure 1) takes its orientation from the celestial equator, which is the earth's equator extended indefinitely as a plane. There is a distinguished point where the celestial equator is supposed to meet a sphere of indefinite radius

centered on the earth (the celestial sphere), called the Aries point. By definition, it is the point occupied by the Sun at the exact moment it crosses the celestial equator going north; that is, the Aries point is the point in the sky (against the background of the fixed stars) where the Sun stands at the spring equinox. The three coordinates in this system are distance from the center of the earth (measured in astronomical units), where 1 AU = the distance from the center of the earth to the center of the Sun, angular distance along the celestial equator from the Aries point (called right ascension, usually measured in hours, minutes, and seconds, where 24 hours = 360 degrees), and angular distance from the celestial equator to its poles (called declination and measured in degrees). These three coordinates uniquely define a point in space. For determining where in the sky something appears, the second and third suffice.

The heliocentric coordinate system (see figure 2) takes its orientation from the ecliptic, which is the plane in which the earth and Sun mutually revolve. The angle between the planes of the ecliptic and the celestial equator is called the obliquity of the ecliptic, and is about 23.5 degrees (see figure 3). The two planes intersect in a line, and one of the two intersections of that line with the celestial sphere is the Aries point. (Think about it: the Sun moves in the plane of the ecliptic, and when it is at the point where it intersects the celestial equator, it is directly above the earth's equator, which is the definition of the Aries point.) The Aries point serves as a reference point for the heliocentric coordinate system as well as the geocentric. Standard rectangular coordinates are sometimes used, with the first axis between the Sun and

Aries point, the second perpendicular to the first in the ecliptic plane, and the third perpendicular to the ecliptic plane. More often, polar coordinates are used. One coordinate is distance from the Sun; the second is longitude, measured in degrees from the Aries point along the ecliptic; the third is latitude, measured in degrees north or south of the ecliptic to the poles. Only longitude and latitude are needed for determining the position of a point in the sky.

Sometimes coordinates are given in a system which is a sort of compromise between the two I have just described. This system is geocentric, but specifies positions by the Sun-identified measures of longitude and latitude. In other words, it specifies where planets stand relative to the ecliptic when viewed from the perspective of the earth. This system is the one most often used in astrological work.

It is not difficult to transform the coordinates of a point given in one of these coordinate systems to the equivalent in one of the others. To go between heliocentric and goecentric coordinates, one only needs to know the position of the earth of Sun in the relevant system[1]. It is easy to imagine that the tabulations of positions that exist for these various systems are related to each other by simple coordinate system transformations.

Such, however, is not the case. In astronomical practice, geocentric and heliocentric coordinates are used for entirely different purposes. Geocentric coordinates are used, for example, for telescope pointing. It is important to know in such an application where the object is to be found in the sky, from the viewpoint of your telescope. You do not care where the object "really is," since if that is

not the same as where you see it, knowing its "true position" is irrelevant. Heliocentric coordinates are generally employed in more theoretical tasks involving the planets as a system. Celestial mechanics, the physics of the motion of objects in the sky, typically works in heliocentric coordinates. The solution of the equations of Kepler, for instance, yields heliocentric coordinates. There is no concern in the heliocentric system with how things appear from the earth. No person looks for objects where heliocentric coordinates say they are; therefore, it is generally thought that the position of an object given heliocentrically is where it "really is."

The central issue all this raises is the relationship between the "apparent "position of a celestial object when viewed from the earth, and the "true" position of the object. The meaning of "apparent" position is clear enough, since it depends on the simple phenomenon of where a person has to look in the sky to see something. The meaning of "true" position is also not too difficult to grasp, but depends on far more than the simple phenomenon of looking, and is, I think, somewhat problematical. The "true" position is sometimes described as the (euclidian) geometrical position. One imagines the solar system reduced in scale so that the scientist can easily examine it from outside of it; the positions that are thus hypothetically determined are thought to be "true" ones. Although one can imagine a giant scientist marking down the positions, it is important to understand that it is impossible in principle for the "true" positions to be verified by direct observation.

The "apparent" and "true" positions of a planet are not the same. Therefore, what is listed in the almanacs and

ephemerides as geocentric right ascension and declination is not related by a mere coordinate transformation to the corresponding heliocentric longitude and latitude. Although they rarely say so, I have found that astrological ephemerides which give geocentric longitude and latitude usually give the "true" positions. Moreover, not even geocentric "apparent" values can be used directly for pointing a telescope - they have been modified to be closer to the apparent position than the "true" ones, but several transformations still stand between telescope oriented values and where a telescope actually has to be pointed.

The magnitude of the discrepancy between these measures is trivial in some cases and for some purposes, but is highly significant in others. I will describe the chief components of the difference, along with some other closely related problems in positional astronomy. For each component, I will describe its effect and magnitude in general terms, and then go on to give equations and their equivalents in BASIC[2]. I will also supply some worked examples. People interested in understanding the general nature of the problem may simply skip the technical interludes, and be none the worse off. I will also discuss some of the problems all this raises for an approach to astronomy that attempts to account for spiritual realities.

I will begin with what is perhaps the easiest to understand of the causes for the discrepancy between apparent and "true" position, namely, the finite speed of light. When we look at a planet in the sky, we see it because light reflected from it has reached our eyes. By the time a particular parcel of light reaches out eyes, however, the planet from which it was reflected has moved ahead on its orbit, and no longer is where the light we see

makes it seem to be[3]. The magnitude of this effect depends on the planet's velocity.

The correction for light time simply involves adding to the observed right ascension a and declination d the distance travelled by the planet since the light left it. If the distance from the planet to the earth is D, in AU's, the time taken by the light's travel is

t=light time(seconds)=499.012D.

Then if the rate of change in coordinates is da and dd (right ascension and declination, respectively), the formula is

a(corrected)=a(observed)+t*da

d(corrected)=d(observed)+t*dd.

Instead of right ascension and declination, longitude and latitude may be used in this formula.

This effect of the speed of light also varies depending on the velocity of the earth. The change in position specifically due to the earth's velocity is called aberration, and was discovered in 1728 by Bradley. It has two components. The major one is due to the revolution of the earth around the Sun; since it varies with a period of a year, it is called annual aberration. To calculate the effect of annual aberration, use these formulae:

dl=-20".496sec(L)cos(Sun-l)

dL=-20".496sin(L)sin(Sun-l)

where

dl = change in longitude, added to "true" position yielding "apparent"

dL = change in latitude, added to "true" position yielding "apparent"

l = longitude

L = latitude

Sun = longitude of the Sun

A BASIC version of the above is:

```
LONG=LONG-(20.496/3600)*(1/COS(LAT))*COS(SUNLONG-LONG)
LAT=LAT-(20.496/3600)*SIN(LAT)*SIN(SUNLONG-LONG)
```

The minor component of aberration is due to the rotation of the earth; since it varies with a period of a day, it is called diurnal aberration. The maximum effect of diurnal aberration is only about a third of a second of arc, and it is usually neglected. Annual aberration, however, can cause a shift of about 20.5 seconds in position.

The combination of all the effects due to the speed of light is called planetary precession. It depends on the relative velocities and positions of the observed body and the body on which observation is taking place.

There is another set of problems which all depend on the fact that planets are not points, but rather are quite large, solid bodies. As with the speed of light problem, there are components due to the observed and others due to the observer. The ephemeridies side-step this issue by assuming that the position of a planet is the position of its gravitational center. Furthermore, for geocentric positions, they assume that the observation is made, in effect, from the gravitational center of the earth. This would only coincide with what an observer on the earth's surface would see in the unlikely event that the observer stood on the line connecting the centers of the two bodies. The planets-are-not-points problems get worse the more angular space in the sky the planet occupies.

One component of this problem is called parallax. It depends first of all on how far away the observed planet (considered to be a point) is, and second, on the relative

position of the observer on the earth. For a given planet, parallax is at a maximum when the planet is on the horizon and the observer is on the equator. The value of this maximum, called equatorial horizontal parallax (see figure 4), amounts to (for mean distances) 57'2".608 for the Moon, and 8".794 for the Sun.

It is easy to imagine that one could account for parallax simply by taking the maximum figure, and adjusting strictly proportionately with a function of the planet's position and the observer's latitude and longitude on the earth. However, things are not so easy as that, because the earth is not a sphere. The exact shape of the earth is called the geoid; the geoid is somewhat flat at the poles and broad at the equator. The equatorial radius is 6378.16 km., whereas the polar radius is only 6356.7747 km. This small deviation from the shape of a sphere can have a large effect on exact astronomical calculations. This can be seen by its effect on latitude (see figure 5): the geocentric latitude of Greenwich, England, which is the angle between the equatorial plane and the line connecting Greenwich to the center of the earth, is 51°17'22".6. Its astronomical latitude, which is the angle between the equatorial plane and a perpendicular to the surface of the earth, is 51°28'38".2. Such a change in latitude also affects the longitude of the point on the ecliptic which stands on the horizon at a given place and time, the Ascendant.

The conversion between astronomical and geocentric latitudes is accomplished by

L(geo)=L(ast)-692".74sin(2L(ast))+1".16sin(4L(ast))

In BASIC, we could have:

```
LAT=LAT-(692.74/3600)*SIN(2*LAT)+(1.16/3600)*SIN(4*LAT)
```

Now that we know how to calculate geocentric latitude,

we can give a formula for the effect of parallax on the apparent position of a heavenly body. I will give the formula as it appears most frequently, for right ascension and declination; conversion to longitude and latitude was discussed above.

DH=arctan[(p/r)sin(H)cos(LAT)/(cos(DECL)
-(p/r)cos(H)cos(LAT))]

DH = change in hour angle

DRA = change in right ascension due to parallax
= arctan[-tan(DH)]

p = ODIST = distance of observer from the center of the earth

r = PDIST = distance of center of object from center of earth

LAT = geocentric latitude of observer

H = hour angle

DECL = "true" declination of object

RA = "true" right ascension of object

The key quantity here is p/r, which is the ratio of the observer's and the object's distances from the center of the earth. When the object is very far away, p/r is small and so is the parallax. The hour angle appearing in this formula is measured along the celestial equator like right ascension, only in the opposite direction; furthermore, its reference point is the meridian which joins the north and south points of the horizon and the zenith. The hour angle of a star, for example, changes at about the same rate as the time of day, while its right ascension, fixed to the Aries point, changes hardly at all. Hour angle is related to the right ascension by sidereal time, which is the hour angle of the Aries point.

RA=ST-H

where ST is the sidereal time.

The corresponding formula for declination is more complicated. First calculate

R=[cos(HP)(sin(DECL)-(p/r)sin(LAT)]
/[cos(DECL)cos(H)-(p/r)cos(LAT)]

then

DDECL=arctan[(R-tan(DECL))/(1+Rtan(DECL))]

Where we have the same variables as above, with the addition of

DDECL = change in declination due to parallax

R = temporary variable

HP = H+DH = hour angle, parallax accounted for

RAP = right ascension, parallax accounted for

These formulas might be translated into BASIC as follows:

```
X=ODIST/PDIST
DH=ATN(X*SIN(H)*COS(LAT))/(COS(DECL)-X*COS(H)*COS(LAT)))
RAP=RA+ATN(-TAN(DH))
RN=COS(H+DH)*(SIN(DECL)-X*SIN(LAT))
R=RN/(COS(DECL)*COS(H)-X*COS(LAT))
DDECL=ATN((R-TAN(DECL))/(1+R*TAN(DECL)))
DP=DECL+DDECL
```

Even when one takes parallax and the geoid into account, one is still left with the actual irregularities of the surface of the earth. Ephemeridies naturally assume that no such irregularities exist. In the worst case, they can have even more of an effect than the geoid, since the height of the highest mountain exceeds the difference between the polar and equatorial radii. In judging the relation of the heavens to a person or event, should one take into account the vertical position of a submarine or an airplane? The existence of astronauts gives a whole new

dimension to this problem.

The class of problems raised by planets not being points is easy to visualize. They come out of asking why the gravitational center of a planet should contain all its positional significance. Why shouldn't the planet be considered to be where <u>all</u> of it is, rather than just a point? The angular space occupied by a body is defined in terms of its semidiameter, which is half the diameter of the body. The greatest magnitudes arise with the Sun and the Moon, each of which occupies about 31 minutes of angular space (twice the semidiameter). The semidiameters of the Sun and Moon are fairly constant, since their distance from the earth does not vary as much as the planets. The semidiameter may be calculated by

S=arcsin(R/r)

where R is the radius of the body, and r the distance to the body. r can be calculated from the center of the earth, or from a point on the surface. The radius R may be taken from any table of values of the planets; for rough work, the distance r may be a mean value for Moon and Sun (the Moon's mean semidiameter is 15'32".6), but should be the actual value for the other planets. Not adjusting for the position of the observer in the case of the Moon (the worst case) can make a difference of '.3 when the Moon is at zenith. If radius is given in kilometers and distance in AU's, you may convert with

1 AU = 149,597,900 km.

Worrying about semidiameter is not just obsessive over-precision, since a key item of information in any system which attempts to extract human significance out of the appearance of the sky is the position of a planet, and making the wrong choice for what one considers the position

to be can have a significant effect in a certain percentage of cases. One might be concerned, for example, about just when the Sun enters Leo in a certain year. The cost of being wrong can be about 12 hours, since the Sun moves about a degree per day and subtends an arc of about a half a degree. Does the Sun "enter" Leo when it first broaches the line? Or has it entered only after all of it is in? What is its status while it is in the process of crossing the line? If the leading edge of the Sun is the point of significance rather than the center, predictions made by secondary progressions and solar arc directions will be wrong by half a year. On the other hand, maybe the arc subtended by the Sun has something to do with the duration of progressions, or their orb of significance.

There is another major problem concerned with the apparent position of a planet, which is due to the fact that the path of light is altered by its entry into the atmosphere of the earth (see figure 6). The amount of the bending, called refraction, depends on atmospheric conditions (chiefly temperature and pressure) and on the position relative to the horizon of what is being observed. The closer an object is to the horizon, the more its apparent position is affected by refraction. The result of refraction is always to make an object appear to be closer to the zenith (straight up) than it "really" is. The extreme case is when a body appears to be directly on the horizon; if the earth had no atmosphere and thus there were no refraction of light, the body would be (on average) 34 minutes below the horizon (34 minutes is called the horizontal refraction). In latitude 60° when the Sun's declination is zero (at the equinoxes, around March 21 and September 21), the effect of refraction is to make the Sun

first appear on the horizon 6.7 minutes before it "really" gets there. Since refraction also works to keep the Sun above the horizon at the end of the day, the net effect is that the day seems to be about 13.3 minutes longer than it would be without an atmosphere.

Calculating the value of refraction is fairly difficult - the introductory textbooks give only approximate formulae, which are highly accurate only when the object is pretty far from the horizon. On the other hand, given all the variables involved, the following formulae give respectable results. First, we care about the zenith distance of the body, since refraction varies from nothing at straight up to maximum at the horizon. Zenith distance may be calculated from

$$\cos(z)=\sin(LAT)\sin(DECL)+\cos(LAT)\cos(DECL)\cos(ST-RA)$$

where

z = zenith distance
LAT = observer's latitude
DECL = object's declination
RA = object's right ascension
ST = sidereal time at the time of observation

Notice that this formula uses the hour angle (= ST-RA), reflecting the rapidly changing relation of an object to the zenith.

The following formula[4] gives the refraction. For zenith distances less than 75°, it is accurate to 0.'1; for zenith distances up to 87°, the error may amount to 1'.0; and for the final three degrees, the error may amount to 3'.

$$R=P/(273+T)*[3.430289(z-\arcsin[0.9986047\sin(0.996714z)])-0.01115929z]$$

where

R = refraction

z = observed zenith distance, not the "true" zenith distance
P = barometric pressure in mm of Hg
T = temperature in degrees Centigrade

Finally, we need to find out how refraction affects the position of the body in one of the usual coordinates.

$$\cos(a)=\cos(90-LAT)\cos(90-DECL)+\sin(90-LAT)\sin(90-DECL)\cos(ST-RA)$$

$$\cos(B)=[\cos(90-LAT)-\cos(a)\cos(90-DECL)]/[(1-\cos(a)\cos(a))\sin(90-DECL)]$$

$$DECL(true)-DECL(observed)=-R\cos(B)$$

$$RA(true)-RA(observed)=-R\sec(DECL(observed))(1-\cos(B)\cos(B))$$

In the above, a and B are just temporary variables. All of the above may be put into BASIC as follows (assuming you will be going backwards, from true values to observed ones):

```
Z=COS(LAT)*COS(DECL)*COS(ST-RA)
Z=ACS(SIN(LAT)*SIN(DECL)+Z)
R=3.430289*(Z-ACS(0.9986047*SIN(0.996714*Z))-0.01115929*Z
R=R*P/(273+T)
A=SIN(90-LAT)*SIN(90-DECL)*cos(ST-RA)
A=ACS(COS(90-LAT)*COS(90-DECL)-A)
B=COS(90-LAT)-COS(A)*COS(90-DECL)
B=B/((1-COS(A)*COS(A))*SIN(90-DECL))
DECL=DECL+R*COS(B)
RA=RA+(R/COS(DECL))*(1-COS(B)*COS(B))
```

The last major problem I would like to raise differs from the previous ones in that it affects our basis for measurement rather than particular measurements we might make. It is the class of problems that come under the heading of precession, all of which result in changes to the relative positions of the ecliptic, the celestial equator, and the background of the stars. Among other things, precession results in changes to the Aries point,

on which our coordinate systems are based.

If the earth were a perfect sphere, its density varying in proportion to distance from the center, there would be no precession. However, the earth is not a sphere, but is flatter at the poles and broader at the equator, as previously mentioned. Moreover, the two bodies which the strongest gravitational attractions to the earth, namely, the Sun and the Moon, generally do not lie in the equatorial plane. Because of this, their attraction cannot be considered to be concentrated on the earth's center, but must be somewhat displaced. Furthermore, the point of displacement is not a constant, but varies with the changing positions of the Sun and Moon. The earth responds to this angular force by making small changes in the orientation of its equator to the fixed stars. Generally, the result is a backwards (retrograde) motion of the Aries point along the ecliptic at a rate of about 50 seconds per year, which amounts to a degree in about 72 years. About two thirds of this effect is due to the Moon, and the rest to the Sun.

The luni-solar precession just mentioned goes through a complete cycle in about 26,000 years. There are similar effects due to the same causes which have a much shorter period, called nutation. Nutation may be considered the local effects of the Sun and the Moon on the Aries point, while the luni-solar precession is the long term, net effect. The largest part of nutation varies with the sine of the Moon's node, which has a period of about 18 years. Its largest effect is about 17 seconds. There are other terms, which involve the positions of the Sun and Moon.

The combined effect of the fact that the planets are not in the plane of the ecliptic also has a precessional

effect, called planetary precession. This amounts to an increase in the longitude of the Aries point by about ".12 per year, and a decrease in the obliquity of the ecliptic by about ".47 per year.

The obliquity of the ecliptic is also affected by long term precession and by nutation. Again, the largest term in nutation varies with the Moon's node, with a largest change of about 9 seconds.

To compute the nutation in longitude and the obliquity of the ecliptic, the following may be used:

$$da=-(17".233+0".017t)\sin(N)+0".209\sin(2N) -1".273\sin(2S)-0".204\sin(2M)$$

$$de=(9".210+0".001t)\cos(N)-0".090\cos(2N) +0".552\cos(2S)+0".088\cos(2M)$$

where

da = periodic change in Aries point due to nutation
de = periodic change in obliquity of ecliptic due to nutation
t = time in julian centuries from 1900
N = longitude of Moon's north node
S = longitude of Sun
M = longitude of Moon

```
DA=-(17.233+.017*T)/3600*SIN(N)+.209/3600*SIN(2*N)
DA=DA-1.273/3600*SIN(2*S)-.204/3600*SIN(2*M)
DE=(9.21+.001*T)/3600*COS(N)-.09*COS(2*N)
DE=DE+.552/3600*COS(2*S)+.088/3600*COS(2*M)
```

In applying these formulae, the change to the obliquity of the ecliptic would be computed and added in before computing other things, while the change in the Aries point would be added to longitudes as a final step.

For completeness, I will add two formulae for computing the general precession. The one for general precession is not periodic, but accumulates over time. The one for the obliquity of the ecliptic is exact.

$$p=50".2564+0".0222t \text{ per year}$$

$$e=23°27'8".26-46".845t-0".0059t^2+0".00181t^3$$

$$e=23°.452294-0°.0130125t-0°.00000164t^2 +0°.000000503t^3$$

Before leaving the direct description of this parade of horrors, a deserving member of the troupe which has not yet been discussed should at least be mentioned, namely, the measurement of time. Suffice it to say by way of illustration that one of the most fundamental ways of measuring time today depends on certain highly regular sub-atomic occurrences, which, in spite of their regularity, occasionally require the irregular insertion of what is called a "leap second" into the official flow of time.

Let me say that my first reaction to the foregoing was one of complete horror. While I recognized the basis of it all, and saw how it was quite justified from a certain point of view, it consists of a specific list of things which have to be accounted for in any viewpoint which seeks to take a spiritual view of the heavens. Asking after the meaning of nutation, for example, seems much more pointed than a general inquiry into the possible truth of astrology, and forces one to face the question of exactly what it is that one sees when one looks up. If one is to seriously pursue astrology (or anything similar, such as the relation between planetary positions and plant life), it simply is not possible to blindly build on what astronomers say about the sky, since what they say might only be true for their sky. Even what the astronomers are especially good at - computation - cannot be taken over without at least serious consideration, if not substantial modification. This is a vast subject area and needs much serious investigation. Here, I will present some of the more obvious issues that arise.

Let us start with the precession of the equinoxes. Insofar as precession moves the vernal point and thus shifts the orientation of one of our coordinate systems with respect to the background of the stars, it is largely a solved problem. We know how to write equations which account for most of the observed movement, and allow us to make suitable predictions. Precession takes on another meaning if it is supposed that the vernal point marks the beginning of a zodiac which lies along the great circle of the ecliptic, and that the zodiac has definite meaning for various aspects of life on earth.

It is helpful to call the imagination into play in understanding why precession might be a problem. Picture the zodiac as a great band in the sky, and yourself sitting in the middle of it. Precession makes the band slowly rotate backwards at a smooth overall rate. The nutational component of precession makes the overall backwards drift actually work out as an elaborate dance, depending on the factors that have been mentioned, the nodes and positions of the Sun and Moon. Every day, the vernal point is at a slightly different position measured against the stars, and its day-to-day movement is by no means simple.

Some sense can be made out of the slow backwards shift of the zodiac against the stars from a spiritual point of view. Briefly, this movement can be seen as corresponding to the evolution of conditions of human life on earth. The zodiac travels with the earth and is defined by its orientation to the heavens; it represents the thing which is undergoing change. The fixed stars correspond to the place out of which change comes, the source of the evolutionary movement[5]. Nutation is another matter altogether. It is hard to make sense out of a possible connection between the dance of the vernal point about its slowly precessing center and the progress of evolution. There might be such a correspondence, but one has never come to my attention, and I am not optomistic that a plausible one will. It is relevant here that the nutational changes are rapid, and must be understood more in terms of where the vernal point would be, rather than where it perceptably is, which can only be measured on the relevant day in the spring. Do the Signs really do this fancy footed shuffle as they slowly move backwards? Or is nutation without any significance at all for the Signs?

Astrologers have sometimes suggested that the transition between adjacent Signs is not a sharp one, but that there is a certain blending of the two Signs around their boundary. To the extent that there is any truth in this notion, could it be a spurious effect of incorporating

nutation into the computation of the boundaries of the Signs, when it should be left out? The effects of nutation are incorporated into the ephemerides which the astrologers and most everyone else use. If the phenomena which they study in fact have nothing to do with what we call nutation, then a certain percentage of the Sign positions of planets will be taken to be in a Sign in which they are not.

An issue relevant to the computation of Sign positions is the growing movement to consider the Signs not to be twelve sharply defined entities, but to result from wave forms which can lead to divisions other than twelve. John Addey[6] and Michel Gauquelin[7] are perhaps the best representatives of this movement. John Addey sees zodiacal space filled with standing waves, each of which relates in particular ways to events on earth. Gauquelin finds that the effects of the diurnal motion of certain planets on certain activities has a wave form. It is important to note that each of their effects was discovered in compiling statistics on large groups of people, while the discrete approach of traditional astrology has always applied to individuals.

The most fundamental issue here is whether it is the geometric or apparent positions of heavenly objects that are relevant to judging the correspondence between the spirit in the sky and the spirit on earth. Closely related to this is what account we should take of the particulars of the location of investigation on earth. It should be clear by now that there is a distinction to be made, and that it makes varying amounts of difference. I do not have an answer to this question, but I think that some things about the answer and how to go about finding it are clear.

If such a thing as planetary conjunction in longitude makes any difference, then it is probably the case that geometric distance makes little difference. Planets are considered to be conjunct when they occupy the same point of longitude, without regard to latitude. Because of their varying inclination to the ecliptic, it is perfectly possible for planets in conjunction to be more than ten degrees apart (in latitude), and highly unusual for there to be no separation at all between them. Could the semidiameters of the aspected planets make a difference here? In several branches of the study of planetary effects, it does seem to be the case that longitude makes a difference which is unaffected by latitude. This is true of Agnes Fyfe's work with plants[8]; while opinion is varied on whether latitude makes any difference astrologically, most people who think it does treat it in a supplemental fashion. If longitude does have an effect that is independent of latitude, it lends weight to the thought that the euclidian geometric positions of objects in the sky are not the ruling ones for the study of spiritual effects. In this connection, not only does longitude often seem to be effective independent of latitude, but geometric distance rarely seems to make much difference.

It is important when studying these questions not to lump all spiritual effects together. It is quite likely that there are large distinctions to be made, and quite possible that a factor might be negligible in one area, but highly significant in another. It might be, for example, that harmonic anaylsis of the zodiac is appropriate for studying the distribution of properties in a group of people, but that discrete zodiac Sign analysis is the proper method for the study of individual characteristics.

It is also likely that things that are important for the study of plants (or animals or countries) are quite different in the study of people. For example, Agnes Fyfe has found[9] that the angles of 60 degrees and 120 degrees between the Moon and certain outer planets make no difference to the analysis by capillary dynamolysis of mistletoe sap, while those relations would be significant in the study of a human natal chart (my apologies to those who ignore these aspects).

It is possible to devise experiments which should help answer some of the questions which have been raised. The experiments could involve testing one or more of a variety of things, including sensitive crystallizations[10], capillary dynamolysis[11], and natal charts. Natal chart testing is probably best done in retrospect, whereas the other methods could be performed at the proper time.

Certain effects of planetary aspects may be tested without regard to the question of zodiacal position. By taking many samples, an accuracy for the overall experiment may be obtained that is greater than the precision of the individual sample.

By using aspects between the Moon and an outer planet, the effect of parallax may be tested. This can be done by comparing the results of tests made when parallax has no effect to results made when it has a maximum effect (see figure 7). If parallax makes no difference, tests made at the moment of conjunction as measured from the center of the earth should give the same results no matter where on the earth they are performed. A similar test can be made of light time, that is, a test of geometric versus apparent position, using the Moon and a distant planet. The moment of exact aspect geometrically can be computed, and so can

the moment of exact aspect between the appearances. Assuming the theoretical relation between the phenomena we are testing and the exact culmination of aspect is known, the center point of the tested phenomenon can be determined from the tests and compared to the moment of exact aspect given by the two methods. This test will probably require greater precision than the one for parallax.

It is not obvious, incidentally, that the peak of an aspect's effect coincides with the moment when the aspect becomes exact. If the effect starts when the planets are a certain distance from exactly aspected, rises as they come close, and then falls away as they separate, a wave of some kind is described. We must be awake to second order effects; for example, consider a first order wave to be a normal (bell shaped) curve centered on the moment when the aspect becomes exact. The actual effect might be best described by the first derivative of the first order wave, and peak at the moment of the sharpest rise in the first wave, on the approach to the exact point of the aspect. Furthermore, it is not obvious that the effect will be symmetrical in all cases. It might be, for example, that the approach to aspect is very important, while falling away from aspect means little in certain cases[12].

It would be a good idea to test out whether latitude and/or declination effects aspects as reflected in the plant and mineral worlds. This could be done by comparing a series of aspects identical except for these factors.

The difference between the various methods of measuring the zodiac can be tested by looking at a variety of cases which come out differently depending on the method used for determining their position in the zodiac, in short, borderline cases.

I have sketched out a couple of representative experiments of the sort that might help clear up some of the problems I described. It should be clear that the experiments only make sense in the context of a spiritual understanding of astronomy, and are relevant to the relatively small area in which spiritual and modern scientific astronomy overlap. They do not speak to the issue of whether of spiritual astronomy is justified, because if it is not, the experiments cannot be carried out as proposed.

The issues I have presented constitute a call for research. Even people with scientific backgrounds who have tried to bring a new spirit into astronomy have not, in general, tried to grasp and struggle with these issues, if not arrive at solutions to them. I feel that in all these little problem areas, each giving us a choice for where we suppose a heavenly body to be, there lies a possibility for greatly deepening out knowledge of the true nature of the world in which we live.

A P P E N D I X

For those who would like to proceed to calculation, I will now present a few worked out examples, and some values of positions before and after the transformations which have been discussed above to check against. For further checking, use the American Ephemeris of the relevant year (these may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington D.C. 20402 for $11 each; the 1978 one is Stock No. 008-054-00071-1). I performed all computations with floating point hardware which uses 48 bits per number,

giving a decimal precision of about 11 digits.

First, we will simply give a list of values relevant to what has been discussed out of the ephemeris. Consider April 2, 1978, midnight at Greenwich, when the julian day was 2443600.5, and the time in julian centuries (my calculation) was .78249144422. The obliquity of the ecliptic at that time was

23°26'22".808.

This value is the true obliquity, the sum of the mean obliquity and the nutation in obliquity, which on that date was

-8".777.

The position of the Sun in rectangular coordinates using the mean equinox and equator for 1978 was

X=0.9780935
Y=0.1890022
Z=0.0819570

The position of the Sun measured from the mean equinox of April 2, 1978, and measured geometrically (almost the "true" position) was

Longitude of Sun = 11°53'50".39
Latitude of Sun = 0".66
Distance of Sun = .9995527

The precession in longitude from the start of 1978 to April 2, 1978 was

12".566.

The nutation in longitude was

1".553.

The precession in longitude from the start of 1950 (a commonly used date for these purposes) and the start of 1978 was

23'27".58.

To get the "true" longitude of the Sun, the true equinox of April 2 rather than the mean one must be used, and the difference between the two is exactly the nutation. So we have the

TRUE longitude of Sun = 11°53'51".943.

This one is no exceptions, absolutely everything taken into account geometric position. The ephemeris also gives a figure for the reduction to apparent longitude, which is the nutation in longitude at that time minus the aberration, which they say is calculated by dividing 20".47 by the true distance. The current accepted value for the aberration constant is 20".496, but this value uses the older constant:

Reduction to apparent longitude = -18".93

Finally, there are listed values for apparent right ascension and apparent declination, which are referred to the true equinox and equator of date, and are affected by aberration. The true obliquity, the value listed above, is used as well.

Apparent right ascension of Sun = 0h43m44.48s
Apparent declination of Sun = 4°42'7".3

Some of the other, nonpositional, values are also listed in the ephemeris. In particular:

horizontal parallax of Sun = 8".80
semidiameter of Sun = 16'1".61

I will also give a few values for Mars and Jupiter. The calculation for the positions of Mars and Jupiter should have resulted in geometric geocentric distances of 1.0949754 and 5.3067906, respectively. The time for the light to traverse the distance is given in the ephemeris as

9.11 and 44.14 minutes, respectively. Here are the heliocentric positions for the mean equinox and ecliptic of date:

Mars longitude = 152°34'41".6
Mars latitude = 1°48'3".2
Jupiter longitude = 99°31'49".7
Jupiter latitude = -56".2 (south)

Here are the corresponding geocentric, partly apparent positions; these positions use the true equinox and ecliptic of date (that is, the mean one plus nutation), and are corrected for planetary aberration. For Jupiter, perturbations by the inner planets have been included in the geocentric value about to be given, but were omitted from the heliocentric value just given.

Mars right ascension = 7h59m18.26s
Mars declination = 23°24'31".7
Jupiter right ascension = 5h54m14.727s
Jupiter declination = 23°25'4".24

Finally, a couple of other values:

Mars horizontal parallax = 8".04
Mars semidiameter = 4".27
Jupiter horizontal parallax = 1".66
Jupiter semidiameter = 17".32

Now let us run through a couple of calculations. First, the correction for light time. The first thing to do is calculate (if you haven't already) the geometric, geocentric distance of the planet in A.U.'s; then, the given formula returns the time taken by the light travelling in seconds. For Mars, we multiply the distance (1.0949754) by the constant, and get 546.4058643 seconds, which is quite close to the given time of 9.11 minutes.

Next we need the rate of change of the (geocentric) position. The best thing is to somehow compute the instantaneous rate of change, but the daily rate will probably do just fine. This may be calculated simply by taking the position exactly a day later and subtracting. Again for Mars, the right ascension is increasing by 74.04 seconds (of time) per day, and the declination is decreasing by 309".0 per day. You must discover the fraction of the day spent while the light was travelling, and multiply by the distance travelled during the day by the planet. In this case, Mars travelled +.468 seconds in right ascension during the nine minutes, and -1".954 in declination. These values should be subtracted from geometric times to measure where in the sky the planet appeared when its light arrived.

The calculation of aberration for the Sun is particularly easy (the result of which is given above), because each of the trigonometric multipliers in the formula reduce to 1. So let us work out the correction in right ascension for Mars. First, we need the position of the Sun minus the position of Mars. This is 0h43m44.48s - 7h59m18.26s = 16h44m26.22s. You could convert to degrees or radians before computing (or, if your computer has calculated the positions, the values are already converted); in any case, the difference is 251.10925 in degrees, or 4.3826831946 in radians. Its cosine is -.3237646753. The secant (= 1 divided by the cosine) of the latitude is 1.00115. (I really should be doing all of this in longitude and latitude alone, but this mixing should have a negligible overall effect.) The formula results in 6".64353 in angular measure. Finally, the correction to the right ascension, to be added to the geometric position

giving an apparent one, is .4429 seconds. The calculation for latitude is similar.

The latitudes for Greenwich, England were given in the text in both astronomical and geocentric measure; they should be sufficient to check your calculation of these numbers.

Similarly, the calculation of semidiameter is fairly easy, and sample values were given above for the Sun, Mars, and Jupiter. Another way to calculate this number is to take the value at unit distance divided by the geocentric distance. The accepted values of the semidiameters at unit distance are:

Mercury = 3".34
Venus = 8".41
Mars = 4".68
Jupiter, equatorial = 98".47
Jupiter, polar = 91".91
Saturn, equatorial = 83".33
Saturn, polar = 74".57
Uranus = 34".28
Neptune = 36".56

In the case of Mars, we would have 4".68 / 1.0949754 = 4".27407, which agrees with the semidiameter given above for Mars on April 2, 1978. If you wanted to compute the position of the leading edge of Mars rather than its center, you would add the semidiameter to the position of the center. Mars would also occupy 4".27 towards its trailing side. Similarly, you could use the span to compute whether in a conjunction in longitude, two planets overlapped or touched by seeing if the distance between them in declination was less than the sum of their semidiameters; if so, they overlap.

We will now work out an example of parallax. Consider Jupiter at midnight at Greenwich (keeping things simple here) on April 2, 1978. The relevant numbers from the ephemeris are

right ascension = 5h54m14.727s
declination = +23°25'04".24
sidereal time = 12h39m56.468s

We would also have to compute the geocentric latitude of Greenwich, which was given above as 51°17'22".6. The calculation for zenith distance results in 78.595342573 degrees, which tells us that Jupiter was fairly close to the horizon at that time and date. The geocentric distance to Jupiter was 5.3067906 A.U. at that date, and as the distance to the center of the earth, I will just use the approximation of 6368 km. The ratio of these, which is the important number for parallax, is 8.0213156 E-6, a small number, of the order of a millionth; from this, we conclude that the parallax will not be large, and in fact, the change in hour angle (or right ascension) is only 3.070126 E-4 degrees. For comparison purposes, let us now assume that at that time and place, the Moon occupied the given place in the sky instead of Jupiter. Using the mean distance of the Moon, 384400 km, the ratio has the value of 0.016566. This corresponds to a change in hour angle (or right ascension) of 0.63262 degrees, or more than half a degree!

Taking the same data as we have just been considering for parallax, let us now compute the refraction; it is likely to be fairly significant in this case, since Jupiter is close to the horizon. Since I have no idea of the atmospheric conditions at Greenwich on April 2, 1978, I am forced to assume an average pressure of 760 mm and an

average temperature of 10°C. The refraction from the formula given is 6.112 E-2 degrees, or about 3.67 minutes. To give you an idea of the amount of variation in these formulas (refraction is more an approximation than others), the formula for mean refraction given in the Smart textbook,

$$R=58".16\tan(z)-0".067\tan^3(z),$$

yields 7.782 E-2 degrees, or 4.67 minutes. The intermediate results in translating the refraction to a change in right ascension and declination are cos(a) = .19645945 and cos(B) = .79599467. Finally, the change in declination is -2'.92, and the change in right ascension is -1'.46.

As a final computational example, I will give some numbers for the nutation for our favorite date. First, we need the arguments required by the formulae:

Moon's north node = 185°.7350
Sun's mean longitude = 9°9905
Moon's longitude = 299°56'41".34
time in julian centuries = .78249144422

The nutation in longitude is then +1".506 (the ephemeris gives 1".553), and the nutation in obliquity is -8".778 (the ephemeris gives -8".777). The discrepancy in nutation in longitude (a twentieth of a second) is small enough so that it should make no practical difference; it arises, I think, from smaller order terms used for calculating the ephemeris which I left out in the formula given here.

I am refraining from giving a "complete" example simply because I think that the proper combination of the factors described in this paper is by no means obvious, and I have no strong favorite which I wish to encourage by giving it as a pattern. I have, however, given an example for each of the major pieces of the puzzle, so you should have no trouble testing code which combines several of the

λ_A = 357.5134 - 0.003514(-0.5677) = 357°.5154
β_A = 1.5865 - 0.003514(-0.2629) = 1°.5874
α_A = 357.0878 - 0.003514(-0.4162) = 357°.0893
δ_A = 0.4669 - 0.003514(-0.4669) = 0°.4685

In working through these examples and in performing any of the indicated computations, the reader should be aware of the following points: (1) the "true" positions were computed from two-body Kepler theory and so are only approximations to the true positions, (2) the true positions refer to the mean equinox and ecliptic of date, (3) this paper illustrates only the aberration correction; to obtain the apparent positions referred to the true equinox and ecliptic of date the corrections for the nutation in longitude and the nutation in obliquity must also be included, but that is a topic for another miniarticle.

David Wilson's program OPTION 1, 25 arms
printed on MATRIX Spinwriter, APPLE II

FIGURE 5

RHW THE EFFECTS OF GEOID

FIGURE 6 EFFECTS OF REFRACTION

Figure 4 Lunar Equatorial Horizontal Paralax
and the Effects of Parallax on conjunction

Figure 3

Figure 1 GEOCENTRIC COORDINATES

Figure 2 HELIOCENTRIC COORDINATES

pieces.

NOTES

1. For the transformation formulas and a discussion, see James Neely: "On vectors, matrices, and coordinate transformations," MATRIX #4, Spring 1979
2. In the BASIC examples, I have used multiple character variable names to make the statements easier to follow and check; if your BASIC does not allow this, simply substitute legal variable names. Furthermore, in order to keep the intention apparent, I have used degrees throughout, although many versions of BASIC require arguments of trigonometric functions to be in radians; again a simple conversion will solve the problem.
3. I am purposefully using the language of modern physics here, to show how "true" positions are deduced from apparent ones. We should be clear that while light in its physical aspect may have finite velocity, the underlying light effect (e.g., the light ether) may have infinite velocity; this relates to the phenomenon of the slowing of time as an object approaches the speed of light, time presumeably ceasing in the limit. From this it follows that, for the light, no time passes, however long its journey may be. For interesting perspectives on this point, see Arthur M. Young: The Reflexive Universe Delacorte Press 1976, especially pp. 10-31, and Dr. Hermann Poppelbaum: Truth and Error in Astrology, New York 1945.
4. Almanac for Computers 1979, US Naval Observatory.
5. There may nonetheless be a place for direct effects of a sidereal or constellations defined zodiac, for example in areas not directly tied to the evolution of human psychology.
6. John Addey: Harmonics in Astrology Cambridge Circle 1976
7. Michel Gauquelin: The Scientific Basis of Astrology, New York 1969.
8. See, for example, A. Fyfe: Moon and Plant, Arlesheim 1967
9. A. Fyfe: "The signature of the planet Mercury in plants" British Homeopathic Journal LXII(4) Oct. 1973, LXIII(1) Jan. 1974, LXIII(2) Apr. 1974.
10. E.E. Pfeiffer: Sensitive Crystallization
11. Fyfe, op. cit.
12. The experiments done by L. Kolisko concerning the relations between planetary positions and the seven planetary metals provide an extreme example ot this sort of effect. During a total eclipse of the Sun, for example, pictures made by a certain process using a solution of silver and gold salts undergo a series of qualitative changes, not well described by any simple two dimensional graph. These changes follow the timing of the different phases of the eclipse quite exactly. See for example L. Kolisko: Gold and the Sun ("An account of experiments conducted in connection with the total eclipse of the Sun of 19 June 1936"), London 1936.

CONVERSATIONAL MATH
A COLUMN FOR BEGINNERS

BUZ OVERBECK

Person 1: I can understand any foriegn language except Greek....try me!
Person 2: Parlez-vous Francais?
Person 1: Thats Greek to me!

Henny Youngman

I'm sure many of us can relate to the above, especially after thumbing thru a couple of editions of Matrix. If Matrix has a flaw, (which we doubt !), perhaps it's that it tends to leave the non-technical reader feeling as though he's shown up at the wrong party. That he just doesn't belong. Do to the technical nature of it's material, Matrix can create the impression that the majority of astrologers are highly trained mathematicians who write grocery lists in nested parenthetical form. This is not true. The majority of astrologers have had a minimum of math, forgotten most of it, use tables and chart forms and, if it's really important, send the stuff to Neil Michelsen. However there is a section of that majority who want more. These are the astrologers who are looking for better ways of doing things, who have bought or are considering buying a computer or programmable calculator, or who just want to know what they're doing in the first place. If you are one of these, then you will find this column useful.

The current philosophy of Matrix is a good one. As I understand it, the Erlewines seek to establish a universal clearing house of astrological techniques and ideas and the only way this can be accomplished is to reduce these ideas and techniques to their essential equations. This is much better than the original idea of publishing "programs", for if one doesn't have the machine the program was written for, it's useless! Only the equation itself is truly universal, if you can read it. If not, you're just as well off with the wrong machine. But this presents a problem. How does Matrix reach the majority of astrologers who aren't technically inclined? There are two solutions: 1. Make the journal less technical, or 2. Make the reader more technical. As there are many "less technical" journals already around, the logical solution seems to be number 2. This column is a step in that direction.

BERLITZ COMPUTING

Mathematics is often referred to as a Universal Language. So is Esperanto. For the majority of us, there is little difference between the two. However, if you must learn a new language, there is much to say for the conversational approach. In this approach you concentrate on learning phrases which are immediately applicable; you learn to understand, and be understood first. Then, after you have some familiarity with, and confidence in, the language, you study the grammer.
This is the method used in this column. The idea will be to get you working the equation. If you can implement the equation you can use the technique. It's as simple as that! No attempt will be made to show why it works, no diagrams or theory will be presented, and the solutions may be crude. But they'll work. The purpose is to get those of you who have had no contact with equations or formulas of this sort a method by which they may be approached. Get it up and running. Then, after you've acquired a bit of confidence and formulas don't intimidate you anymore, you might find yourself motivated to study the grammer. This is how you learned English so you might as well try it with math. Who knows, someday soon you might be speaking Neelynese!

PRINCIPLES

The procedure is to break down each formula into small, recognizable, and workable phrases or modules, solve these, and then reassemble the intermediate results.. At first, there may be many of these "phrases", however the number will decrease as your confidence increases until, ultimatly, you'll see the entire equation as a single module.

REQUIREMENTS

The only requirement is that the reader has a calculator with trigonometric functions, ie; sine, cosine tangent and their inverses, $\sin^{-1}$, $\cos^{-1}$, and $\tan^{-1}$. The procedure for taking these functions vary from machine to machine so check the owners manual to see how yours works. Other nice features are the ability to perform Polar/Rectangular conversions and Degree, (Hour), minutes and seconds to decimals of degrees, (hours). From this point on the above will be noted: d.mmss, h.mmss, d.dddd and h.dddd, (the .dddd signifies decimals).

The latter conversions are particularily useful but not essential. If your machine doesn't have this feature use the following routine.

d.mmss/h.mmss to d.dddd/h.dddd conversion

1. Enter the seconds and divide by 60.
2. Add the minutes and divide by 60.
3. Add the degress or hours = d.dddd or h.dddd.

Example #1: Convert $165^{\circ}\ 45'\ 23"$ to degrees and decimals of a degree.

1. 23/60 = 0.3833...
2. + 45 = 45.3833.../60 = 0.756388...
3. + 165 = $165.^{\circ}$756388...Answer.

Example #2: Convert $16^{h}\ 05^{m}\ 58^{s}$ to hours and decimals of an hour.

1. 58/60 = 0.966...
2. + 5 = 5.966.../60 = 0.09944...
3. + 16 = $16.^{h}$09944...answer.

IMPORTANT NOTE: This will be your first step in solving formulas which use degrees or hours. In all cases degrees and hours are assumend to be expressed in decimals.

If your answer is in degrees or hours it will be necessary to convert back to minutes and seconds. Just reverse the above procedure.

d.dddd/h.dddd to d.mmss/h.mmss conversion

Example #3: Convert $165.^{\circ}$756388 to d.mmss.

1. - 165 (copy) = 0.756388
2. x 60 = 45.3833... - 45 (copy) = 0.3833...
3. x 60 = 22.9999... = 23. Reassemble = $165^{\circ}\ 45'\ 23"$

Example #4: Convert $16.^{h}$09944 to h.mmss

1. - 16 (copy) = 0.09944
2. x 60 = 5.9664 -5 (copy) = 0.9664
3. x 60 = 57.9840 = 58. Reassemble = $16^{h}\ 05^{m}\ 58^{s}$

Hereafter, quantities expressed in hours or degrees will be referred to as time or arc respectively. There is an important relationship between time and arc and it's necessary to be able to convert one to the other, which brings us to our first real life equations: Time = Arc/15 and Arc = Time x 15.

These equations simply state that if you have time and want arc, multiply the time by 15. Conversely, if you have arc and you want time, divide the arc by 15. This is based on the relationship of $1^{h} = 15^{\circ}$ but this is grammer. It's important to know but the formulas will work whether you know it or not! You will be using this relationship to convert the L.S.T. (local sidereal time), of your chart to right ascension in the next lesson.

WHERE'S THE "WHERE"?

A more formal way of writing the above equations are: 1. T = A/15, and 2. A = 15T, where T = time and A = arc.
Here we have an "expression", a combination of letters and numbers. The letters are called "variables" and represent the quantities involved in the problem. The "where" statement tells exactly what these quantities are and consequently is very important. This will be one of the first things we'll look for.

"IF IT'S MONDAY IT MUST BE ALGEBRA"-- Rommel ?

For many centuries it's been fashionable for mathematicians to assign letters of the Greek alphabet as variables, often on the basis of sound. As a result, it's quite common to see δ, (Greek Delta), for Declination, λ, (Greek Lambda), for Longitude, (get it?), and ϕ, (Greek Phi), for Latitude, (well, nobodys perfect). Don't let this throw you; it's just another inconvenience. A glossary of such things is included at the end of the article to aid in the translation. Hopefully this practice will become less common now that the computer has "arrived". Most computers only speak English. Another thing to know, or remember is demonstrated in equation #2 above, namely "15T". Algebraically speaking, it is not necessary to include a multiplication sign when the meaning is unambiguous. Thus 15T, 15 x T and T(15) all mean the same thing, 15 times T. This is important and often at the root of many mistakes made by the inexperienced. There are also different multiplication signs in use. The one which will be used in this series is the asterisk, (*), which is used with computers, and for that reason might prove useful to you in the future. Therefore, 15T can be represented as 15*T.

ORDER OF OPERATIONS

In order for equations to properly be solved, it's important that operations are performend in a specific order. The following order is consistent with computer implementation.

1. Perform all expoential functions. ie; X^2, X^3, etc. ($\sqrt{\ } = X^{.5}$)
2. Perform all multiplication and/or division, (left to right).
3. Perform all addition and/or subtraction, (left to right).

To make sure you understand this, solve: $x = 4^2 + 5 * 3 - 6$. You should get x = 25. If not, review the order of operations.
The normal order of operations may be changed by the use of parenthesis. All computations within parenthesis will be performend first, following the normal order of operations. Thus, $x = 4^2 + 5 * (3 - 5)$ will yield x = 6. Some formulas are written with parenthesis and brackets, [ ] . The brackets serve the same purpose as parenthesis, indicating that the computation enclosed therein be performend first. When an equation includes parenthesis within parenthesis within parenthesis, this is called "nested parenthetical form". One always starts with the computation enclosed within the innermost set of parenthesis and works outward.
We now have enough to suggest an orderly method of approach for the solving of equations.

1. List and define all variables.
2. Break down the formula into modules or "phrases".
3. Solve the individual modules.
4. Reassemble individual solutions, and solve the equation.

In step one, we use the "where" statement, if given, to define the variables. We also search for any other definitions or explanations which may be provided. In step two, we "lift out" computations that need to be solved before the equation itself can be worked. These phrases, or modules are usually those computations which are enclosed in brackets or parenthesis. In step three, we solve, or perform the calculations within these modules, and in step four we plug these individual solutions back into the original formula and complete all pending operations.

Now that the ground work has been laid, it's time to put all of this to use.

JULIAN DAY NUMBERS

In Matrix 3, there is an excellent article by Alexander Borg on the Julian Day Number. There are several routines listed which could prove difficult to those new to the language, and, as a good J.D. routine has many useful applications, (days between dates, progressions, directions, biorhythms etc), this is a good place to begin. Other reasons for this selection include: 1. they look formidable, 2. they demonstrate many of the points mentioned above, (parenthesis, brackets, order of operation, etc), and 3. They are complicated; probably more so than 90% of the equations you will be dealing with on a practical level. So if you can "speak" these fluently, you should have little trouble with the formulas which will be presented in the months to come.

For those interested in such things, (a little grammer here), the Julian Period was introduced in the 16th century by Josephus Justis Scaliger, it has a period of 7,980 Julian years, and this period is based on the least common multiple of the 28 year Solar Cycle, the 19 year Lunar Cycle, and an ancient, non-astronomical cycle of 15 years known as the Cycle of Indiction. The Epoch of the period is 4713 B.C., the year when all three cycles began together. The Julian Day Number is the reckoning of this period in days. Of the routines listed, we will select Isaacson's formula for converting a date to its equivilent JD#, (incoding), and Borgs modification of Isaacson's formula for converting a JD# to its equivilent date, (decoding). As the article is rather spread out due to the inclusion of so many formulas, we have to search carefully for explanations. All the pertinent info is listed below.

DATE TO JD NUMBER - ISSACSON'S FORMULA

$$JDo = D + \left[365.25 * y\right] + \left[30.6 * m\right] + 1720981.5$$

$$\text{Where } y = Y + \left[\frac{M - 14}{12}\right], \qquad m = 15 + 12\left\{\frac{M - 14}{12}\right\}$$

The following abbreviations were used:

$[a]$ = integral part of a, $\{a\} = a - [a]$.
(ie; if a = 5.35, then $[a] = 5$ and $\{a\} = .35$)
D = day, M = month and Y = year.

Validity: March 1, 1900 thru February 28, 2100

SOLVING THE EQUATION

Using the method outlined above we'll solve the equation.

Example #5: Convert the date 1-14-1939 to its equivilent JD number.

Step 1. List and define the variables.
First, define the variables which require no calculation.

D = 14, M = 1, Y = 1939. So far so good. Now what? Find the "where"!

$y = Y + \left[\frac{M - 14}{12}\right]$ and $m = 15 + \left\{\frac{M - 14}{12}\right\}$

These are actually "sub" modules which need to be solved before the main equation can be approached. Start with y and fill in the variables.

$y = 1939 + \left[\frac{1 - 14}{12}\right] = 1939 + \left[\frac{-13}{12}\right] = 1939 + \left[-1.08333...\right] = 1939 + -1$

y = 1938. (Did you remember the integer function?)

Now do m the same way.

$m = 15 + 12\left\{\frac{1 - 14}{12}\right\} = 15 + 12\left\{\frac{-13}{12}\right\} = 15 + 12\left\{-1.08333\right\} = 15 + 12 * -0.08333$

m = 15 + -1, (or m = 15 - 1),
m = 14. Hardly seems worth it!

So, y = 1938; m = 14. The variables are now defined.

Step 2. Break down the formula into modules.
Here we will lift out the expressions enclosed in brackets.

$\left[365.25 * y\right]$ and $\left[30.6 * m\right]$.

Step 3. Solve the individual modules.
All we need to do here is to plug the variables into the modules and perform the necessary calculations.

$\left[365.25 * y\right] = \left[365.25 * 1938\right] = \left[707854.5\right] = \underline{707854}$.

$\left[30.6 * m\right] = \left[30.6 * 14\right] = \left[428.4\right] = \underline{428}$.

Step 4. Reassemble the individual solutions and solve the equation.
This is the easiest step of all!

JDo = 14 + 707854 + 428 + 1720981.5 = 242 9277.5.
JDo = 242 9277.5 !

Work thru this example until you feel comfortable with each step. Don't get discouraged if you make a mistake. Mistakes indicate grey areas in your understanding. When you feel that you have a good grasp of the first example, try the next one.

The following formula reverses the procedure we just went thru. It will take a JD number and convert it to the equivilent date. Again, all the necessary information is provided below.

JD NUMBER TO DATE - ISSACSON/BORG FORMULA

$x = JDo - 1720981.5$, $y = \left[\frac{x - 122.9}{365.25}\right]$, $m = \left[\frac{x - 365.25 * y}{30.6001}\right]$

(Note that $\left\{JDo\right\}$ must equal 0.5)

Then $D = x - \left[365.25 * y\right] - \left[30.6001 * m\right]$,

$M = 1 + 12\left\{\frac{m - 2}{12}\right\}$,

$Y = y + \left[\frac{m - 2}{12}\right]$.

This formula is of interest as it's really not one formula but three, (a seperate formula for the day, month, and year, ((D,M,Y)), respectively), and what's more, doesn't have a "where" statement! This makes no difference as the variables are neatly given at the top. If you need a "where" statement, stick the variables at the bottom and precede them with a "where". No matter; the method of solution is the same.

Example # 6: Convert JD# 242 9277.5 to its equivalent date.

Step 1. List and define the variables.

$x = 242\ 9277.5 - 1720981.5$ — x = 780296

$y = \left[\frac{780296 - 122.9}{365.25}\right] = \left[1938.87\right]$, — y = 1938

$m = \left[\frac{780296 - 365.25 * 1938}{30.6001}\right] = \left[\frac{708296 - 707845.5}{30.6001}\right]$

$= \left[\frac{441.50}{30.6001}\right] = \left[14.43\right]$ — m = 14

Step 2. Break down the formula into modules.

$\left[365.25 * y\right]$, $\left[30.6001 * m\right]$, $\left[\frac{m-2}{12}\right]$, and $\left\{\frac{m-2}{12}\right\}$

Step 3. Solve the individual modules.

$\left[365.25 * 1938\right] = \left[707854.5\right] = \underline{707854}$

$\left[30.6001 * 14\right] = \left[428.40\right] = \underline{428}$

Now $\frac{14 - 2}{12} = 1.0$, so, $\left[1.0\right] = 1$, and, $\left\{1.0\right\} = .0$

Step 4. Reassemble the individual solutions and solve the equation.

D = 708296 - 707854 - 428 = 14. — D = 14
M = 1 + 12 * 0.0 = 1. — M = 1
Y = 1938 + 1 = 1939. — Y = 1939

Therefore the equivilent date is 1-14-1939!

TOURIST: How do you get to Carnegie Hall?
NEW YORKER: Practice! -Anon.

The next step in the learning process is practice. You should work thru the following list, incoding and decoding, until you can confidently, and consistently, get accurate results using the formulas without reference to the examples. This will happen sooner than you think! Now if you're really human, you can expect your first few attempts to crash. Hang in there and try it again. If it just won't work after several attempts, refer to the trouble shooting guide at the end of the article. Remember, these formulas aren't easy; there is a lot that can go wrong in the process of solving them, so when you get them down, you've really accomplished something. Congratulations. Here are the practice dates:

TEST DATES

Date	JD#
8-16-1935	242 8030.5
5-24-1979	244 4017.5
3-04-1920	242 2387.5
2-18-1950	243 3330.5
12-07-1941	243 0335.5
10-31-1965	243 9064.5

TROUBLE SHOOTING

If the result of all your work doesn't check out, (after repeated trys !), the following brief guide should provide a clue as to where you went wrong.

1. Did you convert everything to decimals before using?
2. Did you perform operations enclosed in parenthesis or brackets first?
3. Did you follow the "order of operations" exactly?
4. Did you perform any existing $\left[integer\right]$ or $\left\{fraction\right\}$ function?
5. Did you remember that multiplication signs are often ommited in equations?
6. Did you confuse a lower case letter with an upper case letter, (M/m),?
7. Did you convert the answer back into minutes and seconds?
8. Did you <u>really</u> try solving the equation more than once?

If you can answer "yes" to all of these questions except #6, (which requires a "no"), and still get the wrong answer, chances are you misinterpreted the "where" statement. In this case, go back and read it again. (In the JD# equations #1 and #7 don't apply). If you've checked everything and it <u>still</u> doesn't work, throw all your stuff into a bag and send it to Erlewine; this journal was his idea in the first place!

A GLOSSARY OF GREEK

What follows is a short list of Greek letters along with what they are often used to represent. There are no hard and fast rules here and no attempt is being made to present a complete table. These are just a few of the symbols you'll see used in equations and they are included so that you might familiarize yourself with them.

LETTER	OFTEN REPRESENTS
1. α - l.c. Alpha	Right Ascension
2. β - l.c. Beta	Planetary latitude
3. δ - l.c. Delta	Declination
4. Δ - u.c. Delta	The difference between two quantities
5. ϵ - l.c. Epsilon	The Obliquity of the Ecliptic
6. λ - l.c. Lambda	Planetary longitude
7. ϕ - u.c. Phi	Geographic latitude
8. Ω - u.c. Omega	A planetary node

l.c. = Lower Case u.c. = Upper Case

ACCURACY IN PLANETARY COMPUTATIONS AND SOME REMINISCENCES

JAMES NEELY

It seems as if it were only yesterday when handheld calculators were readily available and desk top "home" computers were in their infancy if not embryonic stages. After producing programs to compute house cusps in numerous systems I was delighted to discover that I could produce two-body computations of planetary positions to within 0°.5 or so on my HP-65 using three cards per body and a very limited 100 program steps per card and an even more severely limited nine storage registers (actually eight, since every trig computation used the ninth register for scratch). I was even more delighted to discover that my HP-65 computations for 100 B.C. to 1 B.C. were within 1°.5 of the values published by Tuckerman [1] and Stahlman and Gingerich [2].

When the HP-67 was introduced I put my trusty HP-65 on the back shelf and luxuriated with 224 program steps per card and a "vast" memory capacity of 26 storage locations, to say nothing of a "smart" card reader that could distinguish between program cards and data cards. I jumped at the opportunity to accept the challenge of the new HP-67 and to see how I could trim my HP-65 programs to fit into a new environment with a minimum of discomfort for the user. As a consequence all of my programs reblossomed with added features (such as optional but automatic sidereal zodiac transformations) and the planetary position computations took on a new look too [3].

My delight was further extended when Hewlett-Packard recognized the astrologically oriented community and produced a collection of my programs in their *HP-67/97 Users' Library Solutions: Astrology*. And it would have been a collection solely of my programs except that they included one program by some unknown intruder named Michael Erlewine. But this apparent blemish soon turned into serendipity as Michael and I came to know each other - and you can see that our relationship has been a savagely competitive one by carefully perusing the past issues of MATRIX. Currently Michael is "bugging" me to start writing the first installment of the long promised series on house computations, but I continue to submit articles such as this one for there are some very current issues that need some sort of discussion.

We were doing fine with what we were doing until almost over night things like "PET's" and "TRS-80's" and uncounted other "desktop" devices were thrust into our consciousness; and with the users of these devices there came a demand for better and better accuracy in the computation of planetary positions. This is a demand that seemingly must be met (although for the life of me I cannot understand why astrologers want their planets to within one minute of arc or better and then turn around and retro-prognosticate with aspects that are based on *ten degree* orbs), and so as we are slowly coming to grips with the accuracy problem it seems opportune to stand back and take a look at what corrections must be made to which bodies to improve accuracy the most.

The table below contains an estimation of the maximum errors in ecliptic longitude that accrue from various sources when the two-body computations are left uncorrected. The perturbation deviations are from the two-body computations which use the equations on page 31 of MATRIX TWO for the Sun through Mars and the 1900-2000 year equations on page 32 of MATRIX TWO for Jupiter through Pluto. It was a shock to the author to discover that the 1900-2000 outer body deviations could be as large as those reported in the table, especially since all users reported accuracy to within 2' to 3'; it turns out that the maximum errors occur either near the year 1900 or the year 2000 and that the accuracy for "current dates" is usually within the reported 2' to 3'.

Body	Perturbations (heliocentric deviation from two-body theory)	Aberration	Nutation
Sun	36"	21"	19"
Mercury	35"	61"	19"
Venus	45"	45"	19"
Mars	2'30"	39"	19"
Jupiter	8'14"	30"	19"
Saturn	7'37"	28"	19"
Uranus	4'15"	26"	19"
Neptune	10'19"	25"	19"
Pluto	15'43"	25"	19"

Ian McKinnon [4] has presented algorithms and HP-67/97 programs based upon the work of Newcomb and Ross (see [4] for the references) which correct for perturbations, aberration and nutation and yield positions of the Sun through Mars to within 0".5. Elsewhere in this issue are preliminary perturbation formulas which reduce the maximum perturbation errors of the outer bodies to within 45" as well as an article which discusses the aberration correction.

This, apparently, is the state of the art in planetary position computations as of this moment with respect to small computers. We expect extended and more accurate formulas from the Naval Observatory to be published soon so that the increased accuracy requirement of users will continue to be met. Such increased accuracy will be obtained by the inclusion of more perturbation corrections, and as that source of error is reduced the aberration corrections and then the nutation corrections must be made; these corrections we must make for ourselves and include in our computer programs, so it is well to start considering them now.

In the meantime I have discontinued work on improving further the 1900-2000 year outer body perturbation computations in favor of developing extended (and hopefully better) outer body perturbation corrections for the 1700-2000 year period. The reader should be reminded, however, that the extensive Lloyd Carpenter technique [5] which will compute the outer body heliocentric positions to within 0".001 for the years 1800 to 2000 is currently available for the (considerably) larger computers.

References:

1. B. Tuckerman, "Planetary, Lunar, and Solar Positions: 601 B.C. to A.D. 1", The American Philosophical Society, 1962.
2. W.D. Stahlman and O. Gingerich, "Solar and Planetary Longitudes for Years -2500 to +2000", The University of Wisconsin Press, 1963.
3. MATRIX TWO, pp 37-50.
4. MATRIX THREE, pp 4-21.
5. Lloyd Carpenter, "Planetary Perturbations in Chebyshev Series", National Aeronautics and Space Administration Technical Note TN D-3168, 1966.

PLOTTING MATHEMATICAL FUNCTIONS ON THE HOME COMPUTERS

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The motivation for this program was the desire to make the computer produce a pattern that had the appearance of a galaxy. The simplist form of a galaxy consistes of two mirror-opposite spirals originating from a common center. A spiral can be thought of as a circle with a changing radius. Think of the hand of a clock moving. As the hand moves, its tip traces out a circle. Now think of a very short clock hand. As it moves it grows longer. The larger the angle traced out by the clock hand, the longer the clock hand grows. In this case, the clock hand will trace out a spiral.

If R is the radius or length of the clock hand and A is the angle which had been swept out by the clock hand, and if the radius is set proportional to the angle, then the spiral is expressed byu R = KA. So in polar coordinates the point (R,A) = (KA,A). To plot this point on the screen we must translate it to rectangular coordinates. This can be accomplished simply by using elementary trigonometric functions to project the point onto the X-axis and the Y-axis. When we do the projection we have (X,Y) = (R COS A, R SIN A) = (KA COS A, KA SIN A). Once we have established this procedure, we may vary the relationship between R and A in any way we like to produce other kinds of spirals. For example, R = K(1-EXP (-A)) will produce a spiral that flows on forever but always stays inside a circle of radius K. R = K SIN A will produce a spiral that first expands and then contracts.

So far we have described spirals with one arm. To draw a galaxy, we would like a spiral with two or more arms. All that is required to accomplish this is to take a complete circle, or 2 PI radians, and divide it by N, the number of desired arms, and start each of the N arms growing at each integer multiple of 2 PI/N and, Presto!, we have a galaxy!

EDITOR'S NOTE:
This program was written by Wilson on the TRS-80 and adapted for the APPLE II which has hi-resolution capabilities. The first section allows the user to create a spiral galaxy shaped drawing with as many arms as desired. On the APPLE II, if more than a dozen arms are selected, the result is an intricate filagreed sphere. The second section allows a reversing scroll to be drawn on the screen.

TRS-80 owners should use a radius (R) or 24 and replace the following line:
750 SET (64 + X*2, 24 - Y)
PET owners will have to implement one of the double resolution programs that are available from a number of sources.

```
70  INPUT "1=GALAXY, 2=SCROLL ";CC
80  ON CC GOTO 90,950
90  INPUT "PICK 1,2,3,4,5, ETC. ";O
100  INPUT "# ARMS IN GALAXY= ";M
150  INPUT "RADIUS (APPLE=95) ";R
250  HGR2 : REM  SET HIGH RESOLUTION MODE
      ON APPLE II
300 N = 5
400  FOR T = 0 TO N * 628 STEP 5
450 T1 = T / 100
500  FOR P = 0 TO M - 1
510  ON O GOTO 520,530,540,550
512  REM  BELOW ARE VARIOUS MATHEMATICAL
     FUNCTIONS
515 RT = R * T1 / (N * 6.28): GOTO 600
520 RT = R * T1 / (N * 6.28): GOTO 600
530 RT = R *  SIN (2 * T): GOTO 600
540 RT = R * T1 / 6.28 +  SIN (10 * T1): GOTO
     600
550 RT = R * (1 -  EXP ( - T1 / 6.28))
560  GOTO 600
600 A = T1 + P * 6.28 / M
650 X = RT *  COS (A)
700 Y = RT *  SIN (A)
750  HPLOT 140 + X,96 + Y
800  NEXT P
850  NEXT T
900  GET G$
925  REM  TRY INPUT 8BELOW9 -60,-60,4,5,.
     05
950  INPUT "X,Y,R,N,S=";X,Y,R,N,S
1000  HGR2
1050  FOR T =  - N TO N STEP S
1100 RT = R
1150 FT = T * T
1200 X = X + RT *  COS (FT)
1250 Y = Y + RT *  SIN (FT)
1300  HPLOT 140 + X,96 + Y
1350  NEXT T
1400  GET G$
```


APPLE II
Option #4, 7 arms
Screen Dump to NEC SPINWRITER

THE ABERRATION CORRECTION

JAMES NEELY

This miniarticle is intended to demonstrate how results of previous work (MATRIX TWO, pp 2-4) can be used to perform the aberration correction. Several articles in previous issues of MATRIX have presented algorithms for computing planetary positions. With the exception of McKinnon's (MATRIX THREE, pp 4-11), these methods can be used to calculate true positions of the planetary bodies to varying degrees of accuracy. It would seem that the aim of astronomy and mathematical astrology would be to produce true positions of bodies as accurately as possible. And for the most part this is correct, however for many purposes we intentionally bias these results in such a way that we distort the *true* position of a body into what we call the *apparent* position of the body.

When we look into the sky and we observe one of the planets we can, with proper equipment, measure the position of that body at some instant in time, say *now*. What we measure is the position as we see it - this is actually called the *observed* position, but for all practical astrological work we may take this to be synonymous with the *apparent* position (if we were observing from the center of the Earth rather than from some point on its surface, then they would be the same). But what we are actually observing is not where the body *is now*, but rather where the body *was when* the light from the body that we are seeing *now* left the body at some earlier time and in a direction such that it would encounter the position into which the Earth has moved and occupies *now*.

Let's try to explain this with a more mundane example. Consider a football quarterback throwing the long "bomb". At some instant in time the quarterback throws the "bomb", but there is no one on the playing field at the point to which the pass is thrown at the the instant that the ball leaves the quarterback's hand. Now, as the ball sails through the air numerous things happen: a few milliseconds after the ball left the quarterback's hand, a defensive tackle clobbered the quarterback so that both are laying on the ground, this while the ball is still sailing through the air. In the meantime a pass receiver is running a deceptive pattern, but one which puts him on a perfect collision course with the airborne football. At the instant of "collision", the pass receiver and the football reach the same point at the same time; the result is a perfectly executed pass reception. But let's examine some details. At the instant that the pass is received, the quarterback's *true* position is flat on the turf entangled with the defensive tackle. But the *apparent* position of the quarterback from the receiver's point of view is the point on the field where the quarterback was at the instant that the ball was thrown. We are assuming, in this crude analogy, that the velocity of light is equivalent to the speed of the ball in flight, and that the receiver "sees" accordingly.

Thus, in orbital mechanics, the two bodies are represented by the planet (passer) and the observer (receiver). At one instant of time some light is emitted from the body in a direction that will coincide with the observer's position at a later instant of time. The observer sees only where the body was at the time that the light left it and not where it's *true* position is *now*.

With "smooth" orbital motion, we may take our calculated *true* position of the body and extrapolate backward in time to where the body must have been for us to observe it at that location. The motion of both the body and the observer combine into the relative motion of the body with respect to the observer. If one then calculates backward in time to where the body had to be at the time that the observed light left the body, one arrives at the *apparent* position of the body.

We now arrive at the philosophical heart of the matter. If you believe that the astrological influences of a body are

transmitted over vast distances *instantaneously*, then you want to use the true position of that body. But if you believe that the maximum velocity of propagation of influences is the velocity of light (Einstein's theory states that no physical signal or influence can be transmitted at a velocity exceeding that of light), then you want to use the apparent position of that body.

Planetary aberration allows the true position of the planetary body to be converted to the apparent position considering the relative motion of the planet to the observer and the time that it takes light to travel from one to the other. For "smooth" motion of both the planet and the observer the aberration calculation is simply:

apparent position = true position - rv/c

where r is the distance between the bodies in astronomical units (the change in distance during the light travel time can be ignored), v is the instantaneous relative motion of the body per day in the coordinate of interest and the velocity of light is c = 173.142 a.u./day.

The computations will be illustrated using the example problem that was presented in MATRIX FOUR on pages 37 through 44. From pages 42 and 44 we find the following information for Mercury on 1 April 1979 at 0h00m E.T.:

True position	Daily motion
r = 0.608488 a.u.	
λ = 357°.5134	λ' = -0°.5677
β = 1°.5865	β' = -0°.2629
α = 357°.0878	α' = -0°.4162
δ = 0°.4669	δ' = -0°.4669

To compute the apparent positions the light-time term r/c = 0.608488/173.142 = 0.003514 days is the time that it took light to travel from Mercury to Earth. The apparent coordinates of Mercury are thus

λ_A = 357.5134 - 0.003514(-0.5677) = 357°.5154

β_A = 1.5865 - 0.003514(-0.2629) = 1°.5874

α_A = 357.0878 - 0.003514(-0.4162) = 357°.0893

δ_A = 0.4669 - 0.003514(-0.4669) = 0°.4685

In working through these examples and in performing any of the indicated computations, the reader should be aware of the following points: (1) the "true" positions were computed from two-body Kepler theory and so are only approximations to the true positions, (2) the true positions refer to the mean equinox and ecliptic of date, (3) this paper illustrates only the aberration correction; to obtain the apparent positions referred to the true equinox and ecliptic of date the corrections for the nutation in longitude and the nutation in obliquity must also be included, but that is a topic for another miniarticle.

MERCURY HOUR

The Astrologer's Astrological Magazine

3509 WATERLICK ROAD C-7, LYNCHBURG, VA. 24502

WE GUARANTEE THAT YOU HAVE NEVER READ ANOTHER ASTROLOGICAL MAGAZINE LIKE THE MERCURY HOUR. IT IS WRITTEN COMPLETELY BY ASTROLOGERS FOR ASTROLOGERS.

There are no "sun-sign" forecasts, just letters, articles, views, contributed by the more than fifteen hundred astrologers who already subscribe. In each of its four photo-type set editions (55 to 60 8½ by 11 pages) it keeps you up to date on what is happening in our world and shares the viewpoints and feelings of our community world-wide. It is interesting, informative and very often humorous.

Steve Arroyo writes of the MH: "The MH fills a communication need in the Astrological Community that no other publication does, just straight-forward honest, personal expression with no frills. It's really a very Aquarian publication. Bob Pelletier, John McCormick, Robert Jansky, Marc Robertson, all have echoed these sentiments about the MH. With endorsements like that, don't you think you owe it to yourself to see what these people are talking about?

See for yourself what it is really like by sending for some sample pages or better yet, enclose $13.00 (Canadian and Foreign subscriptions - $18.00) and start with the latest edition.

ASTRO-GRAPHICS SERVICES
A New Computer Service

ASTRO-GRAPHICS SERVICES is something of a departure from other computer services in that it is a business enterprise that is intended to support the activities of a group of astrologers doing astrological research. After we handle the problem of getting matters where we can all survive financially, we will put all of our resources into the matter of testing astrological techniques, developing new ones and being among those who are attempting to give astrology a firm empirical base using accepted scientific techniques. Although we hope that A.G.S. will provide decent support for this activity, A.G.S. is not intended primarily as a profit-making operation.

Who We Are

A.G.S. was originally conceived by Rob Hand in 1978. At that point he had discovered that the computing material necessary for decent astrological research was simply too expensive to support unless it made some kind of financial return on its investment and was at least partially self-supporting. He then conceived of the idea of A.G.S. as a working collective of astrologers doing research and supporting themselves through providing a computer service for astrologers. At that time Neil Michelsen's ASTRO-COMPUTING SERVICES had just moved to the West Coast and had left a large gap in the Northeast.

Rob had already developed a strong working relationship with Steve Blake of Dennis Port, Mass. The two of them had found that their ideas were very compatible and that they could do creative work together. Gary Christen of N. Bergen, N.J. also was interested in the idea, so that these three plus Pat White have become the nucleus of A.G.S. As we grow we hope to be able to invite other astrologers to join us.

What are our backgrounds? Rob Hand is the author of three books published by Para Research, Planets in Composite, Planets in Transit and Planets in Youth. He has studied astrology since 1960, published several articles in Astrology Now and other publications, and been working in astrological computing since March of 1977. Steve Blake has been studying astrology since the early 1970's and has also written articles for Astrology Now and Matrix. His background in astrological computing has been the adaptation of Rob Hand's programs to the Radio Shack's TRS-80. He has also developed several innovative programs of his own. Gary Christen is one of the few holders of a degree in Astrology from a major university, having received a Bachelor's Degree in Astrology from the Rutgers University, Livingston branch. While at Rutgers, he also studied computer programming. He is primarily known as a Uranian astrologer, and will be responsible for developing A.G.S.'s Uranian services. Pat White is well known as an editor in the astrological field, having been the editor of both the N.C.G.R. Journal for Geocosmic Research, and the Geocosmic News, that same organization's newsletter. She will be responsible for publications by A.G.S.

The Services of A.G.S.

At this writing the complete line of services that we intend to provide is not available. This is a description of what is to come rather than what already exists.

Because of the increasingly widespread use of home computers by astrologers, we do not feel that the greatest future lies in providing basic natal chart services, although we will provide such a line. What we intend to do is to provide specialized calculation services for projects for which there is either no service at the time, or no programs available for small computers. Among these might be special ephemerides, tables, tables of houses, custom printouts and the like. We have already created an abridged ephemeris for a semi-popular book on astrology shortly to be released by a well-known publisher, and are in the process of creating a very high-precision Heliocentric ephemeris. We also do the calculations for Jim Valliere's Kinetic Mundascope, a tool for determing the strongest planetary influences at any given time. Using our Houston Instruments DP-11 drum plotter, we will also be doing the drawings for these tables a bit later on. We can produce reasonably accurate ephemerides, heliocentric or geocentric for any period from 1468 to 2103 A.D. We will extend that time period backward even further eventually.

As mentioned above, our second area of specialty will be graphics products. This is where we have derived our name. Using the plotter mentioned above we able to create graphs, drawings, and all manner of visual aids for astrologers. At present we are working on 45 and 30 degree graphic ephemerides that will be published in pad form so that astrologers can get an overview of the year in advance for themselves or clients. These are being produced in a style similar to the Ebertin transit graphs which, at present do not extend beyond 1980. Of course the Ebertin graphs were only in the 45 degree format which ignores transits by trine, sextile, quincunx and so forth. We will also be able to create finely drawn originals for custom chart blanks. Given the specifications of the design, we can produce any particular chart form that anyone might desire. The only limitation is that it must be eleven inches or less wide. When we get some of the kinks out of the system we will also be able to provide charts for 90 and 360° degree dial work that are immediately ready for reading without any further drawing, complete with glyphs.

A third area of activity will be as a software house. We will be releasing ready-to-run programs for the TRS-80 primarily for larger systems with disk drives and printers. We are avoiding the cassette program field because of difficulties that cassettes present. Software to be

released very soon will include natal charts with wheel printouts in which all planets are accurate to the nearest minute, except the Sun and Moon which will be accurate to plus or minus one second. These will have a wide range of options such as midpoints and midpoint sorts, parans, local space, and a choice of several house systems. Right Ascension, and Heliocentric options will also be available. In addition to these and other prepared programs for the TRS-80, we will also be available to do custom programming for astrologers in BASIC. The price will vary depending upon how easily the programs in question can be either created from scratch or adapted from existing material.

A fourth area is that of publishing. We are already working on the transit graphs, and the Heliocentric ephemeris (which is actually being published by Malcolm Dean's Phenomena Monographs Series, not A.G.S.). We also plan to publish other special ephemerides and tables that astrologers might find of use. Among these will be a comprehensive work on astrological astronomy, however, no date has been set for this yet.

And last we will provide a complete range of services for those astrologers who do not own their own computer. At first these services will be somewhat limited, but we hope to have a line as complete as anyone else's before too long.

Our Mechanical Resources

For those who might be curious as to what we are using for machinery, we have three computer systems, all three Z-80 based. Our first system is a 64K Xitan Alpha mainframe with a Digital Microsystems 600K disk drive, a Diablo printer and a Lear-Siegler CRT. The second system is a 64K Digital Microsystems Computer and integrated disk drive with a second Diablo printer and a Soroc IQ 120 CRT. The third system is a 32K TRS-80 with two disk drives and the Radio Shack Centronics line printer. In addition to this we have a Houston Instruments DP-11 drum plotter which can be run off of either of the first two computers.

If any of the above interests you, please get in touch with us at ASTRO-GRAPHICS SERVICES c/o Robert Hand 217 Rock Harbor Rd. Orleans, Mass. 02563, tel. 617/ 255-0510.

Our thanks to Michael Erlewine and MATRIX magazine for giving us this chance to introduce ourselves.

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COMPUTER CASSETTES REVIEW
Robert Elliot Purser, PO Box 466,
El Dorado, CA 95623; published
quarterly; sample copy is $4;
North American subscription is
$12 a year.

ERRATA in MATRIX IV. Page 3, lines 26-27, column 2: The underlined verbage was omitted: "...position of 1h 48m 44.68s in RA and 11 deg 08' 27.4" in declination; my calculation yielded 1h 48m 45s and 11 deg 08' 31"!"
Page 4 column 2, 9 lines from bottom. Underlined verbiage was omitted: "...17000 days to carpenter's limiting date of 245000.5 and backward in time by 17000 days to 2418000.5, which..."
Page 4, column 2, 8 lines from bottom. 1980 should be 1890.

LETTERS

"Hi --

I have received your first four issues and read them from cover to cover several times and am very pleased with their contents. Your comments concerning leaving the normal harware reviews to other magazines is super. What I have been searching for is details about theory and microcomputer application not repeats of reviews available elsewhere.

I would like to suggest some "ideas" for published software. Before I list them, I would like to say that I grew up in the micro world. What may be obvious to those who have come from large systems-- may not or even will not be to a person entering from the Radio Shack/Pet arena. I would like to think these are constructively given and taken with that approach.

1) Include an example (both INPUT and OUTPUT)
2) Avoid tricks or shortcuts with your particular software/hardware.
  a) May be obvious only to you and your friends.
  b) If you must use a trick, explain it fully.
3) Number lines by 10's or 5's
  a) Allows AUTOLINE feature to be used.
  b) Easier proofing by the audience you are trying to reach.
4) Avoid double alpha for variables (most micros can not do that)
5) Do use lots of remarks
  a) Explain each variable
  b) Explain purpose of each section.
  c) Explain DATA statements.
    1) What order is the data in?
    2) What is content of each data group?
6) Dont use 0.0666667 when 1/15 is what you meant.
  a) Allow the new user to code it to the best way for his system.
  b) Do not use or least resist older progrmming habits that do not apply to the micro world (FORTRAN) in the same way. way.

Major James Gunkel
2145 Red Rock Drive
Beavercreek, Ohio 45431

[Editor's Note: I agree with Jim's letter with the exception of point #4. In this regard, I invoke point 6a of the above letter. Single letter variables are not part of the current micro world. All of the new machines make use of 2 letter variables and so will the authors of BASIC programs in future issues of MATRIX. PLEASE.]

"MATRIX--
I've just read your fourth issue and find it as usual fascinating. The lead article, by James Neely, which sounded boring from the description turned out to be worthwhile. I should have known. My only complaint is that I wish there were more in the issue.
... I relly appreaciate your hardware reviews. Often they cover information I don't find in the standard publications (BYTE, etc.), or I see it first in MATRIX. In such a fast moving field, equipment reviews, etc. are a real necessity. I'd like to see a little information on the computers available in, say, the $2000 to $4000 range. If youve more money to spend, what will your extra money buy you. Also, it would be useful to tell readers what they can do with a disk drive, why it is so valuable. Imagine keeping all your files on a small diskette..."

Doug Kellogg
Box 963
Ashland, ORE 97520

[Editor's note: MATRIX will play down extensive hardware reviews..but make this information available thru their FULL SOFTWARE CATALOG]

It seems like only yesterday that I was encouraging Noel Tyl to get his first HP-67 programmable calculator. And then there I was showing him the Commodore PET. Each time he needed a little room to think about it before jumping in. He has just turned the tables on me by introducing me to The Source which is a vast telecomuting network. I have written more about this information net elsewhere in this double issue.

Just hearing him rave about the present and future possibilities was enough to un-nerve me. "A major utility within ten years" was one his remarks that got me going. All I needed was a home computer or a terminal and for a one time hook-up fee of $100 I could reach the Source.

My curiosity coupled with my fear of missing out on one of this centuries great ideas got the best of me. I shelled out my $100 and hooked my apple onto the source. As I write this, I have had access to the source for about 24 hours...not enough time to give you an expert opinion. However I was surprised to have the source inform me when I turned it on this morning that there was a letter waiting for me from Noel. The letter was great but much greater was my surprise when in the middle of reading it (for the second time) my screen was interupted with the phrase "want to chat?" Here was Noel, in person, ready to chat with me on a Sunday morning. It was great!

I havn't figured out how to justify or rationalize this extravagance from a financial point of view yet...but I am working on it. I might even be willing to leave it at that... an extravagance. Actually I have at least a half-dozen schemes going on how to use the source for minor profit making.

While I have not gotten around to looking at menus for restaurants in other cities yet, I have dipped in here and there on the Source. I looked at their Bargain department where they will send me a quotation on any major appliance or anything within 24 hours. One of their bargains was a new 19 inch RCA T.V for $300 and something. I have peeked into the bottomless UPI files for simply endless and detailed news stories on all subjects under the sun. The New York Times Data Base allows me to ask for stories on one or more topics and the computer will produce only those stories that combine the topics selected! Think of the research opportunities for astrologers. Here are countless news stories from the present and the past available at once. Event research would have an instant library available.

As mentioned, I have not had time to look into more than a few windows on the Source but so far I agree with Noel that we have here a major utility. It is an eerie feeling that I get of looking into the future when using this information network. It is nice to have my friend Noel in there too to chat with. How about some MATRIX readers joining us?

- Michael Erlewine

MATRIX SOFTWARE AUTHORS

Here is what we are looking for in the way of software:

1) Programs for the Commodore PET, APPLE II and Radio Shack TRS-80 (Level II) computers. Programs can be 8K, 16K or larger in length in either tape or disk format. We are interested in astrological programs of any kind. In particular, we are looking for programs that we do not have or programs with unusual features. Our goal is to have every valid astrological technique available for these home computers.

Please see to it that the program you submit to us is 'menu' driven and includes enough clear documentation for a user to operate it. Do not send us your only copy! MATRIX will pay authors about a 50% of NET royalty. The exact figure will be agreed upon by author and MATRIX staff. If you want a quick response as to whether we are interested in a given program, give us a call at (313) 663-6677.

(2) PROGRAMMABLE CALCULATORS. We are also interested in carefully documented programs for the more popular brands of calculators. Carefully prepare your programs so that they may be photocopied. It is best to send us the original and keep a copy for yourself since we will have to make copies from whatever you send us. We will pay a royalty for each program ordered and paid for by a customer.

(3) DOCUMENTED LISTINGS. Yes we are interested in carefully documented and remarked listings in FORTRAN and other programming languages. Or astrology programs for micro systems other than the PET, TRS and APPLE. If you get one of the MATRIX BASIC programs up and running on one of these machines, send it in and we will make it available to others for a nominal fee.

(4) MATRIX SEMINAR SERIES. We are preparing a series of guidebooks to accompany many of the MATRIX program cassettes. Buz Overbeck is working on the major techniques. IF you have mastered an important astrological technique to the point of wanting to help us write a program for it and also a guidebook for interpretation, give us a call.

The first volume in our MATRIX Seminar Series is ready for press. This is a beginner's guide to computer astrology written by Buz Overbeck. It introduces the entire subject of astrology from the beginning. This book is designed to accompany any of the MATRIX Natal Packages and is available either with a program or by itself. This is the first in what will be a library of guidebooks on major astrological techniques. This series will be written from a modern informed point of view.

ASTROLOGY NOW: Computer Boom Issue

By all means try to pick up the next issue of ASTROLOGY NOW since it is all about computers. You will find several MATRIX contributors as article authors in this issue. James Neely, Robert Hand, Charles Jayne, John McCormick, Steve Blake and your editor -among others.

Remember that the large majority of astrologers have yet to make their peace with the new home computers. This issue should really mark the beginning of real acceptance of the new machines by the average astrologer. Single copies of this issue should be available at your local astrology bookstore or you may write for them to: ASTROLOGY NOW, 213 E. 4th ST., St. Paul, MN 55101. Single issues are $2.00 Our thanks to Noel Tyl for making this computer information available to a greater majority.

AFA to carry MATRIX Software

The American Federation of Astrologers (AFA) will be marketing MATRIX Software on a nationwide basis. The AFA will be selling retail thru their own company as well as distributing programs to their book dealers. We hope that this move will make astrological computer programs available to a much greater number of astrologers. Bob Cooper, president of the AFA, has been very interested in all aspects of MATRIX..the magazine and the computer software and hardware. 1980 should be the year that the home computer makes it's first real entrance into the astrological community at large.

MATRIX

MATRIX MAGAZINE
1041 N. Main St.
Ann Arbor, MI 48104
(313) 663-6677

COMPUTER SYSTEMS FROM MATRIX

You can buy your Commodore or APPLE computer system directly from MATRIX. We are an authorized Commodore dealer and have APPLE equipment as well. Here are a few reasons why you might want to do business with us as opposed to local stores.

(1) You know who we are and what we stand for. John Townley called recently to tell me that when he took his APPLE II computer back to the store where he bought it for some adjustments, they acted like they didn't even know him. The computer business is a fast-moving and competitive market. We will be there when you need us to make those extra calls and see to it that you get the service you need. I have found that I can get my Commodore customers almost instant service from local repair centers by making a call to Commodore if the local repair center seems reluctant to do warranty work. Here at MATRIX, we have learned that you have to go to bat for your customers. We do just that.
(2) FREE SOFTWARE with a hardware purchase. We do not discount prices, but we don offer free astrological software with each purchase. Buy your machine from us and get a Natal Package as a bonus...or any other program of your choice. The larger the system you purchase, the more free programs you get. Simple enough?
(3) GOOD SERVICE. We have a complete service center here in Ann Arbor for PET and APPLE computer components. If you can't get just what you want done locally, you can UPS it here and I will see to it that you get the finest attention. I am glad to be there when you have questions about your new machine too. Just give me a call.
(4) WE HAVE EXPERIENCE. We have been running these home computers since they first appeared in 1977. We have expanded versions of the PET, APPLE II and TRS-80, complete with floppy disks, modems and line printers. Better yet we have written many of the astrological programs now available for these machines.

Last, but not least, we could use your business! We are trying to grow as a company and are sharing many of the benefits of our growth with readers thru MATRIX Magazine, new programs and various research projects. Right now we are working to make the Neely Vol. XII planet positions for ancient dates available to all. We are astrologers and could use your support.

OUR FULL CATALOG

Our FULL CATALOG is growing everyday. Here is the place to read about varius computer systems, check out the specifications and look at illustrations. Our fall catalog has screen or line-printer output samples for most of our programs. Here is a chance to read about each MATRIX program in detail and to look at a picture of what these programs output to the video screen or line printer. We cannot afford to give these catalogs away but you may deduct their $3.00 cost from your next software order. The FULL SOFTWARE CATALOG is $3.00 ($4.00 FIRSTCLASS) and can be ordered now from MATRIX.

We have dozens of programs for the Commodore PET, APPLE II and TRS-80 computer systems written by some of the world's finest astrological programmers. There is not room in this ad to describe them. Send for our free Software Flyer for a list of the most popular programs.

ASTROLOGICAL PROGRAMMING MANUAL
by Michael Erlewine

Our new BASIC programming manual is finished and at the printers. We have been promised copies by early November. The book is 8 1/2 x 11 and is 220 pages long. It is designed for the beginning programmer with no previous programming experience. However, it also contains an extended section of astrological programs and subroutines of value to the advanced student. Worked examples with intermediate variable listings make the book easy to trouble-shoot. The book is available thru MATRIX for $12.50 POSTPAID

1980 CIRCLE ASTROLOGICAL CALENDAR

This is our 12th year! Our 1980 calendar has complete geocentric and heliocentric ephemerides, Michelsen Aspectarian and many other valuable features. This year's cover is a full color photo of the Earth as taken from the moon. The calendar is put together by Michael, Margaret and Stephen Erlewine. 1980 CIRCLE BOOKS CALENDAR is $3.50 POSTPAID



>1980

Issue VII MATRIX MAGAZINE

Front Cover		THE 1980 JOHNDRO AWARD
James Neely	6	ORBITAL ELEMENTS FOR THE TRANSNEPTUNIANS
Michael Erlewine	13	MATRIX HOROSCOPE PROGRAM IN BASIC
Charles Jayne	22	ABOUT PRINTERS
Buz Overbeck	23	CONVERSATIONAL MATH
Michael Erlewine	26	DOT-MATRIX ASTROGLYPHS
Charles P. Jones	28	INTRODUCTION TO MICROGRAPHICS
Mark Pottenger	32	ON ASTRO-GEOGRAPHY
Mark Pottenger	33	FIXED STAR PROGRAM
Fairbairn & Wesenberg	47	ASTEK I: ASTRO-COMPUTER
Dwight W. Johnson	49	PLANETARY HOURS & DAY OF WEEK
Editor	54	THE FIRST A.C.T.
Editor	55	A.C.T. SCHEDULE
	1	NEWS, NEWS, NEWS,
	4	BASIC BITS
	60	ADZ

315 Marion Big Rapids, MI 49307
(616) 796-2483
Note: New Address

THE 1980 JOHNDRO AWARD

TO

NEIL F. MICHELSEN

Commencing in 1978 The Johndro Award for excellence in the technical aspects of Cosmecology is being given to those who have distinguished themselves through some major contribution. Dr. Harlan T. Stetson of M.I.T. coined the term COSMECOLOGY many years ago as the study of the Earth's adaptation to its cosmic environment. While this embraces the ancient science of Astrology, it also includes a number of other sciences. The award is named after the famous American Radio Engineer, Mathematician and Astrologer L. Edward Johndro.

Neil F. Michelsen is, without a doubt one of the real pioneers in the field of computer astrology. In the early 1970s Michelsen's ASTRO-COMPUTING SERVICES provided astrologers with a glimpse of what might be possible through the use of a computer and modern graphic printing techniques. Michelsen achieved printer output including a perfectly round chart wheel and special astrological glyphs at a time when most computer print-out was not acceptable to the average astrologer. Michelsen then produced the first in a series of volumes of the AMERICAN EPHEMERIS which may be the first book ever fully typeset through computer means. This series set a new standard of excellence in astrological ephemerides. Michelsen has continued to benefit astrology by making his computer complex available for astrological research projects. Perhaps the most important computer assisted astrological research in the world today is being performed at his facility.

Michelsen's work and basic generosity has provided modern astrology with direction at a time when it is much appreciated.

- Michael Erlewine

COSMECOLOGY BULLETIN - Charles A. Jayne
JOURNAL OF GEOCOSMIC RESEARCH - Robert Hand
MATRIX MAGAZINE - Michael & Margaret Erlewine

MATRIX MAGAZINE Issue Seven

MATRIX is a periodical with a single copy price (postpaid) of $5 ($6 FIRSTCLASS). Subscribers are notified as each issue is ready. Address all inquiries to: MATRIX, 315 Marion Avenue, Big Rapids MI 49307 (616) 796-2483

MATRIX is produced and edited by
Michael & Margaret Erlewine

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WHAT'S NEW?

For one, we've moved from Ann Arbor to Big Rapids. To the reader, a move of some 200 miles to the north may seem trivial, but for your editor (Sun Sign= Cancer) this counts as a major event. We moved ourselves at the Full Moon Eclipse of March 1st despite an admonition from our dear friend Charles Jayne to the effect that such a move would turn out other than we might expect. My response to Charles is that most events in my life tend to turn out otherwise than I have expected and often that has been a good thing too.

At any rate, three trucks FULL headed north on the day of the Lunar Eclipse filled with computers, belongings and what seems (on arrival) to be lots of junk. Big Rapids is a small town in the middle of the state. We have a lot more room and, better yet, a real yard and neighborhood for our kids. It is beautiful here with a Big Sky and the stars are crystal clear. We even have a room that guests can stay in (no more sleeping in our office!). Altho we are off the beaten track, perhaps some of you will brave it here for a visit.

The first two months were confused and filled with leaky roofs and other traditional house hunters watch-out-fors. Things have calmed down a bit by now (June) and MATRIX Magazine and Software are as back-to-normal as they will get. We have a lot of news items concerning what we have been doing since our last issue- aside from fixing leaky roofs and the like.

MATRIX Programming Manual

Our programming book is, at last, available! A word of explanation about the delay in publishing the MANUAL OF COMPUTER PROGRAMMING FOR ASTROLOGERS. The book was delivered in manuscript form to Llewelyn Publications in time for a scheduled release in Novemeber of 1979. We waited. Nothing happened. Llewelyn was having cash flow problems and scratched some of its publications including ASTROLOGY NOW and (after a long time) our book. We were able to buy back our own manuscript and the AFA offered to go ahead with publication. This was in February of 1980. The book arrived in April and back orders were shipped directly from AFA headquarters in Tempe Arizona. We now have it in stock here at MATRIX. Sorry for the inconvenience and delay. We hope this book will prove useful to those of you who are trying to learn BASIC on the small home computers.

A.C.T. (Astrological Conference on Techniques)

The ACT conference is a 'go' and in the final stages of preparation. The conference is to be a meeting place and get-together that includes over thirty of the world's finest technical and research astrologers. We hope it is the first in a series of future conferences of similar nature. The idea for the ACT conference came in 1976 when Charles Jayne and your editor first met and spent some time together. Robert Hand soon joined in and we have been working towards a major conference of this kind ever since. There had been several failed attempts to have the conference until we approached Bob Cooper of the AFA about holding the conference jointly with the bi-annual AFA convention. The AFA offered to provide ACT with two convention rooms (free of charge) and to include our mini-conference as an integral part of their larger convention. ACT was finally happening.

Charles Jayne flew out to Big Rapids for two hardworking days in April and the final schedule was completed. We hope that some MATRIX readers will be able to attend. If you will take a look at the program for ACT in this issue, you will agree that we have pulled together some top people. It is hoped that the lectures, panel discussions plus the behind the scene chance for many of us to meet one another will serve to strengthen the bonds of cooperation among technical and research astrologers. Both Margaret and myself will be there for the entire convention, so be sure to look us up at the MATRIX suite.

ASTEK I: New Astrological Computer

The article in this issue on the new ASTEK I should interest many of you. We have just completed the software for this machine and are looking forward to delivery of the final product in the fall. The idea of a small hard-wired computer dedicated to astrological work that retails for under $400 should appeal to a great many astrologers. The ASTEK I provides a portable machine designed for the student of astrology who cannot afford or is not ready to commit themselves to a small microcomputer system. MATRIX has provided the software for the ASTEK I in consultation with Charles Jayne and James Neely. This new machine will provide an introduction to computer astrology for a great many who otherwise might have ignored the home computer revolution. Congratulations to Euro-Am on their new product.

A NEW PORTABLE SYSTEM FROM HEWLETT-PACKARD

One of the more noteworthy events in computer hardware since our last issue has been the advent of the HP-85 portable computer system from Hewlett-Packard. The HP-85 weighs only 20 pounds and fits into a small carrying case about the size of a portable typewriter. This small machine contains some very BIG features that include: a CRT (T.V. screen) with high resolution graphics (like the APPLE II), On-Screen editing, Built-in hi-speed tape transport with up to 217K of storage per cartridge. An interactive graphics system that allows graphs, chart wheels and astrological characters. A built in printer that gives instant hard-copy of the hi-res screen and a full 32K of user RAM.

The engineering of the HP-85 is, as those of you who have used HP machines might know, incredibly fine. There is no question that Hewlett-Packard is tops when it come to the engineering department. The BASIC is more refined than that available on any of the other small micro systems and contains many advanced features. The HP-85 allows sharing of variables between a series of programs that can be chain loaded one after another to obtain the effect of almost unlimited memory. File handling is a built in feature.

That is the good news. The bad news is that the HP-85 costs about $3200 in its 16K version. MATRIX has purchased the HP-85 and will support the machine with a full line of astrological software. This new machine will appeal to the same group of astrologers who might purchase Digicomp's DR-70. They are about the same price. The HP-85 offers a flexible and very attractive yet portable machine capable of doing many other tasks aside from astrological computations. The HP-85 supports a wide variety of peripheral devices including large disks, line printers and plotters.

NEW SOFTWARE ADVANCES

The world of astrological software is marching right along. There are so many interesting and noteworthy additions to the general library of astrological software, that we have but space enough here to mention a few. Those of you who are interested in reading in detail about this subject are encouraged to invest in the new 1980 MATRIX Full Catalog just published. This new catalog is a total re-write and contains in-depth information and sample output of a wide variety of astrological software from many sources. The catalog is about the size of an issue of MATRIX and therefore we cannot afford to send out free copies. The price of the catalog is $4 and that price is refundable against any software order. Here then are some of the more striking additions to modern astrological software:

Programs from David B. Black

David B. Black, a professional programmer at the expert level, has written a powerful SORT routine in 6502 machine language code. This sort program, which is being marketed to several large companies aside from MATRIX, includes a number of remarkable features other than the fact that it can sort 1000 items in less than three seconds. The SORT can sort items on matches found up to 20 levels deep! To give you an idea of what this means in practical terms, we might ask the sort to find all individuals in a group with Sun in Aries AND Moon in Taurus AND Mercury in Pisces and so on up to twenty items. Or we can sort on aspects or what-have-you. Needless to say, the SORT allows for instant sorting of midpoints and any other large groups of items. The sort is now available on the Commodore PET and soon on the APPLE II.

David Black is also working on a planetary routine in machine language that will given 'instant' planets. He has completed two other major programs of interest to readers. A program called WHERE-WHEN offers powerful transit analysis of a radix chart. The user may select which planets to consider by transit...the time inteval to be used and even which aspects to consider. The resulting aspects are displayed in chronological order. Black's program includes some 'fancy' programming with quadri-interpolation of planet positions to conserve time. The program is now available on the Commodore PET. A second version being developed will include mundane aspects. For example, when does Mars oppose Jupiter this century? or when does a given planet conjunct a given ascendant? and so on.

A second program developed by David Black, COMPLETE DIRECTIONS PROGRAM was written in consultation with Charles A. Jayne and made available on the Commodore PET. This program, which includes input of optional planets or points, is capable of providing direct and converse Solar Arcs, Solar Declination arcs, Ascendant arcs and Vertical arcs. Included are both ecliptic and declination parallels and contraparallels.

NEW PROGRAMS FROM JAMES NEELY

Neely has developed the new Trans-Neptune elements presented in the article in this issue. In addition, he has made available planetary position programs of high accuracy and increased time span. MATRIX is now able to provide planetary accuracy of about one minute of arc for the time range of 1700 thru 2300 AD. Also accuracy of 1 second of arc is available for the time span from 1800 thru 2000. This is not to mention the Neely development of a mini-graphic ephemeris routine and special astrological glyphs on the Commodore PET printer.

NEW from BUZ OVERBECK

Buz Overbeck has provided some powerful new software for the Commodore PET. A complete Hindu Astrology package provides instant access to this fascinating yet little known area of astrology. Overbeck has also provided a Pythagorean Numerology program, a Sunrise/Moonrise program and a powerful Speculum program that includes the SORTing algorithm developed by David Black. More important, Overbeck has developed the driver routine and the file-handling routines for the new MATRIX turnkey disk system.

MATRIX SEMINAR SERIES

Overbeck has also produced the first volume in the new MATRIX seminar series to be published by the AFA. This new series of books is designed to help astrologers learn about major astrological techniques with the aid of a computer. Overbeck has written the introductory volume to the series entitled AN INTRODUCTION TO THE NEW ASTROLOGY. This volume introduces the beginner to important concepts of modern astrology. The orientation of this book ignores a considerable amount of 'heresay' astrology and concentrates on the major astrological techniques that can be put to use and tested. The book allows the student to learn to use and interpret with the techniques while leaving the calculations to the computer. Other volumes in preparation include Harmonics, Uranian, Heliocentric and Hindu astrology.

TURNKEY DISK PROGRAMS

The home chart service is now a reality. MATRIX software is offering several fully automated disk-based astrological programs. 'Turnkey' means that all you do is turn on the machine, and the rest is handled by the computer system. No loading tapes or even programs from disk.

A disk-based complete astrological system on the TRS-80 has been developed by programmer-astrologer David Cochrane of Florida. The Cochrane system, which requires both disk and line printer, includes a wide variety of options. These include natal charts, transits, harmonic analysis, etc. One of the features of the Cochrane system is a complete traditional synastry package.

Robert Hand and his associates at ASTROGRAPHICS have developed a disk-based system for the TRS-80 and the APPLE II computer. The system can output hardcopy for natal charts and includes a variety of add-on program modules that may be purchased to enlarge the system. The ASTROGRAPHICS as well as the COCHRANE system require 48K and dual disks and are available thru MATRIX Software.

MATRIX has developed its own disk based system for the Commodore PET, APPLE II and TRS-80. The components of the system were designed by the editor and Buz Overbeck on the Commodore system. The system was implemented on the Apple by Barry Karr and on the TRS-80 by Stephen Erlewine. The MATRIX system is available in two styles: Research and Business.

The RESEARCH system is all 'menu' driven and includes client data and chart files. Charts can be 'batch' processed and stored in disk files. Client information, background, etc. is stored too. Charts can be cast and stored in one of several degrees of planet accuracy. The package supports the Uranians (Trans-Neptunians) too. The user may order the disk package with any number of program modules: Solunars, Transits, Progressions, etc. More programs may be added to the system at any time. The package includes some fancy printout capabilities too. A round wheel complete with aspect grid and sorted midpoints is available for hard copy at any time.

The BUSINESS system is designed for the small bookstore and home chart service where quantity output is essential. This system is primarily oriented towards batch processing of orders and hard-copy (printout). The system allows input of many chart orders at a time. Each order can be specified in detail. For instance one can indicate that a natal chart, solar return chart for a given year and several lunar return charts plus a progressed chart is desired. Program accepts multiple orders of this kind. When you have entered the various charts needed, the system takes over and generates all of the different charts for each of the several orders. The MATRIX disk systems are now available.

Thus the era of the home chart service is upon us.

ASTROLOGICAL LINE PRINTERS

David Horbovetz of the ASTROLOGER'S MEDIUM in Chicago has developed and is marketing a high-quality dot matrix printer (TAM Line Printer) for use with home computers. The printer includes the planets, signs and aspect glyphs or symbols as a built in feature. The TAM line printer, available for the PET, APPLE and TRS-80 computers, is a full 80-column tractor feed printer with upper-case only. Custom programs written by MATRIX for the TAM format the special astrological characters on special paper that is used by the TAM. This paper makes use of a printed chart wheel. The result, shown below, is really very handsome. The TAM sells for around $1000 without an interface.

Special astrological characters have also been developed for the Commodore PET printer and the PAPER TIGER printer for use with the APPLE II. MATRIX offers special astrological glyphs on the Commodore Printer and ASTROGRAPHICS has developed the same feature for the PAPER TIGER. Included below is a sample of an 8 1/2 x 11 chart format that can be obtained on ANY 80 column printer. This program is available thru MATRIX for the PET, APPLE and TRS-80 machines.

One last note on astrological printing features. MATRIX has developed a machine language screen dump routine that is a built-in part of almost all MATRIX software on the Commodore PET. The routine allows the user to view program results on the CRT (video display) in the normal manner. When hardcopy of any material displayed on the CRT is desired, the user presses a special key. The program automatically 'dumps' or prints the entire screenfull out to the line printer for a permanent record.

INTERPRETATION PACKAGE

Several natal interpretation programs have been announced in recent months. ASTROGRAPHICS has their ASTRO-SCOPE which provides a quick analysis of the radix planets by sign, house and aspect. The text has been assembled by Rob Hand, Steve Blake and Gary Christen. On another level is the SEX-O-SCOPE with text by none other than the author of PLANETS IN LOVE John Townley. Townley, who has recently added another member to his family, analyzes the sexual potentials of the natal horoscope in a language that is blunt, direct and refreshingly honest.

A more comprehensive interpretation package is being designed by Charles and Vivia Jayne who have had many years of experience writing astrological interpretations. The Jayne Package will be a large professional program fit for the small bookstore or home chart service. It will provide a transit analysis to the radix chart of the client. A years analysis will be assembled and printed out in booklet form on the line printer. The bookstore or chart service will market the finished product to local customers. MATRIX will provide the programming and file handling chores for the Jaynes interpretation package. MATRIX is also preparing a dynamic form of chart interpetation called ASTRO-TALK that assembles an interpretataon by creating its gwf grammar and syntax. All of the above interpetations programs are available from MATRIX.

And that is, in brief, a quick look at some of the new developments in astrological software. These and many more new programs are described and illustrated in detail an the new 1980 MATRIX FULL CATALOG which your editor recommends to MATRIX readers as a worthwhile investment in order to gain an appreciation of the great strides forward astrological software has made in quite a short amount of time. Much of this software wall be on display and demonstrated at the AFA convention in Few Orleans in August of 1980.

MATRIX Software Company a Success!

As editor, I have tried to separate MATRIX the magazine from MATRIX Software the company. I am sure readers want to know how we are making out as a dealer in one of the fastest-moving new industries in the world. MATRIX Software and hardware has been a complete success thus far. We are able to provide astrologers not only with the Commodore system but also with the APPLE, ATARI and Hewlett-Packard HP-85 not to mention Centronics and NEC Spinwriter printers- all from stock. We have grown from a tiny dealer of computer hardware to one of the largest dealers in the country. This is due to the fact that our clients are located in almost every state of the union. Now that we are a 'big' dealer, we can provide much better service on machines in any part of the country. We have learned to really support any hardware problems that develop and have the clout to see that local dealers provide full cooperation. Our software catalog continues to grow with new and more powerful programs and packages from many authors. Keep in mind that a few years ago we had almost no accuracy on these small machines. MATRIX can now offer programs with one minute accuracy that include the time span from 1700 to 2300...or one second accuracy from 1800 to 2000! We are receiving more and more help from programmers around the world in the design and testing of our programs. All in all, we feel that these new developements constitute an important new resource for astrologers. Our goal at this point, for MATRIX Software, is to provide astrologers with the machines and software necessary for thier work. The advent, in recent months, of the new disk-based astrological business and research software packages allows us to offer something in the way of computer software for almost everyone. Thanks are in order to many of our MATRIX readers for their assistance and patience while we learned to build our astrological software into what it is today. When I consider the new Commodore disk-based system developed by Overbeck and myself (using the programs of Neely and others), I cant help but reflect on the incredible changes that have taken place. The advent of computer astrology has got to be one of the most important events in the history of modern astrology. I, for one, am glad to be here and to have had the opportunity to witness this transformation.

MORSELS FROM NEELY

Here are a few tidbits we received from James Neely that should interest you micro and BASIC fans. These are super-slick ways to handle some of the inverse trig functions in BASIC. In these formulas, PI=4*ATN(1) and TP=PI+PI.

FULL QUADRANT ARCTANGENT
(Input X & Y; Output AT):

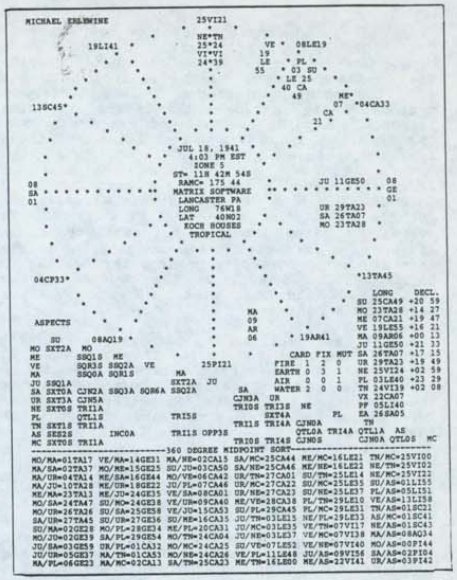
```
AT=ATN(Y/(X-1E-9*(X=0)))-PI*(X<0):
AT=AT-TP*(AT<0)
```

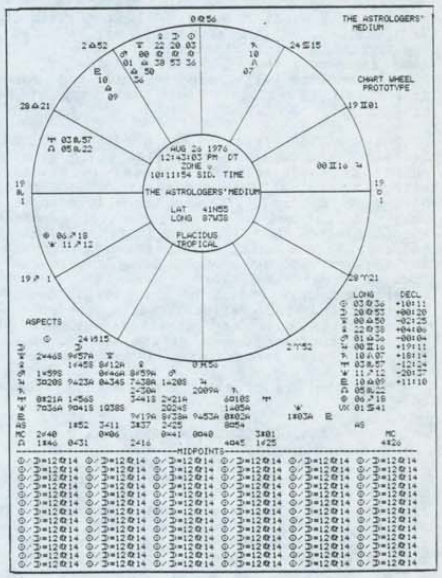
ARCCOSINE (AC=ARCCOS(X)):

```
AC=ATN(SQR(1-X*X)/(X-1E-9*(X=0)))-PI*(X<0)
```

ARCSINE (AS=ARCSIN(X)):

```
Y=SQR(1-X*X):AS=ATN(X/(Y-1E-9*(Y=0))
```



The Above are samples of the new MATRIX 8 1/2x11 chart output. The top example will run on any 80-column printer, the bottom shows the special graphics on the TAM line printer.

STATISTICAL PROGRAMS FROM NEELY & THOMAS

A statistics series, consisting of several modules, is under development by James Neely and William Thomas. Module I gives a tutorial of the foundations of statistical analysis, including elementary probability theory, astrological data presentation and using statistical hypotheses. The written text is designed in an interactive mode; the reader is expected to perform exercises and analyses on an 8K PET as part of the instruction process. Programs for performing chi-square goodness-of-fit tests and contingency table analyses are included.

Module II, currently under development, contains instructions and programs for carrying out several types of statistical analyses, including binomial tests, Kolmogorov-Smirnov tests and Vn tests. Included are data/file management routines, a planetary data generation routine and a decision tree to aid the user in determining the proper analysis to perform with each particular data set. It is anticipated that the programs in this module will require a 16K PET with a disk drive.

A third module is planned which will be devoted to several advanced analysis methods, possibly including cluster analysis, discriminant analysis, principal component analysis and harmonic analysis.

Your editor has seen the first module of the series along with the written text material. It is outstanding, which is what we have grown to expect from Mr. Neely. Astrologers have long awaited a 'painless' way to learn something about statistics and research methods. The goal of this series, is to provide the average astrologer with the know-how needed to make sensible decisions of a research nature in their own particular area of work. The series, which will be made available thru MATRIX Software, is being written on the Commodore PET but will be translated to the APPLE II and the TRS-80.

HARDWARE UPDATE, NEWS , ETC.

The Commodore (PET) system continues to impress the staff here at MATRIX. Let me give some of the news items. Commodore introduced the first intelligent floppy disk some time ago. The Commodore disk differs from that of Radio SHack and APPLE in that it does not require any of the user's RAM memory to operate. It has it's own 6502 microprocessor and is capable of reading and writing to the disk in the background while the PET computer is busy doing something else entirely. We mentioned this disk in a previous MATRIX. Commodore has brought out several other disk related items. First, a new and improved Disk Operating System (DOS) that has some real enhancements. In particular, random-sequential file handling is made so easy that any user can create their own files or data base.

Commodore has released a new one megabyte 5 1/4" dual disk system called the 8050. A 3.2 megabyte 8-inch disk has been announced for the fall of 1980 with a 10 megabyte hard disk early in 1981. Commodore also has released a high quality communications modem for computer to computer talking over the phone lines.

Of greatest interest to astrology, fans is the new PASCAL compiler released in July 1980. This version of PASCAl has a full ten digits precision which makes it the only PASCAl on a micro system with more than six digit precision. What is great about this is that a compiled language is ever so much faster than an interpreted language like most BASICs. Commodore has also announced a 26K BASIC to be released in the fall of 1980. This BASIC will have 18-digit double precision and about every kind of bell and whistle possible. If you consider that the current Commodore BASIC (which is a great BASIC) is an 8K BASIC, this should give you an idea of what a 26K BASIC will be like. And last, but far from least, Commodore is releasing a 64K add-on memory module that will raise the amount of RAM or user memory in a 32K PET to a whopping 96K!

Elsewhere in this issue, I have detailed how the Commodore printer is capable of producing special astro-glyphs. Commodore also has a whole series of really fine word-processing systems- all in machine language. This text is being written using the WORD-PRO III which allows for right-hand justification by spreading spaces between words. The new 12-inch screen 80-column PET is also now available. Commodore has not done much in the waya of a media blitz but they have produced the most complete computer system on the market in the lower price ranges. More detail on these new Commodore products can be found in our new 1980 MATRIX SOFTWARE CATALOG.

APPLE has come across with a really nice small thermal printer that can print anything on the apple screen in a jiffy. In addition, a bit-pad for drawing maps and what not on the high-res screen is available from APPLE. The APPLE III has been announced and we will have more news on that machine in the next issue. A plug-in card for the APPLE has been annonced that contains a Z-80 microprocessor which will allow Z-80 based software to be run on that machine. It will be interesting to see what is done with this.

Radio shack has introduced their large Model II but it is more or less more of the same- not interesting to our staff. Microsoft has produced a BASIC compiler for the TRS-80 that is due for release that should be very interesting. More on that next time.

ATARI has produced a small computer system that very much resembles the APPLE. They have a plug-in ROM game called STAR RAIDERS that is, by far, the best thing I have seen produced on a hi-res system. It employs color, sound and three-dimensional wrap-around techniques to provide you with a real-time STARTREK. Enemy ships swoop at you, over you and come from behind. This program has to be seen and played with to be believed. I am not, in general, prone to games either.

There you have the news highlights for this issue. Give us a call if you have questions of this nature. (616) 796-2483

- Michael Erlewine

ORBITAL ELEMENTS FOR THE TRANSNEPTUNIAN PLANETS

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INTRODUCTION

Do the so-called TransNeptunian Planets (TNP's) behave as true material planets or as some other entity? Some astrologers claim that it is unimportant for the TNP's to act as if they are planets as long as they behave properly on charts. In fact in Germany they are referred to as TransNeptunian Points rather than planets [Ref. 1]. We believe that Witte intended his TNP's to have orbital characteristics of planets for not only does his ephemeris [Ref. 2] include positions of Uranus and Neptune but more importantly he refers to Cupido, Hades, Zeus and Kronos as planets. An analysis of Witte's ephemeris of Uranus enabled the author to confirm [Ref. 3] that the TNP ephemerides of Witte and Sieggruen [Ref. 4] are consistent with Newtonian mechanics.

The purpose of this paper is to present a complete set of orbital elements for the TNP's and a comparision of positions predicted by these elements to those of Witte and Sieggruen. The 'fit' is not exact and so this might be construed as evidence that orbital mechanics cannot be used to predict TNP positions precisely. Such a judgement is certainly the perogative of the reader, however the author feels that most discrepancies can be blamed on imperfections in his analysis rather than upon deviations from orbital theory.

METHOD

The Witte and Sieggruen ephemerides list only the postions of the annual solar conjunctions of the TNP's (to determine TNP positions at other times a "Sonnenlauf" or "Sun Path" correction table must be used). A disk file containing the year and position of each conjunction (at 10 year intervals) was prepared using a Commodore 2001 System. From the position, the time of each conjunction was computed to the nearest 0.001 day using an accurate solar ephemeris program and then the epoch of date position was precessed to epoch 1900.0. The Julian day number and epoch 1900.0 position for each conjunction was added to the disk file. It should be noted that conjunction position ephemerides are simultaneously heliocentric and geocentric; this fact was a considerable aid in the analysis.

Next a difference table was prepared from the disk file by dividing the difference of consecutive positions by the difference of consecutive Julian day numbers. From a difference table it is possible to estimate the perihelion and aphelion positions by noting where the TNP moves most rapidly and most slowly, respectively. From the motion at perihelion and aphelion it is also possible to estimate the eccentricity of the orbit; these estimates were used as preliminary orbital elements. The elements were then improved by a method that can best be described as educated trial and error: a computer program was written that would read the time and position information from the disk file and compute the position from the elements; the elements were then 'tweeked' in an effort to minimize the largest discrepancy between the ephemeris position and the computed position.

After a preliminary best fit had been obtained for all of the TNP's the orbital inclination and ascending node values fiven by Witte for Cupido and Hades were introduced and their eccentricities were again adjusted for a best fit. The inclination of Kronos was taken to be zero since Witte stated that its inclination is "trifling". Witte commented that Zeus was in its nodal position in 1911 but apparently he did not have enough information to decide whether it was the ascending or descending node. Since no value of Zeus' inclination was given it has been set to zero also.

The analysis of the Sieggruen TNP's was exceptionally easy. No inclination information was given and the difference tables of these bodies showed that their motion was uniform (circular). Consequently their inclination and eccentricity could be set equal to zero. In such cases the longitude of the node, the argument and longitude of perihelion and the time of perihelion passage become meaningless. For the sake of defining orbital elements the argument of perihelion was taken to be the position of the body at 0.5 January 1900 at which time T = 0; T is the number of Julian centuries from Julian day 2415020. At T = 0 the mean anomaly M and the node were set equal to zero. The factor of 1.3960 degrees in each node term is the precession per Julian century. The resulting elements are presented in Table I. A comparison of the ephemeris positions and computed positions are presented in Table II.

DISCUSSION

The significance of each column in Table II is: A. Year; B. Ephemeris position, epoch of date; C. Julian day number at conjunction; D. Ephemeris position, epoch of date, in decimal form; E. Ephemeris position of epoch 1900.0; F. Computed position, epoch of date; G. Computed latitude; and H. Position error (column F minus column D). The values in columns D through H are rounded to the nearest 0.01 degree. The value in column H is computed from columns F and D prior to rounding, consequently column H occasionally differs from the difference of the values printed in columns F and D.

An examination of Table II reveals that the largest errors (with the exception of Admetos, which will be discussed later) occur in the Cupido and Hades tables and these are 0.03 degrees; because of rounding this error may be as large as 0.035 degrees, or 2'06". For the Zeus, Kronos and Vulkanus tables the largest error is less than 0.025 degrees or 1'30". For Apollon and Admetos (see below) the error is less than 0.005 degrees or 54" and for Poseidon the error is less than 0.005 degrees or 18".

The 1980 and 1990 figures for Admetos show errors of 0.04 degrees, but the author believes that the source of this error is a miscalculation in the ephemeris itself, and for the following reason. Positions of Admetos are given yearly from 1600 through 1999. By differencing this table it is easily seen that the yearly motion is 35' except that every twelfth year the motion is 36' (1777 and 1778 have identical entries but that occurs because of the "Jahreswende" or "year-end" effect discussed in Ref. 3). This periodic reoccurrence of 36' every twelfth year is natural because the actual yearly motion of Admetos is 35'05" so that every 12 years and additional 1' of motion accrues. This pattern is broken once and only once in the entire table and that is between the years 1974 and 1975 where the motion given is 33' instead of 36' as it should be for this twelfth year; it is this entry which is in error and has been perpetrated throughout the remainder of the table. Since this table was printed prior to 1974 it is inconceivable that Sieggruen predicted on theoretical or astrological grounds that the motion of Admetos should be retarded by 3' between 1974 and 1975.

The determination of a TNP position at a time other than a solar conjunction is similiar to determining a planet's position by interpolation of the 'prior' and 'next' positions in a standard ephemeris. A linear interpolation is peformed using the TNP's motion between the 'prior' conjunction and the 'next' conjunction positions to obtain the TNP's heliocentric longitude. To determine the geocentric longitude this heliocentric position must be corrected for the Sun's apparent motion from the time of the 'prior' conjunction. The correction factor to be added or subtracted is obtained from the "Sun Path" table for the body.

Table III contains a Sun Path correction for each of the TNP's; it has been computer generated using the mean distances of the TNP's contained in Table I. These tables can be compared to those of Witte and Sieggruen (not reproduced here). The largest discrepancy between the original tables and Table III is 2' for Cupido, Apollon and Poseidon; the largest discrepancy for the remaining tables is 1'. Michelsen has observed [Ref. 5] that these tables are based upon the assumption of circular (uniform) motion of the Earth and the TNP's and hence represent average sun path corrections. For a body with a large eccentricity the sun path correction becomes more complicated. For example, Witte includes six correction tables to be used with Uranus.

The computed latitude of Cupido and Hades, displayed in Column G of Table III cannot be directly compared to the latitude tables given by Witte since the Column G figures include precession whereas Witte's tables do not. Wite does not list the epoch for which his Cupido and Hades latitude tables were generated although he does explicitly state that his latitude table for Uranus and Neptune are for epoch 1880, January 1.0. If we assume that the TNP latitudes are also for epoch 1880, January 1.0, then an approximate comparision can be made as illustrated in the following way: Subtract the year FROM 1880, multiiply the result by 0.014 (or, more precisely, by 0.01396), algebraically add the result to the longitude of the TNP and then enter Witte's table with this unprecessed longitude to determine the epoch 1880 latitude and hence the equivalent latitude of date. For example, Table II list the latitude of Cupido for the 1350 conjunction to be -0.92 degrees (or -55'). Subtract 1350 from 1880 to obtain +530 years of motion thaat must be precessed. Multiply 530 by 0.014 to obtain 7.40 degrees, or 7 deg 24' precession correction. At the 1350 conjunction Cupido was in 4GE04. Algebraically add 7 deg 24' to this figure to obtain the epoch 1880 position of 11GE28. Witte lists the 10GE00 latitude as -56' and the 15GE00 latitude as -53'. Interpolating to 11GE28 we find Cupido's latitude to be -55', which is in agreement with Table II.

CONCLUSIONS

It is evident that Witte treated his TNP's as actual planets. Not only does he call them planets but he also has developed ephemerides which are consistent with orbital mechanics. That the work presented here does not agree exactly with Witte's ephemerides can be attributed for the most part with the nature of the analysis and perhaps in a minor part to possible rounding inconsistencies in the ephemerides themselves even though the ephemerides must be treated as if they are exact.

Siegrruens's TNP's also behave in a manner consistent with orbital mechanics even though it is highly unlikely that all four should have perfectly uniform motion. This unlikely behavior can possibly be attributed to the fact that even the fastest moving of these bodies would have moved only about 15 degres in 25 years and this may not have been enough time for Sieggruen to have detected any small deviation from uniform motion. Certainly enough time has elapsed for his students to have detected deviations of positions in their charts.

ACKOWLEDGEMENTS

The author wishes to thank Buz Overbeck for his valuable comments, criticisms, witticisms and especialy for his encouragement to do this work over the past four years and Michael Erlewine for his insistent prodding to get it written for MATRIX and for delaying publication until it was ready.

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TABLE I

CUPIDO

A = 40.99837, E = 0.00460, I = 1.0833, ARG. PERIHELION = 171.4333
M = 163.7409 + 137.13640T NODE = 129.8325 + 1.3960T

HADES

A = 50.66744, E = 0.00245, I = 1.0500, ARG. PERIHELION = 148.1796
M = 27.6496 + 99.81803T NODE = 161.3339 + 1.3960T

ZEUS

A = 59.21436, E = 0.00120, I = 0, ARG. PERIHELION = 299.0440
M = 165.1232 + 79.00633T NODE = 0 + 1.3960T

KRONOS

A = 64.81690, E = 0.00305, I = 0, ARG. PERIHELION = 208.8801
M = 169.0193 + 68.98746T NODE = 0 + 1.3960T

APOLLON

A = 70.29949, E = 0, I = 0, ARG. PERIHELION = 138.0533
M = 0 + 61.0765T NODE = 0 + 1.3960T

ADMETOS

A = 73.62765, E = 0, I = 0, ARG. PERIHELION = 351.3350
M = 0 + 56.98245T NODE = 0 + 1.3960T

VULKANUS

A = 77.25568, E = 0, I = 0, ARG. PERIHELION = 55.8983
M = 0 + 53.015987T NODE = 0 + 1.3960T

POSEIDON

A = 83.66907, E = 0, I = 0, ARG. PERIHELION = 165.5163
M = 0 + 47.03868T NODE = 0 + 1.3960T

TABLE II: CUPIDO

A	B	C	D	E	F	G	H
1350	04GE04	2214282.34	64.07	71.73	64.06	-0.92	+0.00
1360	17GE53	2217949.22	77.88	85.41	77.88	-0.76	+0.00
1370	01CN42	2221616.13	91.70	99.08	91.68	-0.55	-0.02
1380	15CN28	2225282.99	105.47	112.71	105.46	-0.32	-0.01
1390	29CN14	2228949.82	119.23	126.34	119.24	-0.07	+0.01
1400	13LE00	2232616.60	133.00	139.96	133.02	+0.19	+0.02
1410	26LE48	2236283.34	146.80	153.62	146.81	+0.44	+0.01
1420	10VI37	2239950.00	160.62	167.30	160.62	+0.66	+0.01
1430	24VI28	2243616.60	174.47	181.01	174.45	+0.84	-0.01
1440	08LI19	2247283.08	188.32	194.72	188.31	+0.98	-0.01
1450	22LI12	2250949.49	202.20	208.46	202.20	+1.06	+0.00
1460	06SC07	2254615.82	216.12	222.24	216.12	+1.08	+0.00
1470	20SC04	2258282.09	230.07	236.05	230.06	+1.04	+0.00
1480	04SA02	2261948.31	244.03	249.88	244.04	+0.94	+0.00
1490	18SA00	2265614.47	258.00	263.71	258.03	+0.78	+0.03
1500	02CP01	2269280.66	272.02	277.58	272.05	+0.58	+0.03
1510	14CP38	2272580.21	284.63	290.07	284.67	+0.37	+0.03
1520	28CP41	2276246.44	298.68	303.98	298.70	+0.11	+0.01
1530	12AQ43	2279912.70	312.72	317.88	312.73	-0.15	+0.01
1540	26AQ44	2283579.01	326.73	331.75	326.75	-0.40	+0.01
1550	10PI44	2287245.38	340.73	345.61	340.75	-0.63	+0.02
1560	24PI43	2290911.84	354.72	359.46	354.74	-0.83	+0.02
1570	08AR41	2294578.39	8.68	13.28	8.70	-0.97	+0.01
1580	22AR37	2298245.03	22.62	27.08	22.63	-1.06	+0.01
1590	06TA31	2301911.74	36.52	40.84	36.53	-1.08	+0.02
1600	20TA24	2305578.54	50.40	54.58	50.41	-1.05	+0.01
1610	04GE15	2309245.37	64.25	68.29	64.25	-0.95	+0.00
1620	18GE05	2312912.25	78.08	81.98	78.08	-0.80	-0.01
1630	01CN54	2316579.16	91.90	95.66	91.88	-0.61	-0.02
1640	15CN41	2320246.03	105.68	109.30	105.66	-0.38	-0.02
1650	29CN26	2323912.86	119.43	122.91	119.44	-0.13	+0.01
1660	13LE13	2327579.67	133.22	136.56	133.23	+0.13	+0.01
1670	27LE01	2331246.43	147.02	150.22	147.01	+0.38	+0.00
1680	10VI49	2334913.11	160.82	163.88	160.82	+0.61	+0.00
1690	24VI40	2338579.74	174.67	177.59	174.64	+0.80	-0.02
1700	08LI31	2342246.26	188.52	191.30	188.49	+0.95	-0.02
1710	22LI24	2345912.69	202.40	205.04	202.37	+1.05	-0.03
1720	06SC18	2349579.04	216.30	218.80	216.28	+1.08	-0.02
1730	20SC14	2353245.33	230.23	232.59	230.22	+1.06	-0.01
1740	04SA12	2356911.57	244.20	246.42	244.19	+0.97	-0.01
1750	18SA10	2360577.74	258.17	260.25	258.18	+0.82	+0.01
1760	02CP11	2364243.94	272.18	274.12	272.19	+0.63	+0.01
1770	14CP48	2367543.49	284.80	286.61	284.81	+0.43	+0.01
1780	28CP50	2371209.70	298.83	300.51	298.84	+0.18	+0.01
1790	12AQ53	2374875.96	312.88	314.42	312.87	-0.09	-0.01
1800	26AQ54	2378542.25	326.90	328.29	326.89	-0.34	-0.01
1810	10PI54	2382208.60	340.90	342.15	340.90	-0.58	+0.00
1820	24PI53	2385875.03	354.88	356.00	354.89	-0.78	+0.01
1830	08AR51	2389541.55	8.85	9.82	8.86	-0.94	+0.01
1840	22AR48	2393208.16	22.80	23.63	22.80	-1.04	+0.00
1850	06TA42	2396874.84	36.70	37.39	36.71	-1.08	+0.01
1860	20TA36	2400541.62	50.60	51.15	50.59	-1.06	-0.01
1870	04GE27	2404208.44	64.45	64.86	64.44	-0.98	-0.01
1880	18GE18	2407875.31	78.30	78.57	78.27	-0.85	-0.03
1890	02CN06	2411542.19	92.10	92.23	92.08	-0.66	-0.02
1900	15CN54	2415209.08	105.90	105.89	105.87	-0.44	-0.03
1910	29CN40	2418875.92	119.67	119.52	119.65	-0.19	-0.02
1920	13LE26	2422542.74	133.43	133.15	133.43	+0.06	+0.00
1930	27LE13	2426209.50	147.22	146.79	147.22	+0.32	+0.00
1940	11VI01	2429876.20	161.02	160.45	161.01	+0.55	+0.00

TABLE II: HADES

A	B	C	D	E	F	G	H
1350	21LE01	2214362.84	141.02	148.68	141.03	-0.23	+0.02
1360	01VI07	2218025.71	151.12	158.64	151.14	-0.05	+0.02
1370	11VI15	2221688.56	161.25	168.63	161.25	+0.13	+0.00
1380	21VI22	2225351.33	171.37	178.61	171.36	+0.31	-0.01
1390	01LI30	2229014.07	181.50	188.60	181.48	+0.48	-0.02
1400	11LI38	2232676.74	191.63	198.59	191.61	+0.64	-0.03
1410	21LI46	2236339.36	201.77	208.59	201.74	+0.77	-0.02
1420	01SC54	2240001.92	211.90	218.58	211.89	+0.88	-0.01
1430	12SC03	2243664.44	222.05	228.59	222.04	+0.97	-0.01
1440	22SC13	2247326.94	232.22	238.62	232.20	+1.02	-0.01
1450	02SA23	2250989.40	242.38	248.65	242.37	+1.05	-0.01
1460	12SA33	2254651.83	252.55	258.67	252.55	+1.04	+0.00
1470	22SA44	2258314.26	262.73	268.72	262.74	+1.00	+0.00
1480	02CP55	2261976.68	272.92	278.76	272.93	+0.93	+0.01
1490	12CP05	2265272.86	282.08	287.80	282.10	+0.84	+0.02
1500	22CP17	2268935.29	292.28	297.86	292.30	+0.72	+0.01
1510	02AQ29	2272597.75	302.48	307.92	302.50	+0.58	+0.01
1520	12AQ41	2276260.23	312.68	317.98	312.69	+0.42	+0.01
1530	22AQ53	2279922.75	322.88	328.04	322.89	+0.24	+0.00
1540	03PI04	2283585.30	333.07	338.09	333.08	+0.06	+0.01
1550	13PI16	2287247.92	343.27	348.15	343.27	-0.12	+0.00
1560	23PI27	2290910.57	353.45	358.19	353.45	-0.30	+0.00
1570	03AR38	2294573.27	3.63	8.23	3.63	-0.48	+0.00
1580	13AR48	2298236.02	13.80	18.26	13.80	-0.63	+0.00
1590	23AR58	2301898.83	23.97	28.29	23.96	-0.77	+0.00
1600	04TA07	2305561.69	34.12	38.30	34.12	-0.88	+0.00
1610	14TA16	2309224.59	44.27	48.31	44.27	-0.97	+0.00
1620	24TA25	2312887.54	54.42	58.32	54.41	-1.02	-0.01
1630	04GE33	2316550.52	64.55	68.31	64.54	-1.05	-0.01
1640	14GE40	2320213.51	74.67	78.29	74.67	-1.04	+0.00
1650	24GE47	2323876.53	84.78	88.26	84.78	-1.00	+0.00
1660	04CN54	2327539.56	94.90	98.24	94.90	-0.94	+0.00
1670	15CN01	2331202.59	105.02	108.22	105.00	-0.84	-0.01
1680	25CN07	2334865.58	115.12	118.18	115.11	-0.72	-0.01
1690	05LE13	2338528.57	125.22	128.14	125.21	-0.57	-0.01
1700	15LE19	2342191.53	135.32	138.10	135.31	-0.41	-0.01
1710	25LE24	2345854.43	145.40	148.04	145.41	-0.24	+0.01
1720	05VI30	2349517.30	155.50	158.00	155.52	-0.06	+0.02
1730	15VI38	2353180.16	165.63	168.00	165.62	+0.12	-0.01
1740	25VI45	2356842.95	175.75	177.97	175.74	+0.30	-0.01
1750	05LI53	2360505.69	185.88	187.97	185.86	+0.47	-0.03
1760	16LI01	2364168.38	196.02	197.96	195.98	+0.63	-0.03
1770	26LI09	2367831.00	206.15	207.95	206.12	+0.76	-0.03
1780	06SC17	2371493.57	216.28	217.95	216.26	+0.88	-0.02
1790	16SC26	2375156.10	226.43	227.96	226.42	+0.96	-0.02
1800	26SC36	2378818.62	236.60	237.98	236.58	+1.02	-0.02
1810	06SA46	2382481.09	246.77	248.01	246.75	+1.05	-0.02
1820	16SA56	2386143.52	256.93	258.04	256.93	+1.04	-0.01
1830	27SA07	2389805.96	267.12	268.08	267.11	+1.01	-0.01
1840	07CP18	2393468.38	277.30	278.12	277.30	+0.94	+0.00
1850	16CP28	2396764.55	286.47	287.16	286.47	+0.85	+0.01
1860	26CP40	2400427.00	296.67	297.22	296.67	+0.73	+0.00
1870	06AQ52	2404089.46	306.87	307.28	306.87	+0.59	+0.00
1880	17AQ04	2407751.94	317.07	317.34	317.06	+0.43	+0.00
1890	27AQ15	2411414.43	327.25	327.39	327.26	+0.25	+0.01
1900	07PI27	2415076.99	337.45	337.45	337.45	+0.07	+0.00
1910	17PI39	2418739.59	347.65	347.51	347.64	-0.11	-0.01
1920	27PI50	2422402.23	357.83	357.55	357.83	-0.29	-0.01
1930	08AR01	2426064.94	8.02	7.59	8.00	-0.46	-0.01
1940	18AR11	2429727.67	18.18	17.62	18.18	-0.62	-0.01
1950	28AR21	2433390.47	28.35	27.65	28.34	-0.76	-0.01
1952	00TA23	2434123.04	30.38	29.65	30.37	-0.78	-0.01
1954	02TA25	2434855.62	32.42	31.66	32.40	-0.81	-0.01
1956	04TA27	2435588.18	34.45	33.66	34.43	-0.83	-0.02

TABLE II: ZEUS

A	B	C	D	E	F	G	H
1360	00TA23	2217899.77	30.38	37.91	30.38	+0.00	+0.00
1370	08TA26	2221560.50	38.43	45.82	38.44	+0.00	+0.00
1380	16TA29	2225221.27	46.48	53.73	46.49	+0.00	+0.01
1390	24TA32	2228882.06	54.53	61.64	54.54	+0.00	+0.01
1400	02GE35	2232542.88	62.58	69.55	62.59	+0.00	+0.00
1410	10GE37	2236203.69	70.62	77.44	70.63	+0.00	+0.01
1420	18GE40	2239864.54	78.67	85.35	78.67	+0.00	+0.01
1430	26GE42	2243525.38	86.70	93.25	86.72	+0.00	+0.02
1440	04CN45	2247186.24	94.75	101.16	94.76	+0.00	+0.01
1450	12CN47	2250847.09	102.78	109.05	102.80	+0.00	+0.01
1460	20CN50	2254507.94	110.83	116.96	110.84	+0.00	+0.00
1470	28CN52	2258168.77	118.87	124.86	118.88	+0.00	+0.01
1480	06LE54	2261829.58	126.90	132.75	126.92	+0.00	+0.02
1490	14LE57	2265490.39	134.95	140.66	134.96	+0.00	+0.01
1500	22LE59	2269151.15	142.98	148.55	143.00	+0.00	+0.02
1510	01VI02	2272811.90	151.03	156.46	151.04	+0.00	+0.01
1520	09VI04	2276472.60	159.07	164.36	159.09	+0.00	+0.02
1530	17VI07	2280133.29	167.12	172.27	167.13	+0.00	+0.01
1540	25VI10	2283793.94	175.17	180.18	175.18	+0.00	+0.01
1550	03LI13	2287454.55	183.22	188.09	183.23	+0.00	+0.01
1560	11LI16	2291115.13	191.27	196.00	191.28	+0.00	+0.02
1570	19LI20	2294775.69	199.33	203.93	199.34	+0.00	+0.00
1580	27LI23	2298436.19	207.38	211.84	207.39	+0.00	+0.01
1590	05SC27	2302096.67	215.45	219.76	215.45	+0.00	+0.00
1600	13SC31	2305757.13	223.52	227.69	223.52	+0.00	+0.00
1610	21SC35	2309417.56	231.58	235.62	231.58	+0.00	+0.00
1620	29SC39	2313077.96	239.65	243.54	239.65	+0.00	+0.00
1630	07SA43	2316738.34	247.72	251.47	247.72	+0.00	+0.00
1640	15SA47	2320398.71	255.78	259.40	255.79	+0.00	+0.01
1650	23SA52	2324059.07	263.87	267.34	263.86	+0.00	+0.00
1660	01CP57	2327719.43	271.95	275.28	271.94	+0.00	-0.01
1669	09CP13	2331013.74	279.22	282.43	279.21	+0.00	-0.01
1680	17CP17	2334674.09	287.28	290.35	287.28	+0.00	+0.00
1690	25CP22	2338334.45	295.37	298.30	295.36	+0.00	-0.01
1700	03AQ26	2341994.81	303.43	306.22	303.43	+0.00	+0.00
1710	11AQ31	2345655.19	311.52	314.17	311.51	+0.00	-0.01
1720	19AQ35	2349315.59	319.58	322.09	319.59	+0.00	+0.00
1730	27AQ40	2352976.02	327.67	330.04	327.66	+0.00	-0.01
1740	05PI44	2356636.48	335.73	337.96	335.73	+0.00	+0.00
1750	13PI49	2360296.96	343.82	345.91	343.81	+0.00	-0.01
1760	21PI53	2363957.47	351.88	353.83	351.88	+0.00	-0.01
1770	29PI57	2367618.01	359.95	1.76	359.94	+0.00	-0.01
1780	08AR01	2371278.59	8.02	9.69	8.01	+0.00	-0.01
1790	16AR04	2374939.20	16.07	17.60	16.07	+0.00	+0.01
1800	24AR08	2378599.85	24.13	25.53	24.13	+0.00	+0.00
1810	02TA12	2382260.54	32.20	33.45	32.19	+0.00	-0.01
1820	10TA15	2385921.24	40.25	41.36	40.25	+0.00	+0.00
1830	18TA18	2389581.98	48.30	49.27	48.30	+0.00	+0.00
1840	26TA22	2393242.76	56.37	57.20	56.35	+0.00	-0.02
1850	04GE24	2396903.55	64.40	65.09	64.40	+0.00	+0.00
1860	12GE27	2400564.37	72.45	73.00	72.45	+0.00	+0.00
1870	20GE29	2404225.18	80.48	80.90	80.49	+0.00	+0.01
1880	28GE32	2407886.03	88.53	88.81	88.53	+0.00	+0.00
1890	06CN34	2411546.87	96.57	96.70	96.57	+0.00	+0.01
1900	14CN37	2415207.73	104.62	104.61	104.61	+0.00	+0.00
1910	22CN39	2418868.57	112.65	112.50	112.65	+0.00	+0.00
1920	00LE41	2422529.40	120.68	120.40	120.69	+0.00	+0.01
1930	08LE44	2426190.24	128.73	128.31	128.73	+0.00	+0.00
1940	16LE46	2429851.04	136.77	136.20	136.77	+0.00	+0.01
1950	24LE49	2433511.84	144.82	144.11	144.81	+0.00	+0.00

TABLE II: KRONOS'

A	B	C	D	E	F	G	H
1360	28PI08	2217866.83	358.13	5.66	358.12	+0.00	-0.01
1370	05AR09	2221526.36	5.15	12.54	5.14	+0.00	-0.01
1380	12AR09	2225185.91	12.15	19.40	12.15	+0.00	+0.00
1390	19AR10	2228845.50	19.17	26.27	19.16	+0.00	-0.01
1400	26AR10	2232505.11	26.17	33.13	26.17	+0.00	+0.00
1410	03TA10	2236164.73	33.17	40.00	33.18	+0.00	+0.01
1420	10TA11	2239824.41	40.18	46.87	40.19	+0.00	+0.01
1430	17TA12	2243484.10	47.20	53.75	47.20	+0.00	+0.00
1440	24TA13	2247143.81	54.22	60.63	54.22	+0.00	+0.00
1450	01GE14	2250803.54	61.23	67.50	61.24	+0.00	+0.00
1460	08GE15	2254463.30	68.25	74.38	68.26	+0.00	+0.01
1470	15GE17	2258123.08	75.28	81.27	75.28	+0.00	+0.00
1480	22GE19	2261782.87	82.32	88.17	82.31	+0.00	-0.01
1490	29GE21	2265442.66	89.35	95.06	89.34	+0.00	-0.01
1500	06CN23	2269102.45	96.38	101.96	96.38	+0.00	+0.00
1510	13CN26	2272762.27	103.43	108.87	103.43	+0.00	-0.01
1520	20CN29	2276422.07	110.48	115.78	110.47	+0.00	-0.01
1530	27CN32	2280081.88	117.53	122.69	117.53	+0.00	-0.01
1540	04LE35	2283741.66	124.58	129.60	124.58	+0.00	+0.00
1550	11LE39	2287401.45	131.65	136.52	131.65	+0.00	+0.00
1560	18LE43	2291061.22	138.72	143.45	138.71	+0.00	+0.00
1570	25LE47	2294720.98	145.78	150.38	145.79	+0.00	+0.00
1580	02VI52	2298380.72	152.87	157.32	152.86	+0.00	+0.00
1590	09VI56	2302040.43	159.93	164.25	159.94	+0.00	+0.01
1600	17VI01	2305700.12	167.02	171.19	167.03	+0.00	+0.01
1610	24VI06	2309359.80	174.10	178.14	174.11	+0.00	+0.01
1620	01LI11	2313019.44	181.18	185.08	181.20	+0.00	+0.02
1630	08LI17	2316679.07	188.28	192.04	188.30	+0.00	+0.01
1640	15LI23	2320338.67	195.38	199.00	195.39	+0.00	+0.01
1650	22LI29	2323998.24	202.48	205.96	202.48	+0.00	+0.00
1660	29LI35	2327657.78	209.58	212.92	209.58	+0.00	-0.01
1670	06SC41	2331317.30	216.68	219.88	216.67	+0.00	-0.01
1680	13SC46	2334976.78	223.77	226.82	223.76	+0.00	+0.00
1690	20SC51	2338636.24	230.85	233.77	230.86	+0.00	+0.01
1700	27SC57	2342295.69	237.95	240.73	237.94	+0.00	-0.01
1710	05SA02	2345955.11	245.03	247.67	245.03	+0.00	+0.00
1720	12SA07	2349614.51	252.12	254.62	252.11	+0.00	+0.00
1730	19SA11	2353273.89	259.18	261.54	259.19	+0.00	+0.01
1740	26SA16	2356933.28	266.27	268.49	266.27	+0.00	+0.00
1750	03CP20	2360592.64	273.33	275.41	273.34	+0.00	+0.01
1759	09CP41	2363886.05	279.68	281.64	279.70	+0.00	+0.01
1770	16CP45	2367545.40	286.75	288.56	286.76	+0.00	+0.01
1780	23CP48	2371204.76	293.80	295.47	293.82	+0.00	+0.02
1790	00AQ51	2374864.11	300.85	302.38	300.87	+0.00	+0.02
1800	07AQ54	2378523.48	307.90	309.29	307.91	+0.00	+0.01
1810	14AQ57	2382182.86	314.95	316.20	314.96	+0.00	+0.01
1820	21AQ59	2385842.23	321.98	323.10	321.99	+0.00	+0.01
1830	29AQ02	2389501.64	329.03	330.01	329.03	+0.00	-0.01
1840	06PI03	2393161.04	336.05	336.89	336.05	+0.00	+0.00
1850	13PI05	2396820.48	343.08	343.78	343.08	+0.00	-0.01
1860	20PI06	2400479.93	350.10	350.66	350.10	+0.00	+0.00
1870	27PI08	2404139.41	357.13	357.55	357.11	+0.00	-0.02
1880	04AR09	2407798.91	4.15	4.43	4.13	+0.00	-0.02
1890	11AR09	2411458.41	11.15	11.29	11.14	+0.00	-0.01
1900	18AR10	2415117.97	18.17	18.16	18.15	+0.00	-0.01
1910	25AR10	2418777.53	25.17	25.02	25.16	+0.00	+0.00
1920	02TA11	2422437.14	32.18	31.90	32.17	+0.00	-0.01
1930	09TA11	2426096.76	39.18	38.76	39.18	+0.00	+0.00
1940	16TA11	2429756.40	46.18	45.62	46.20	+0.00	+0.01
1950	23TA12	2433416.08	53.20	52.50	53.21	+0.00	+0.01

TABLE II: APOLLON

A	B	C	D	E	F	G	H
1600	10AQ42	2305477.70	310.70	314.88	310.69	+0.00	-0.01
1610	16AQ57	2309136.29	316.95	320.99	316.95	+0.00	+0.00
1620	23AQ12	2312794.91	323.20	327.10	323.21	+0.00	+0.01
1630	29AQ28	2316453.55	329.47	333.23	329.46	+0.00	+0.00
1640	05PI43	2320112.20	335.72	339.34	335.72	+0.00	+0.01
1650	11PI59	2323770.88	341.98	345.47	341.98	+0.00	+0.00
1660	18PI14	2327429.57	348.23	351.58	348.24	+0.00	+0.00
1670	24PI30	2331088.29	354.50	357.71	354.50	+0.00	+0.00
1680	00AR45	2334747.01	.75	3.82	.75	+0.00	+0.00
1690	07AR01	2338405.77	7.02	9.94	7.01	+0.00	+0.00
1700	13AR16	2342064.54	13.27	16.05	13.27	+0.00	+0.00
1710	19AR32	2345723.35	19.53	22.18	19.53	+0.00	-0.01
1720	25AR47	2349382.16	25.78	28.29	25.79	+0.00	+0.00
1730	02TA03	2353041.02	32.05	34.42	32.04	+0.00	-0.01
1740	08TA18	2356699.88	38.30	40.53	38.30	+0.00	+0.00
1750	14TA34	2360358.77	44.57	46.66	44.56	+0.00	-0.01
1760	20TA49	2364017.65	50.82	52.77	50.82	+0.00	+0.00
1770	27TA05	2367676.59	57.08	58.89	57.08	+0.00	-0.01
1780	03GE20	2371335.51	63.33	65.00	63.34	+0.00	+0.00
1790	09GE36	2374994.47	69.60	71.13	69.59	+0.00	-0.01
1800	15GE51	2378653.42	75.85	77.24	75.85	+0.00	+0.00
1810	22GE07	2382312.39	82.12	83.37	82.11	+0.00	-0.01
1820	28GE22	2385971.35	88.37	89.48	88.37	+0.00	+0.00
1830	04CN38	2389630.34	94.63	95.60	94.63	+0.00	-0.01
1840	10CN53	2393289.32	100.88	101.71	100.89	+0.00	+0.00
1850	17CN09	2396948.31	107.15	107.84	107.14	+0.00	-0.01
1860	23CN24	2400607.28	113.40	113.95	113.40	+0.00	+0.00
1870	29CN40	2404266.26	119.67	120.08	119.66	+0.00	-0.01
1880	05LE55	2407925.21	125.92	126.19	125.92	+0.00	+0.00
1890	12LE11	2411584.18	132.18	132.31	132.18	+0.00	-0.01
1900	18LE26	2415243.11	138.43	138.42	138.43	+0.00	+0.00
1910	24LE42	2418902.05	144.70	144.55	144.69	+0.00	-0.01
1920	00VI57	2422560.96	150.95	150.66	150.95	+0.00	+0.00
1930	07VI13	2426219.86	157.22	156.79	157.21	+0.00	-0.01
1940	13VI28	2429878.73	163.47	162.90	163.47	+0.00	+0.00
1950	19VI44	2433537.59	169.73	169.03	169.73	+0.00	-0.01
1960	25VI59	2437196.43	175.98	175.14	175.98	+0.00	+0.00
1970	02LI15	2440855.25	182.25	181.26	182.24	+0.00	-0.01
1980	08LI30	2444514.04	188.50	187.37	188.50	+0.00	+0.00
1990	14LI46	2448172.81	194.77	193.50	194.76	+0.00	-0.01

TABLE II: ADMETOS

A	B	C	D	E	F	G	H
1600	26VI37	2305709.94	176.62	180.79	176.62	+0.00	+0.01
1610	02LI28	2309368.32	182.47	186.50	182.47	+0.00	+0.00
1620	08LI19	2313026.68	188.32	192.21	188.32	+0.00	+0.00
1630	14LI10	2316685.01	194.17	197.92	194.16	+0.00	+0.00
1640	20LI01	2320343.34	200.02	203.63	200.01	+0.00	+0.00
1650	25LI52	2324001.64	205.87	209.34	205.86	+0.00	-0.01
1660	01SC42	2327659.90	211.70	215.04	211.71	+0.00	+0.01
1670	07SC33	2331318.16	217.55	220.75	217.55	+0.00	+0.00
1680	13SC24	2334976.42	223.40	226.46	223.40	+0.00	+0.00
1690	19SC15	2338634.65	229.25	232.17	229.25	+0.00	+0.00
1700	25SC06	2342292.87	235.10	237.88	235.09	+0.00	-0.01
1710	00SA57	2345951.08	240.95	243.59	240.94	+0.00	-0.01
1720	06SA47	2349609.26	246.78	249.28	246.79	+0.00	+0.00
1730	12SA38	2353267.45	252.63	254.99	252.63	+0.00	+0.00
1740	18SA29	2356925.63	258.48	260.70	258.48	+0.00	+0.00
1750	24SA20	2360583.80	264.33	266.41	264.33	+0.00	+0.00
1760	00CP11	2364241.98	270.18	272.12	270.18	+0.00	-0.01
1770	06CP02	2367900.14	276.03	277.83	276.02	+0.00	-0.01
1780	11CP17	2371192.48	281.28	282.96	281.28	+0.00	+0.00
1790	17CP08	2374850.64	287.13	288.67	287.13	+0.00	+0.00
1800	22CP59	2378508.82	292.98	294.38	292.98	+0.00	+0.00
1810	28CP50	2382166.99	298.83	300.09	298.83	+0.00	-0.01
1820	04AQ41	2385825.17	304.68	305.80	304.67	+0.00	-0.01
1830	10AQ31	2389483.33	310.52	311.49	310.52	+0.00	+0.00
1840	16AQ22	2393141.53	316.37	317.20	316.37	+0.00	+0.00
1850	22AQ13	2396799.74	322.22	322.91	322.21	+0.00	+0.00
1860	28AQ04	2400457.97	328.07	328.62	328.06	+0.00	-0.01
1870	03PI55	2404116.20	333.92	334.33	333.91	+0.00	-0.01
1880	09PI46	2407774.45	339.77	340.04	339.75	+0.00	-0.01
1890	15PI36	2411432.69	345.60	345.74	345.60	+0.00	+0.00
1900	21PI27	2415090.97	351.45	351.45	351.45	+0.00	+0.00
1910	27PI18	2418749.27	357.30	357.16	357.30	+0.00	+0.00
1920	03AR09	2422407.59	3.15	2.87	3.14	+0.00	-0.01
1930	09AR00	2426065.93	9.00	8.58	8.99	+0.00	-0.01
1940	14AR51	2429724.29	14.85	14.29	14.84	+0.00	-0.01
1950	20AR41	2433382.64	20.68	19.98	20.68	+0.00	+0.00
1960	26AR32	2437041.03	26.53	25.69	26.53	+0.00	+0.00
1970	02TA23	2440699.45	32.38	31.40	32.38	+0.00	+0.00
1980	08TA11	2444357.83	38.18	37.06	38.23	+0.00	+0.04
1990	14TA02	2448016.28	44.03	42.77	44.07	+0.00	+0.04

TABLE II: VULKANUS

A	B	C	D	E	F	G	H
1600	13SA10	2305786.42	253.17	257.34	253.17	+0.00	+0.00
1610	18SA37	2309444.21	258.62	262.65	258.62	+0.00	+0.00
1620	24SA04	2313101.99	264.07	267.96	264.07	+0.00	+0.00
1630	29SA31	2316759.76	269.52	273.27	269.52	+0.00	+0.00
1640	04CP58	2320417.54	274.97	278.58	274.97	+0.00	+0.00
1651	10CP25	2324075.30	280.42	283.89	280.42	+0.00	+0.00
1660	15CP20	2327367.32	285.33	288.68	285.32	+0.00	-0.01
1670	20CP47	2331025.09	290.78	293.99	290.77	+0.00	-0.01
1680	26CP14	2334682.88	296.23	299.30	296.22	+0.00	-0.01
1690	01AQ41	2338340.66	301.68	304.61	301.67	+0.00	-0.02
1700	07AQ08	2341998.45	307.13	309.92	307.12	+0.00	-0.02
1710	12AQ35	2345656.25	312.58	315.23	312.57	+0.00	-0.02
1720	18AQ02	2349314.06	318.03	320.54	318.01	+0.00	-0.02
1730	23AQ29	2352971.88	323.48	325.85	323.46	+0.00	-0.02
1740	28AQ56	2356629.71	328.93	331.16	328.91	+0.00	-0.02
1750	04PI23	2360287.55	334.38	336.47	334.36	+0.00	-0.02
1760	09PI49	2363945.39	339.82	341.77	339.81	+0.00	-0.01
1770	15PI16	2367603.26	345.27	347.08	345.26	+0.00	-0.01
1780	20PI43	2371261.15	350.72	352.39	350.71	+0.00	-0.01
1790	26PI10	2374919.05	356.17	357.70	356.16	+0.00	-0.01
1800	01AR37	2378576.97	1.62	3.01	1.61	+0.00	-0.01
1810	07AR04	2382234.90	7.07	8.32	7.06	+0.00	-0.01
1820	12AR31	2385892.85	12.52	13.63	12.51	+0.00	-0.01
1830	17AR58	2389550.81	17.97	18.94	17.96	+0.00	-0.01
1840	23AR25	2393208.79	23.42	24.25	23.41	+0.00	-0.01
1850	28AR52	2396866.80	28.87	29.56	28.86	+0.00	-0.01
1860	04TA19	2400524.81	34.32	34.87	34.30	+0.00	-0.01
1870	09TA46	2404182.84	39.77	40.18	39.75	+0.00	-0.01
1880	15TA12	2407840.86	45.20	45.47	45.20	+0.00	+0.00
1890	20TA39	2411498.93	50.65	50.78	50.65	+0.00	+0.00
1900	26TA06	2415157.00	56.10	56.09	56.10	+0.00	+0.00
1910	01GE32	2418815.07	61.53	61.39	61.55	+0.00	+0.02
1920	06GE59	2422473.16	66.98	66.70	67.00	+0.00	+0.02
1930	12GE26	2426131.27	72.43	72.01	72.45	+0.00	+0.02
1940	17GE54	2429789.39	77.90	77.34	77.90	+0.00	+0.00
1950	23GE21	2433447.51	83.35	82.65	83.35	+0.00	+0.00
1960	28GE48	2437105.64	88.80	87.96	88.80	+0.00	+0.00
1970	04CN15	2440763.77	94.25	93.27	94.25	+0.00	+0.00
1980	09CN42	2444421.91	99.70	98.58	99.70	+0.00	+0.00
1990	15CN09	2448080.03	105.15	103.89	105.15	+0.00	+0.00

TABLE II: POSEIDON

A	B	C	D	E	F	G	H
1600	20AR21	2305547.56	20.35	24.53	20.35	+0.00	+0.00
1610	25AR12	2309204.94	25.20	29.24	25.20	+0.00	+0.00
1620	00TA03	2312862.34	30.05	33.95	30.05	+0.00	+0.00
1630	04TA54	2316519.75	34.90	38.66	34.90	+0.00	+0.00
1640	09TA45	2320177.17	39.75	43.37	39.75	+0.00	+0.00
1650	14TA36	2323834.61	44.60	48.08	44.60	+0.00	+0.00
1660	19TA27	2327492.06	49.45	52.79	49.45	+0.00	+0.00
1670	24TA18	2331149.52	54.30	57.50	54.30	+0.00	+0.00
1680	29TA09	2334806.98	59.15	62.21	59.15	+0.00	+0.00
1690	04GE00	2338464.45	64.00	66.92	64.00	+0.00	+0.00
1700	08GE51	2342121.93	68.85	71.63	68.85	+0.00	+0.00
1710	13GE42	2345779.42	73.70	76.35	73.70	+0.00	+0.00
1720	18GE33	2349436.91	78.55	81.06	78.55	+0.00	+0.00
1730	23GE24	2353094.41	83.40	85.77	83.40	+0.00	+0.00
1740	28GE15	2356751.91	88.25	90.48	88.25	+0.00	+0.00
1750	03CN06	2360409.41	93.10	95.19	93.10	+0.00	+0.00
1760	07CN57	2364066.91	97.95	99.90	97.95	+0.00	+0.00
1770	12CN48	2367724.42	102.80	104.61	102.80	+0.00	+0.00
1780	17CN39	2371381.92	107.65	109.32	107.65	+0.00	+0.00
1790	22CN30	2375039.42	112.50	114.03	112.50	+0.00	+0.00
1800	27CN21	2378696.92	117.35	118.74	117.35	+0.00	+0.00
1810	02LE12	2382354.41	122.20	123.45	122.20	+0.00	+0.00
1820	07LE03	2386011.90	127.05	128.16	127.05	+0.00	+0.00
1830	11LE54	2389668.38	131.90	132.87	131.90	+0.00	+0.00
1840	16LE45	2393326.86	136.75	137.58	136.75	+0.00	+0.00
1850	21LE36	2396984.32	141.60	142.29	141.60	+0.00	+0.00
1860	26LE27	2400641.78	146.45	147.00	146.45	+0.00	+0.00
1870	01VI18	2404299.23	151.30	151.71	151.30	+0.00	+0.00
1880	06VI09	2407956.67	156.15	156.42	156.15	+0.00	+0.00
1890	11VI00	2411614.09	161.00	161.13	161.00	+0.00	+0.00
1900	15VI51	2415271.51	165.85	165.84	165.85	+0.00	+0.00
1910	20VI42	2418928.91	170.70	170.55	170.70	+0.00	+0.00
1920	25VI33	2422586.30	175.55	175.26	175.55	+0.00	+0.00
1930	00LI24	2426243.68	180.40	179.97	180.40	+0.00	+0.00
1940	05LI15	2429901.05	185.25	184.68	185.25	+0.00	+0.00
1950	10LI06	2433558.40	190.10	189.39	190.10	+0.00	+0.00
1960	14LI57	2437215.74	194.95	194.10	194.95	+0.00	+0.00
1970	19LI48	2440873.06	199.80	198.81	199.80	+0.00	+0.00
1980	24LI39	2444530.37	204.65	203.52	204.65	+0.00	+0.00
1990	29LI30	2448187.67	209.50	208.23	209.50	+0.00	+0.00

TABLE III: SONNENLAUF TABLEN

DEG	CUPIDO	HADES	ZEUS	KRONOS	APOLLON	ADMETOS	VULCAN	POSEIDON
	262.512	360.656	455.659	521.834	589.424	631.773	679.040	765.327
	40.998	50.667	59.214	64.816	70.299	73.627	77.255	83.669
10	+0 16	+0 13	+0 11	+0 10	+0 09	+0 09	+0 09	+0 08
20	+0 33	+0 26	+0 22	+0 20	+0 19	+0 18	+0 17	+0 15
30	+0 48	+0 38	+0 33	+0 30	+0 27	+0 26	+0 25	+0 23
40	+1 02	+0 50	+0 42	+0 38	+0 35	+0 33	+0 32	+0 29
50	+1 14	+1 00	+0 51	+0 46	+0 42	+0 40	+0 38	+0 35
60	+1 25	+1 08	+0 58	+0 52	+0 48	+0 46	+0 44	+0 40
70	+1 34	+1 15	+1 03	+0 58	+0 53	+0 50	+0 48	+0 44
80	+1 40	+1 20	+1 08	+1 01	+0 56	+0 53	+0 51	+0 47
90	+1 44	+1 23	+1 10	+1 03	+0 58	+0 55	+0 52	+0 48
100	+1 46	+1 24	+1 11	+1 04	+0 58	+0 56	+0 53	+0 48
110	+1 45	+1 23	+1 09	+1 03	+0 57	+0 55	+0 52	+0 47
120	+1 41	+1 19	+1 07	+1 00	+0 55	+0 52	+0 49	+0 45
130	+1 35	+1 15	+1 02	+0 56	+0 51	+0 49	+0 46	+0 42
140	+1 28	+1 08	+0 56	+0 51	+0 46	+0 44	+0 41	+0 38
150	+1 18	+1 00	+0 50	+0 44	+0 40	+0 38	+0 36	+0 33
160	+1 07	+0 51	+0 42	+0 37	+0 33	+0 32	+0 30	+0 27
170	+0 55	+0 41	+0 33	+0 29	+0 26	+0 25	+0 23	+0 21
180	+0 42	+0 31	+0 24	+0 21	+0 19	+0 17	+0 16	+0 14
190	+0 30	+0 20	+0 15	+0 13	+0 11	+0 10	+0 09	+0 08
200	+0 17	+0 10	+0 07	+0 05	+0 04	+0 03	+0 02	+0 02
210	+0 06	+0 01	-0 01	-0 02	-0 03	-0 03	-0 04	-0 04
220	-0 04	-0 07	-0 08	-0 09	-0 09	-0 09	-0 09	-0 09
230	-0 12	-0 14	-0 14	-0 14	-0 14	-0 14	-0 14	-0 14
240	-0 18	-0 19	-0 19	-0 18	-0 18	-0 18	-0 17	-0 17
250	-0 22	-0 22	-0 22	-0 21	-0 21	-0 20	-0 20	-0 19
260	-0 23	-0 24	-0 23	-0 22	-0 22	-0 21	-0 21	-0 20
270	-0 22	-0 23	-0 23	-0 22	-0 21	-0 21	-0 21	-0 20
280	-0 19	-0 20	-0 20	-0 20	-0 20	-0 19	-0 19	-0 18
290	-0 12	-0 15	-0 16	-0 16	-0 16	-0 16	-0 16	-0 16
300	-0 04	-0 09	-0 11	-0 11	-0 12	-0 12	-0 12	-0 12
310	+0 07	-0 00	-0 04	-0 05	-0 06	-0 06	-0 07	-0 07
320	+0 19	+0 09	+0 05	+0 03	+0 01	+0 00	-0 00	-0 01
330	+0 33	+0 21	+0 14	+0 11	+0 09	+0 08	+0 07	+0 05
340	+0 48	+0 33	+0 25	+0 21	+0 18	+0 16	+0 15	+0 12
350	+1 04	+0 46	+0 35	+0 31	+0 27	+0 25	+0 23	+0 20
360	+1 20	+0 59	+0 47	+0 41	+0 36	+0 34	+0 31	+0 28

MATRIX HOROSCOPE PROGRAM

Authored by Michael Erlewine
James Neely (orbital elements)

We have published several partial natal programs in previous issues of MATRIX. Many of you have these up and running on one computer system or another. Some of you have written asking for an example of a finished program complete with all of the bells & whistles. Here is an sxample of a finished program written in a Microsoft BASIC that should fill the bill.

The chief problem encountered in publishing a detailed program such as this one is that many of the details are, almost by necessity, machine specific. For example, screen format commands vary from computer to computer. It is one thing to calculate natal positions, house cusps, etc. and another to present this information in a usable form. Formatting information on the CRT or display screen is an essential part in finishing up a program for actual use. We have received a number of requests for this kind of detail.

This program was written in Microsoft BASIC on a Commodore PET computer. The PET has a precision of 9 places in floating point (PI= 3.14159265) and the natal program will work for dates from 1900 to 2000. In general, the 'number crunching' portions of the program will run (as written) on the PET, APPLE and TRS-80, all of which feature a version of Microsoft BASIC. The major area of difference between these Microsoft BASICs has to do with screen format. In this case, we are using the special graphic-string method of screen format specific to the Commodore machines. Please read the section on PET screen control in detail.

THE LISTING

The listing is straight forward and should be easy to read. Note that the lines wrap around and are continued on the next line. This will often break up a word or data constant. Common sense should be used in piecing together sections that are separated in this fashion. Ample REMARK statements have been included to advise you as to what is happening in each line.

The enclosed program outputs the chart Angles, Helio and Geocentric planet Longitudes & Latitudes and Right Ascensions & Declinations. The user may select to view a small rectangular chart wheel in either Koch or Placidus house cusps. An Aspectscope is available for planet aspect analysis and midpoints in the wheel center. Also available is an aspect grid that will display the angular separation, aspect names and midpoints between the planets. A midpoint sort is included. All of this is menu driven and includes complete screen formatting.

This program, which represents a large amount of effort on the part of the author and James Neely is for your personal use. The planetary program is the sole copyright of MATRIX Software and James Neely and is not to be made part of any software for sale commercially. That is, use this program with our blessing for anything you may need it for in your work or as part of a home chart service. Our request is that you do not sell the program itself without our written permission. If you have written a program that you feel would interest other astrologers and wish to include this natal routine as part of that program, give us a call. We may be able to help you market it thru MATRIX Software.

PROGRAM OUTPUT

Sample screen output are included below. The output shows how each of the various screenfulls should look. This output assumes a screen 40 columns wide by 24 lines high. All characters are standard ASCII. These sample outputs were obtained thru use of a 6502 machine language program that 'dumps' a screen load of data to a line printer. This screen dump feature is a standard part of most MATRIX software programs. Users may select to print any single screenfull of data by pressing a single key. After the screen dump is accomplished, the program returns to CRT(screen) orientation. The output given here is oriented to the screen rather than to the line printer. It also includes the use of Reverse-Field (black letters on white backgrounds) to highlight certain areas. Reverse Field will not print out on most printers. We have replaced the reverse field used in the rectangular chart wheel arms with asterisks (*). The program lines, however, are written with liberal use of this Reverse-Field feature. See the notes on Commodore screen output for details.

LINE-BY-LINE VARIABLE STATUS

Also included is a line-by-line variable output for at least some of the number crunching sections. This variable printout should prove useful in debugging the program. In particular those of you with systems that use a different dialect of BASIC will find that the variable status can be checked out and errors easily located.

The variable output list is easy to use. The line number, variable name and variable value in memory AT THE COMPLETION of that line are given. Keep in mind that in some lines the value of a variable may change. Listed here are the values held in memory when the given line has been fully executed. We include a run-thru for both the sun, moon and mercury. This should suffice to spot errors. If you can get these to run correctly than you can be sure that errors in subsequent planets can be found in the DATA statements rather than in the number-crunching routines.

Only the heavy number crunching routines are given in detail. It is assumed that the various aspect and house routines plus the screen format can be solved one way or another.

Commodore Screen Format

The area of greatest difference between machines has to do with the way the particular version of BASIC handles screen format work. Each brand (PET, APPLE, TRS-80, ATARI, etc.) has different screen format commands. It is

important that you understand how the PET formats the screen so that you can reproduce the effect on your own machine. The PET makes use of special graphic characters enclosed in quotes for screen formatting. In the enclosed listing, we have indicated these special graphic commands by giving the ASCII code for the command enclosed in brackets.. i.e. [147], [157] and so forth. When you encounter one of these special commands, consult the following table to see what it does to the screen. Then consult the manual for your machine to determine how to duplicate this effect. Here are the commands.

PET Special Cursor Commands

Cursor up one line	[145]
Cursor down one line	[17]
Cursor right one character	[29]
Cursor left one character	[157]
Home cursor to upper left	[19]
Clear screen, Home	[147]
Reverse field (begin)	[18]
Reverse field (end)	[146]

Reverse field gives a white background with a dark character instead of the more usual dark background with a light charcter. reverse field is used particularly in screen menus to hi-light the first letter of an option to be selected. A similar effect can be obtained by enclosing the first letter in parentheses...i.e. (N)EW, (A)SPECTS, etc.

Additional Notes

Some of the sections are more complex than they might be. For instance, in order to save memory space the midpoint values and their reference (two planets that have the midpoint) are combined and stored in a floating point array. The method of encoding and decoding this information might be dispensed with if memory was not a concern. Some of you may have difficulty following the routines that create the aspect and midpoint grids. I am certain that many and any part of this program might be optimized and written differently. The value of the listing as it is written is that it is a running program that has been field tested for about a year. I feel that it is a better idea to use the program as written rather than to re-write it and risk a lot of new 'bugs' that would confuse readers.

DATA INPUT INSTRUCTIONS

The sample chart is that of the author: July 18, 1941 at 4:03 PM EST (5:03 EDT) in Lancaster, PA 76 W 18, 40 N 02. Th birth info format should be followed with care:

DATE:=? Accepts Month, Day and Year in the format MM.DDYYYY where 'MM' is the number of months from 01 to 12, 'DD' is days from 01 to 31 and 'YY' is years from 1900 to 2000. Note use of decimal point between 'MM.DD'. Months and Days that are single digits (less than 10) must be entered as a two-digit number preceded by a zero (1 would be 01, etc.).

AM*PM? Accepts 'AM' if morning birth and 'PM' if afternoon birth.

TIME? Accepts time of the event in HH.MM format where 'HH' stands for the number of hours after midnight or noon (after 'AM' or 'PM' has been selected) and 'MM' stands for the number of minutes after the given hour. NOTE the decimal point (.) is used to separate


```
DATE=? 07.181941
AM*PM? PM
TIME? 4.03
TZ? 5                    RAMC= 175.73
LONG? 76.18               MC= 25VI21
LAT ? 40.02              ASC= 08SA01
DELTA T? 24              VTX= 22CA07

HELIO                    GEO
   LONG     LAT            LONG     LAT

EA 25CP49  +00 00  SU 25CA49  +00 00
ME 03PI57  -06 43  ME 07CA21  -03 28
VE 25VI14  +03 21  VE 19LE55  +01 36
MA 24AQ22  -01 51  MA 09AR06  -03 41
JU 03GE47  -00 46  JU 11GE50  -00 41
SA 20TA37  -02 12  SA 26TA07  -02 06
UR 26TA54  -00 13  UR 29TA23  -00 13
NE 27VI03  +01 17  NE 25VI24  +01 15
PL 03LE53  +04 23  PL 03LE40  +04 16
                   MO 23TA28  -04 20
                   NO 25VI38  +00 00

WHEEL NEW MORE R.A.



        1NE 25VI242VE 19LE550ME 07CA21
        9NO 25VI385          8SU 25CA49
        L            V       LPL 03LE40
        I            I       E
        4            2       1
*13SC45**1***SUN***1****MIDPT9**04CA33*
        *2MON*SXT* 62 24GE38*JU 11GE50
        *3MER    * 18 16CA35*
        *4VEN    * 24 07LE52*
        *5MAR    *107 02GE28*
        *6JUP*SSQ* 44 03CA50*
*08SA01***7SAT*SXT* 60 25GE58***08GE01*
        *8URA*SXT* 56 27GE36*MO 23TA28
        *9NEP*SXT* 60 25LE37*SA 26TA07
        *:PLU    *  8 29CA45*UR 29TA23
        *;NOD*SXT* 60 25LE44*
        *  ASPECTS NEW MORE *
*04CP33**0**KOCH***2*HOUSES**1**13TA45*
        8            5MA 09AR069
        A            P       A
        Q            I       R
        1            2       4
        9            1       1



---------------- ASPECTS ----------------
SUN* 62* 18* 24*107* 44* 60* 56* 60*  8
-----------------------------------------
SXT*MON* 44* 86* 44* 18*  3*  6*122* 70
-----------------------------------------
   *SSQ*MER* 43* 88* 26* 41* 38* 78* 26
-----------------------------------------
   *SQR*SSQ*VEN*131* 68* 84* 81* 35* 16
-----------------------------------------
   *SSQ*SQR*   *MAR* 63* 47* 50*166*115
-----------------------------------------
SSQ*   *   *   *SXT*JUP* 16* 12*104* 52
-----------------------------------------
SXT*CJN*SSQ*SQR*SSQ*   *SAT*  3*119* 68
-----------------------------------------
SXT*CJN*   *   *   *   *CJN*URA*116* 64
-----------------------------------------
SXT*TRI*   *   *   *   *TRI*TRI*NEP* 52
-----------------------------------------
   *QTL*   *   *TRI*   *   *SXT*   *PLU
-------- MAJOR ASPECTS ----------------

MIDPT GRID CONT RUN
```

```
  3  REM MATRIX HOROSCOPE ROUTINE
  4  REM AUTHORED BY MICHAEL ERLEWINE
  5  REM ORBITAL ELEMENTS AND HARMONIC TERMS BY J
     AMES NEELY
  6  REM WRITTEN IN MICROSOFT (COMMODORE PET) EXP
     ANDED BASIC
  7  REM COPYRIGHT 1980 BY MICHAEL ERLEWINE & JAM
     ES NEELY
  8  REM PERMISSION TO USE BUT NOT TO SELL (IN AN
     Y PART)
  9  REM
 10  REM NAMES FOR CS ARRAY
 20  DATA EAR,MON,MER,VEN,MAR,JUP,SAT,URA,NEP,PLU
     ,NOD,ASC,"MC "
 30  REM DATA FOR ASPECT AS ARRAY
 40  DATA CJN7000,OPP7180,SQR7090,TRI7120,QTL3072
     ,SXT5060,SSQ5045
 50  DATA SES3135,INC3150
 60  REM SUN ELEMENTS BEGIN AT 358.4758
 70  DATA 358.4758,35999.0498,-.2E-3,.01675,-.4E-
     4,0,1,101.2208,1.7192,.0005,0,0
 80  REM MERCURY ELEMENTS BEGIN AT 102.2794
 90  DATA 0,0,0,0,102.2794,149472.5151,0,.20561,.
     2E-4,0,.387098,28.7538,.3703
100  REM VENUS ELEMENTS BEGIN AT 212.6032
110  DATA .0001,47.1459,1.185,.0002,7.0029,.0019,
     -.2E-4,212.6032,58517.8039,.0013
120  DATA .00682,-.5E-4,0,.7233,54.3842,.5082,-.1
     4E-2,75.7796,.8999,.4E-3
130  REM MARS ELEMENTS BEGIN AT 319.5294
140  DATA 3.3936,.1E-2,0,319.5294,19139.8585,.2E-
     3,.09331,.9E-4,0,1.5237,285.4318
150  REM JUPITER ELEMENTS BEGIN AT 225.4928
160  DATA 1.0698,.1E-3,48.7864,.77099,0,1.8503,-.
     7E-3,0,225.4928,3033.6879,0
170  DATA .04838,-.2E-4,0,5.2029,273.393,1.3383,0
     ,99.4198,1.0583,0,1.3097,-.52E-2
180  REM JUPITER HARMONIC TERMS BEGIN AT -.001
190  DATA 0,-.001,-.0005,.0045,.0051,581.7,-9.7,-
     .0005,2510.7,-12.5,-.0026,1313.7
200  DATA -61.4,.0013,2370.79,-24.6,-.0013,3599.3
     ,37.7,-.001,2574.7,31.4,-.00096
210  DATA 6708.2,-114.5,-.0006,5499.4,-74.97,-.00
     13,1419,54.2,.0006,6339.3,-109
220  DATA .0007,4824.5,-50.9,.0020,-.0134,.0127,-
     .0023,676.2,.9,.00045
230  DATA 2361.4,174.9,.0015,1427.5,-188.8,.0006,
     2110.1,153.6,.0014,3606.8,-57.7
240  DATA -.0017,2540.2,121.7,-.00099,6704.8,-22.
     3,-.0006,5480.2,24.5,.00096
250  REM SATURN ELEMENTS BEGIN AT 174.2153
260  DATA 1651.3,-118.3,.0006,6310.8,-4.8,.0007,4
     826.6,36.2,174.2153,1223.50796
270  DATA 0,.05423,-.2E-3,0,9.5525,338.9117,-.316
     7,0,112.8261,.8259,0,2.4908
280  REM SATURN HARMONIC TERMS BEGIN AT .0009
290  DATA -.0047,0,-.0009,.0037,0,.0134,1238.9,-1
     6.4,-.00426,3040.9,-25.2,.0064
300  DATA 1835.3,36.1,-.0153,610.8,-44.2,-.0015,2
     480.5,-69.4,-.0014,.0026,0,.0111
310  DATA 1242.2,78.3,-.0045,3034.96,62.8,-.0066,
     1829.2,-51.5,-.0078,640.6,24.2
320  DATA -.0016,2363.4,-141.4,.0006,-.0002,0,-.0
     005,1251.1,43.7,.0005,622.8
330  REM URANUS ELEMENTS BEGIN AT 74.1757
340  DATA 13.7,.0003,1824.7,-71.1,.0001,2997.1,78
     .2,74.1757,427.2742,0,.04682
350  REM URANUS HARMONIC TERMS BEGIN AT -.0021
360  DATA .00042,0,19.2215,95.6863,2.0508,0,73.52
     22,.5242,0,.7726,.1E-3,0,-.0021
370  DATA -.0159,0,.0299,422.3,-17.7,-.0049,3035.
     1,-31.3,-.0038,945.3,60.1
380  DATA -.0023,1227,-4.99,.0134,-.02186,0,.0317
     ,404.3,81.9,-.00495,3037.9,57.3
390  DATA .004,993.5,-54.4,-.0018,1249.4,79.2,-.0
     003,.0005,0,.0005,352.5,-54.99
400  REM NEPTUNE ELEMENTS BEGIN AT 30.13294
410  DATA .0001,3027.5,54.2,-.0001,1150.3,-88,30.
     13294,240.45516,0,.00913,-.00127
420  REM NEPTUNE HARMONIC TERMS BEGIN AT .1832
430  DATA 0,30.11375,284.1683,-21.6329,0,130.6841
     5,1.1005,0,1.7794,-.0098,0,.1832
440  DATA -.6718,.2726,-.1923,175.7,31.8,.0122,54
     2.1,189.6,.0027,1219.4,178.1
450  DATA -.00496,3035.6,-31.3,-.1122,.166,-.0544
     ,-.00496,3035.3,58.7,.0961,177.1
460  DATA -68.8,-.0073,630.9,51,-.0025,1236.6,78,
     .00196,-.0119,.0111,.0001
470  REM PLUTO ELEMENTS BEGIN AT 229.781
480  DATA 3049.3,44.2,-.0002,893.9,48.5,.00007,14
     16.5,-25.2,229.781,145.1781,0
490  DATA .24797,.002898,0,39.539,113.5366,.2086,
     0,108.944,1.3739,0,17.1514
500  REM PLUTO HARMONIC TERMS BEGIN AT -.0426
510  DATA -.0161,0,-.0426,.073,-.029,.0371,372,-3
     31.3,-.0049,3049.6,-39.2,-.0108
520  DATA 566.2,318.3,.0003,1746.5,-238.3,-.0603,
     .5002,-.6126,.049,273.97,89.97
530  DATA -.0049,3030.6,61.3,.0027,1075.3,-28.1,-
     .0007,1402.3,20.3,.0145,-.0928
540  DATA .1195,.0117,302.6,-77.3,.00198,528.1,48
     .6,-.0002,1000.4,-46.1
550  REM HORIZ & VERTICAL COORDINATES FOR PRINTIN
     G PLANETS IN HOUSES
560  DATA 0,13,0,19,10,19,20,19,30,19,30,13,30,7,
     30,1,20,1,10,1,0,1,0,7
570  REM CONSTANT 'PI'
580  PI=3.14159265
590  REM DIMENSION ARRAYS
600  DIMC$(13),C(14),K(13),HS(12),M(79),R(12,2),T
     (3)
610  REM RD CONVERTS RADIANS TO DEGREES, DR CONVE
     RTS DEGREES TO RADIANS
620  RD=180/PI:DR=PI/180
630  REM FNS PERFORMS SINE FUNCTION WHEN VALUE IS
      IN DEGREES
640  DEF FNS(X)=SIN(X*DR)
650  REM ZODIAC NAME MASTER STRING
660  ZAS="ARTAGECALEVILISCSACPAQPI"
670  REM 'MO' IS USED IN MODULUS FUNCTION (FNU)
680  MO=360
690  REM CONVERTS NUMBER ENTERED IN DEGREES AND M
     INUTES TO DEGREES AND DECIMALS
700  DEF FNQ(X)=SGN(X)*(INT(ABS(X))+(ABS(X)-INT(ABS
     (X)))*100/60)
710  REM 'QW$','K$' AND 'O$' ARE USED FOR PET SCR
     EEN FORMAT
720  QW$="[19][17][17][17][17][17][17][17][17][17][17]
     [17][17][17][17][17][17][17][17][17][17][17][17]
     [17][17][17]":K$="      ":O$="[19][17][17]
     [17][17][17][17][17][17]"
730  REM 'FNU' IS UNITY OR MODULUS FUNCTION, RETU
     RNS ANSWER WITHIN A CIRCLE
740  DEF FNU(X)=X-(INT(X/MO)*MO)
750  REM 'FNW' RETURNS DEGREE-DECIMAL RESULT ROUN
     DED TO TWO PLACES
760  DEF FNW(X)=INT(X*100+.5)/100
770  REM 'FNY' IS ARC COSINE ROUTINE
780  DEF FNY(X)=ATN(SQR(1-X*X)/X)
790  REM 'FNX' IS ARCSINE ROUTINE
800  DEF FNX(X)=ATN(X/SQR(1-X*X))
810  REM FILL PLANET AND ASPECT NAME ARRAYS
820  FOR I=1TO13:READ C$(I):NEXT I:FOR I=1TO9:READ
     A$(I):NEXT I
830  REM SELECT BETWEEN TROPICAL AND SIDEREAL OUT
     PUT
840  PRINT "[147][18]T[146]ROPICAL/[18]S[146]IDER
     EAL?":GOSUB 3040:PRINT "[147]";:SD=0:IF Q$="
     S" THEN SD=1
850  REM INPUT DATE STRING AND BREAK IT DOWN X=MO
     NTH, Y=DAY AND Z=YEAR
860  INPUT"DATE=";E$:X=VAL(MID$(E$,1,2)):Z=VAL(MID$
     (E$,6,4)):Y=VAL(MID$(E$,4,2))
870  REM MORNING OR AFTERNOON EVENT INPUT
880  INPUT"AM*PM";A$
890  REM INPUT TIME IN HH.MM FORMAT
900  INPUT"TIME";U
910  REM INPUT STANDARD TIME ZONE IN HH
920  INPUT"TZ";V
```

```
930   REM ENTER GEOGRAPHIC LONGITUDE IN DDD.MM (+=
      WEST, -=EAST)
940   INPUT"LONG";C:L5=FNQ(C)
950   REM ENTER GEOGRAPHIC LATITUDE IN DD.MM (+=NO
      RTH, -=SOUTH)
960   INPUT"LAT ";C:LA=DR*FNQ(C)
970   REM ENTER DELTA CORRECTION (ZERO IF NOT DESI
      RED)
980   INPUT"DELTA T";DT
990   REM ADD TIME ZONE IN HOURS TO EVENT TIME CON
      VERTED TO DECIMALS
1000  U=FNQ(U)+V
1010  REM ADD 12 HOURS IF 'PM' BIRTH
1020  IF A$="PM" THEN U=U+12
1030  REM JULIAN DAY NUMBER ROUTINE
1040  JD=367*Z-INT(7*(Z+INT((X+9)/12))/4):JD=JD+INT
      (275*X/9)+Y+1721013.5:I=1
1050  JD=JD-.5*SGN(100*Z+X-190002.5)+.5:C=(JD-2415
      020)+U/24
1060  REM 'T' IS CENTURY INCREMENT WITHOUT DELTA T
       CORRECTION
1070  T=C/36525
1080  REM 'RA' IS SIDEREAL TIME (RAMC) CALCULATED
      IN DEGREES AND THEN TO RADIANS
1090  RA=DR*FNU((6.6460656+2400.0513*T+2.58E-5*T*T
      +U)*15-L5)
1100  REM MEAN LUUNAR NODE AND NUTATION ROUTINE
1110  GOSUB 2690
1120  REM CALCULATE OBLIQUITY OF ECLIPTIC
1130  OB=DR*(23.452294-.0130125*T)
1140  REM CHECK FOR SIDEREAL OPTION
1150  IF SD=1 THEN GOSUB 5050
1160  REM CENTURY INCREMENT 'T' INCLUDING DELTA T
      CORRECTION
1170  T=(C+DT/86400)/36525
1180  REM CHART ANGLES SUBROUTINE
1190  R2=RA:O=-OB:B=LA:GOSUB 2780:C=MC
1200  REM PRINT OUT CHART ANGLES IN UPPER LEFT HAN
      D CORNER OF SCREEN
1210  PRINT SPC(20)"[145][145][145][145]RAMC="FNW(
      RD*RA):GOSUB 2110:PRINT SPC(20)"  MC= "AS
1220  C=AS:GOSUB 2110:PRINT SPC(20)" ASC= "AS
1230  C=VT:GOSUB 2110:PRINT SPC(20)" VTX= "AS:C(12
      )=AS:C(13)=MC
1240  REM PRINT PLANET POSITION HEADER
1250  PRINT "[17]HELIO"SPC(14)"GEO":AS="   LONG
       LAT":PRINT ASSPC(5)AS:PRINT
1260  REM BEGIN PLANET ROUTINE
1270  REM PLANET LOOP (INCLUDES LUNAR ROUTINE)
1280  FOR I=1TO10
1290  REM LUNAR SUBROUTINE
1300  IF I=2 THEN 1980
1310  REM MODULUS FUNCTION IN RADIANS RATHER THAN
      DEGREES
1320  MO=2*PI
1330  REM CALCULATE MEAN ANOMALY 'M'
1340  GOSUB 2530:M=FNU(S)
1350  REM CALCULATE ECCENTRICITY 'E'
1360  GOSUB 2530:E=RD*S
1370  REM SOLVE KEPLER'S EQUATION FOR ECCENTRIC AN
      OMALY 'EA'
1380  EA=M:FOR A=1TO5:EA=M+E*SIN(EA):NEXT A
1390  REM READ SEMI-MAJOR AXIS 'AU'
1400  READ AU
1410  REM BEGIN VELOCITY COORDINATES ROUTINE
1420  E1=.01720209/(AU^1.5*(1-E*COS(EA)))
1430  REM CALCULATE 'AP' ARGUMENT OF PERIHELION
1440  GOSUB 2530:AP=S
1450  REM CALCULATE PERIFOCAL COORDINATES 'XW' AND
       'YW'
1460  XW=-(AU*E1)*SIN(EA):YW=(AU*E1)*(1-E*E)^.5*COS
      (EA)
1470  REM CALCULATE ASCENDING NODE 'AN'
1480  GOSUB 2530:AN=S
1490  REM CALCULATE INCLINATION 'IN'
1500  GOSUB 2530:IN=S
1510  REM ROTATE VELOCITY COORDINATES
1520  X=XW:Y=YW:GOSUB 2650
1530  REM HELIO ECLIPTIC RECTANGULAR COORDINATES
1540  XH=X:YH=Y:ZH=G
1550  REM SET MODULUS FUNCTION TO DEGREES
```



```
1560  MO=360
1570  REM STORE SUN'S VELOCITY COORDINATES
1580  IF I=1 THEN XA=-XH:YA=-YH:ZA=-ZH:AB=0:GOTO 1
      620
1590  REM GEO VELOCITY COMPONENTS FOR PLANETS OTHE
      R THAN THE SUN
1600  XW=XH+XA:YW=YH+YA:ZW=ZH+ZA
1610  REM PERIFOCAL COORDS FOR TRANSFORM TO RECT P
      OSITION COORDINATES
1620  X=AU*(COS(EA)-E):Y=AU*SIN(EA)*(1-E*E)^.5
1630  REM ROTATE FOR RECTANGULAR POSITION COORDINA
      TES
1640  GOSUB 2650:XX=X:YY=Y:ZZ=G
1650  REM CALCULATE HARMONIC TERMS FOR PLANETS BEY
      OND AND INCLUDING JUPITER
1660  IF I>5 THEN GOSUB 2590:XX=XX+T(2):YY=YY+T(1)
      :ZZ=ZZ+T(3)
1670  REM SET RETROGRADE STRING 'RS' AND ABBERATIO
      N 'BR' TO NULL
1680  RS="  ":BR=0
1690  REM CONVERT HELIO RECTANGULAR COORDINATES TO
       HELIO SPHERICAL
1700  GOSUB 2310:AB=1
1710  REM ASSIGN HELIO POSITION TO 'CH' ARRAY
1720  CH(I)=SS
1730  REM COMPUTE HELIO DAILY MOTION IN RADIANS
1740  XK=(XX*YH-YY*XH)/(XX*XX+YY*YY)
1750  REM STORE EARTH/SUN COORDINATES, ASSIGN 'SUN
      ' TO CS(1)
1760  IF I=1 THEN CS(1)="SUN":X1=XX:Y1=YY:Z1=ZZ:GOTO
      1820
1770  REM CONVERT HELIO TO GEOCENTRIC RECTANGULAR
      COORDINATES
1780  XX=XX-X1:YY=YY-Y1:ZZ=ZZ-Z1
1790  REM CALCULATE GEOCENTRIC DAILY MOTION
1800  XK=(XX*YW-YY*XW)/(XX*XX+YY*YY)
1810  REM CALCULATE ABERRATION 'BR'
1820  BR=.0057683*SQR(XX*XX+YY*YY+ZZ*ZZ)*RD*XK
1830  REM IF 'XK' NEGATIVE, SET RETROGRADE FLAG
1840  IF XK<0 THEN RS=" [18]R[146]"
1850  REM CONVERT RECTANGULAR TO SPHERICAL COORDIN
      ATES
1860  GOSUB 2310
1870  REM ASSIGN LONGITUDE TO 'C' ARRAY, LATITUDE
       TO 'M' ARRAY
1880  C(I)=SS:M(I)=P:PRINT
1890  REM STORE AS NEGATIVE NUMBER IF RETROGRADE
1900  IF XK<0 THEN C(I)=-SS
1910  NEXT I
1920  REM PRINT OUT MOON AND NODE POSITIONS
1930  C=C(2):P=LT:PRINT TAB(19);:I=2:RS="  ":GOSUB
      2420
1940  P=0:C=C(11):I=11:PRINT :PRINT TAB(19);:GOSUB
      2420:PRINT
1950  REM MENU TITLE
1960  PRINT "[17][18]W[146]HEEL [18]N[146]EW [18]M
      [146]ORE [18]R[146].A.";:GOTO 2440
1970  REM LUNAR ROUTINE
1980  MO=360:LL=973563+1732564379*T-4*T*T:G=101239
      5+6189*T:M=3600
1990  G1=1203586+14648523*T-37*T*T:L=(LL-G1)/M:D=1
      262655+1602961611*T-5*T*T
2000  L1=((LL-D)-G)/M:F=(LL-LN*M)/M:ML=22639.6*FNS
      (L)
2010  D=D/M:Y=2*D:ML=ML-4586.4*FNS(L-Y)+2369.9*FNS
      (Y)+769*FNS(2*L)-669*FNS(L1)
2020  REM 'ML' IS LUNAR LONGITUDE
2030  ML=ML-411.6*FNS(2*F)-212*FNS(2*L-Y)-206*FNS(
      L+L1-Y)+192*FNS(L+Y)
2040  ML=ML-165*FNS(L1-Y)+148*FNS(L-L1)-125*FNS(D)
      -110*FNS(L+L1):RS="  "
2050  REM 'P' IS LUNAR LATITUDE
2060  P=18465*FNS(F)+1010*FNS(L+F)-999*FNS(F-L)-62
      4*FNS(F-Y)+199*FNS(F+Y-L)
2070  P=P-167*FNS(L+F-Y)+117*FNS(F+Y)+62*FNS(2*L+F
      )-33*FNS(F-Y-L)
2080  LT=(P-32*FNS(F-2*L)-30*FNS(L1+F-Y)-45*FNS(L
      2*F)+40*FNS(L-2*F))/M:M(2)=LT
2090  C(2)=FNU((LL+ML-55*FNS(2*F-Y))/M+SD):C(11)=FN
      U(LN+SD):GOTO 1910
```

```
2100  REM ROUTINE TO CONVERT DEGREE/DECIMAL TO ZOD
      IAC NOTATION
2110  U=ABS(C):Z3=INT(U)
2120  REM 'Q' IS THE NUMBER OF THE ZODIAC SIGN FRO
      M 1 TO 12
2130  Q=INT(Z3/30)+1
2140  REM 'XS' IS THE DEGREES
2150  XS=RIGHT$(STR$(1000+INT(FNW((Z3/30-INT(Z3/30
      ))*30))),2)
2160  REM 'ZZS' IS THE MINUTES
2170  ZZS=RIGHT$(STR$(1000+INT(((U-Z3)*60+.5))),2)
2180  REM 'BS' CONTAINS THE TWO-LETTER ZODIAC SIGN
2190  BS=MID$(ZAS,Q*2-1,2)
2200  REM 'AS' INDICATES THE SIGN OF THE LATITUDE
      FACTOR
2210  AS="+":IF C<0 THEN AS="-"
2220  REM 'DS' USED FOR LATITUDE & DECLINATION SIG
      N
2230  DS=AS+XS+" "+RIGHT$(ZZS,2)
2240  REM RIGHT ASCENSION FORMAT IN 360-DEGREE NOT
      ATION
2250  IF EQ=1 THEN BS=" ":XS=RIGHT$("  "+STR$(Z3),
      3)
2260  REM READ AND CALCULATE DATA VALUES
2270  ZS=LEFT$(CS(I),2)+" "+XS+BS+RIGHT$(ZZS,2)
2280  REM DEGREES-ZODIAC SIGN-MINUTES STRING
2290  AS=RIGHT$(ZS,6):RETURN
2300  REM RECTANGULAR TO SPHERICAL CONVERSION ROUT
      INE
2310  X=XX:Y=YY:GOSUB 2570
2320  REM ADD NUTATION AND ABERRATION TO POSITION
2330  K=A:C=RD*A+NU-BR
2340  REM ADD 180-DEGREES IF EARTH/SUN
2350  IF I=1 AND AB=1 THEN C=FNU(C+180)
2360  REM STORE PLANET LONGITUDE IN 'C' AND 'SS'
2370  C=FNU(C+SD):SS=C
2380  REM CALCULATE PLANET LATITUDE
2390  Y=ZZ:X=R:GOSUB 2570:IF A>.35 THEN A=A-2*PI
2400  P=RD*A
2410  REM PRINT LONGITUDE & LATITUDE
2420  GOSUB 2110:PS=ZS+RS:C=P:GOSUB 2110:PRINT PSD
      $"  ";:RETURN
2430  REM MENU SELECTION ROUTINE
2440  GOSUB 3040:REM GET ROUTINE
2450  REM SELECT FOR MORE OPTIONS
2460  IF QS="M" THEN 2880
2470  REM SELECT RIGHT ASCENSION & DECLINATION
2480  IF QS="R" THEN 5170
2490  REM SELECT BETWEEN TWO HOUSE SYSTEMS
2500  IF QS="W" THEN PRINT " [18]K[146]OCH [18]P[146]
      LACIDUS";:GOTO 4040
2510  GOTO 2440
2520  REM READS ORBITAL ELEMENTS
2530  READ S,S1,S2:S=DR*(S+S1*T+S2*T*T):RETURN
2540  REM POLAR TO RECTANGULAR COORDINATE CONVERSI
      ON
2550  X=R*COS(A):Y=R*SIN(A):RETURN
2560  REM RECTANGULAR TO POLAR CONVERSION
2570  R=SQR(X*X+Y*Y):A=ATN(Y/(X-1E-9*(X=0)))-PI*(X
      <0)-2*PI*(A<0):RETURN
2580  REM HARMONIC TERMS FOR OUTER PLANET ROUTINE
2590  K(6)=11:K(7)=5:K(8)=4:K(10)=4:K(9)=4
2600  FOR IK=1TO3:IF I=6 AND IK=3 THEN T(3)=0:RETURN
2610  IF IK=3 THEN K(I)=K(I)-1
2620  GOSUB 2530:A=0:FOR IJ=1TOK(I):READ U,V,W
2630  A=A+DR*U*COS((V*T+W)*PI/180):NEXT IJ:T(IK)=R
      D*(S+A):NEXT IK:RETURN
2640  REM ROTATE ROUTINE USED FOR POSITION & VELOC
      ITY COORDINATES
2650  GOSUB 2570:A=A+AP:GOSUB 2550:D=X:X=Y:Y=0:GOSUB
      2570:A=A+IN:GOSUB 2550:G=Y:Y=X:X=D
2660  GOSUB 2570:A=A+AN:IF A<0 THEN A=A+2*PI
2670  GOSUB 2550:RETURN
2680  REM LUNAR NODE 'LN' AND NUTATION 'NU' ROUTIN
      E
2690  LN=FNU(259.1833-1934.1419*T):MS=FNU(279.6967
      +36000.76*T)
2700  NU=(-(17.2327+.01737*T)*FNS(LN)-1.273*FNS(2*
      MS))/3600:RETURN
```

```
2710  REM COORDINATE CONVERSION ROUTINE, INPUT L=L
      ONG VALUE, B= LATITUDE VALUE
2720  REM OUTPUT 'G'= LONG VALUE, 'Q'= LAT VALUE
2730  A=B:R=1:GOSUB 2550:Q=Y:R=X:A=L:GOSUB 2550:G=
      X:X=Y:Y=Q:GOSUB 2570
2740  A=A+O:GOSUB 2550:Q=FNX(Y):Y=X:X=G:GOSUB 2570
      :IF A<0 THEN A=A+2*PI
2750  G=A:RETURN
2760  REM CHART ANGLES SUBROUTINE: MIDHEAVEN, ASCE
      NDANT AND VERTEX
2770  REM MIDHEAVEN ROUTINE
2780  A=R2:R=1:GOSUB 2550:X=X*COS(O):GOSUB 2570:MC
      =FNU(SD+RD*A)
2790  REM ASCENDANT ROUTINE
2800  L=R2:GOSUB 2730:AS=FNU(SD+RD*(G+PI/2))
2810  REM VERTEX ROUTINE
2820  L=R2+PI:B=PI/2-ABS(B):IF LA<0 THEN B=-B
2830  GOSUB 2730:VT=FNU(SD+RD*(G+PI/2)):RETURN
2840  REM ELIMATES NEGATIVE NUMBERS DUE TO RETROGR
      ADE ASSIGNMENT
2850  FOR I=1TO10:C(I)=ABS(C(I)):NEXT I:RETURN
2860  REM BEGIN MORE OPTIONS ROUTINE
2870  REM STRINGS USED FOR GRID DISPLAY
2880  P1$="[145]   *   *   *[160][160][160]*[160][160]
      [160]*   *   *[160] [160]*[160][160][160]* "
      :GOSUB 2850
2890  P2$="----------------------------------------
      -"
2900  REM SELECT GEO OR HELIO POSITIONS
2910  PRINT "[147][18]G[146]EO OR [18]H[146]ELIO [18]
      N[146]EW":GOSUB 3040:IF QS="H" THEN 3990
2920  REM GEO VARIABLE SET-UP
2930  NM=45:CN=9:NN=10
2940  REM GRID, ANGULAR SEPARATION AND ASPECT NAME
       ROUTINES
2950  GOSUB 3440:GOSUB 3100:GOSUB 3590
2960  REM MENU SELECTION
2970  PRINT "[18]M[146]IDPT GRID [18]C[146]ONT [18]
      R[146]UN":GOSUB 3040
2980  REM MIDPOINT ROUTINE
2990  IF QS="M" THEN GOSUB 3150:GOSUB 3040
3000  REM OPTION SELECTION
3010  IF QS="R" THEN 2880
3020  GOTO 3210
3030  REM 'GET' ROUTINE
3040  GETQS:IF QS="" THEN 3040
3050  REM RUN PROGRAM FROM START
3060  IF QS="N" THEN RUN 600
3070  RETURN
3080  REM ANGULAR SEPARATION IN GRID ROUTINE
3090  REM 'TS' USED FOR CURSOR PLACEMENT
3100  TS="[19][17]":Y=3:FOR I=1TONN:PRINT TSSPC(Y)
      ;
3110  FOR J=I+1TONN:IF I=NN AND J=NN+1 THEN 3130
3120  GOSUB 3500:PRINT SPC(1)AS;
3130  NEXT J:Y=Y+4:TS=TS+"[17][17]":PRINT :PRINT :
      NEXT I:RETURN
3140  REM MIDPOINT GRID ROUTINE
3150  PRINT UP$TAB(8)"[145][145][145]---- MIDPOINT
      S":TS="[19][17][17]":Y=40:A=1:N=CN
3160  FOR J=1TONN:WS=TS:PRINT TS;:FOR I=J+1TONN:IF
      J=NN AND I=NN+1 THEN PRINT :RETURN
3170  GOSUB 3760:PRINT WSSPC(Y)RIGHT$("  "+STR$(INT
      (M(A)+.5)),3)"*"
3180  WS=WS+"[17][17]":NEXT I:N=N-1:Y=Y+4:TS=TS+"[17]
      [17]":PRINT :PRINT :NEXT J:RETURN
3190  REM SORTED MIDPOINTS ROUTINE
3200  REM INPUT VALUE FOR SORT DIAL
3210  INPUT"ENTER DIAL 360=360";MO
3220  REM SELECT FOR GEO OR HELIO
3230  RT=13:IF NN=9 THEN RT=9
3240  REM ASSIGN MIDPOINTS TO SORTING ARRAY
3250  A=1:FOR I=1TORT:FOR J=I+1TORT:GOSUB 3760:A=A
      +1:NEXT J:NEXT I:GOSUB 3640:MO=360
3260  REM DISPLAY MIDPOINTS ROUTINE
3270  PRINT "[147]";
3280  PRINT "[19][18]Z[146]OD/[18]3[146]60 [18]M[146]
      ORE":GOSUB 3040:XC=0:IF QS="3" THEN QE=1:XC=
      1
3290  IF QS="M" THEN 2880
```

```
3300  PRINT "[147]------------ MIDPOINT SORT ------
      ----"
3310  XZ=0:Y=1:A=1:FOR I=1TO4:PRINT "[19][17]";:FOR
      JI=1TO23
3320  REM GEO OUT
3330  IF A=79 AND NN=10 THEN 3430
3340  REM HELIO OUT
3350  IF A=37 AND NN=9 THEN 3430
3360  REM ROUND MIDPOINT AND PRINT
3370  C=M(A)+.5:GOSUB 2110
3380  IF M(A)>=XZ THEN PRINT SPC(Y)"[157] [18]"BS"
      [146]":XZ=Q*30:JI=JI+1
3390  PX=M(A):GOSUB 3850
3400  REM 360-DEGREE NOTATION FLAG
3410  IF XC=1 THEN XS=RIGHT$(" "+STR$(INT(C)),3)
3420  PRINT SPC(Y)"[157]"XS" "YY$:A=A+1:NEXT JI:Y=
      Y+10:NEXT I
3430  GOTO 3280
3440  PRINT "[147]";"---------------- ASPECTS ----
      ----------":PRINT
3450  PRINT P1$
3460  FOR I=1TO9:PRINT P2$:PRINT P1$:NEXT I
3470  PRINT "-------- MAJOR ASPECTS --------------
      --"
3480  Y=0:PRINT "[19]";:FOR I=1TONN:PRINT TAB(Y)"[17]
      ""[18]"C$(I)"[146]":Y=Y+4:NEXT I:RETURN
3490  REM OUTPUT ROUNDED ANGULAR SEPARATION IN PRI
      NT STRING
3500  X=ABS(C(I)-C(J)):IF X>180 THEN X=360-X
3510  AS=RIGHT$("   "+STR$(INT(X+.5)),3):RETURN
3520  REM RETURNS ASPECT LETTER NAME IF WITHIN RAN
      GE
3530  AS=ABS(C(I)-C(J)):IF AS>180 THEN AS=360-AS
3540  AS="    ":FOR W=1TO9:X=ABS(AS-VAL(RIGHT$(AS(W
      ),3))):
3550  XY=VAL(MID$(AS(W),4,1)):IF X<XY THEN AS=LEFT$
      (AS(W),3):GOTO 3570
3560  NEXT W
3570  RETURN
3580  REM PRINT ASPECT NAMES IN GRID
3590  T$="[19][17][17]":Y=40:N=CN:FOR J=1TONN
3600  WS=T$:FOR I=J+1TONN:IF J=NN AND I=NN+1 THEN
      RETURN
3610  GOSUB 3530:PRINT WSSPC(Y)AS"*":WS=WS+"[17][17]
      ":NEXT I:N=N-1:Y=Y+4:T$=T$+"[17][17]"
3620  PRINT :PRINT :NEXT J:RETURN
3630  REM SHELL-METZNER SORT
3640  N=78:IF NN=9 THEN N=36
3650  M=N
3660  M=INT(M/2):IF M=0 THEN 3740
3670  J=1:K=N-M
3680  I=J
3690  L=I+M:IF M(I)<M(L) THEN 3720
3700  X=M(I):M(I)=M(L):M(L)=X:I=I-M:IF I<1 THEN 37
      20
3710  GOTO 3690
3720  J=J+1:IF J>K THEN 3660
3730  GOTO 3680
3740  RETURN
3750  REM MIDPOINT SUB
3760  W=0:X=ABS(C(I)-C(J)):IF X<=180 THEN GOTO 379
      0
3770  W=180:IF (C(I)+C(J))/2<180GOTO 3790
3780  W=-180
3790  X=FNU((C(I)+C(J))/2+W):X=(INT((X+.01)*100)/1
      00)+.001
3800  REM STORE MIDPOINT AND PLANET INDICATOR IN S
      TRING ARRAY
3810  M$=LEFT$(STR$(X),8)
3820  MA$=STR$(A):IF A<10 THEN MA$="0"+RIGHT$(MA$,
      1)
3830  M(A)=VAL(STR$(VAL(M$+MA$+"9"))):RETURN
3840  REM ROUTINE TO PULL OUT MIDPOINT COMBINATION
      S
3850  M$=STR$(PX)
3860  REM REMOVES ACCIDENTAL CHARACTERS FROM END O
      F STRING
3870  IF RIGHT$(M$,1)<>"9" THEN X=LEN(M$):M$=LEFT$
      (M$,X-1):GOTO 3870
3880  REM BACK OUT PLANETARY COMBINATION FROM SORT
       ARRAY
```



```
3890  A$=RIGHT$(M$,3):X=VAL(LEFT$(A$,2))
3900  REM GEO OR HELIO IN 'RT'
3910  RT=12:IF NN=9 THEN RT=8
3920  REM STEP DOWN ROUTINE
3930  T=1:FOR K=RTTO1STEP-1:IF X<=K THEN 3960
3940  X=X-K:T=T+1:NEXT K
3950  REM CREATE FINAL OUTPUT STRING FOR PRINT TO
      SCREEN
3960  Y1$=Y$+STR$(Z1)+" ":YY$=LEFT$(C$(T),2)+"/"+LEFT$
      (C$(T+ABS(X)),2):RETURN
3970  REM HELIO SET-UP ROUTINE
3980  REM RETURNS IF HELIO SET-UP HAS TAKEN PLACE
3990  IF LT=1 THEN 2950
4000  REM POSITIONS HELIO PLANETS & NAMES STRINGS
4010  LT=1:NM=36:CN=8:NN=9:C$(1)="EAR":FOR K=2TO9:
      C(K)=CH(K+1):C$(K)=C$(K+1)
4020  C(1)=CH(1):C$(1)="EAR":NEXT K:C$(10)="    ":GOTO
      2950
4030  REM READS HOUSE PRINT POSITIONS INTO 2 DIMES
      ION 'R' ARRAY
4040  FOR I=1TO12:FOR J=1TO2:READ R(I,J):NEXT J:NEXT
      I:GOSUB 2850
4050  REM CHOICE OF HOUSE SYSTEM AND BRANCH IF KOC
      H IS SELECTED
4060  GOSUB 3040:PRINT " OK":IF Q$="K" THEN 5090
4070  REM PLACIDUS HOUSE ROUTINE
4080  Y=0:R1=RA+DR*30:FF=3:GOSUB 4150:M(5)=FNU(L+1
      80):HS$="PLACIDUS "
4090  R1=RA+DR*60:FF=1.5:GOSUB 4150:M(6)=FNU(L+180
      ):FF=1:GOSUB 4150:M(1)=L
4100  R1=RA+DR*120:FF=1.5:Y=1:GOSUB 4150:M(2)=L:R1
      =RA+DR*150:FF=3
4110  GOSUB 4150:M(3)=L:M(4)=FNU(MC+180-SD):FOR I=
      1TO6:M(I)=FNU(M(I)+SD):NEXT I
4120  FOR I=1TO6:C=FNU(M(I)+180):M(I+6)=C:GOSUB 21
      10:HS(I+6)=AS
4130  C=M(I):GOSUB 2110:HS(I)=AS:NEXT I:GOTO 4220
4140  REM SUBROUTINE USED IN PLACIDUS ROUTINE FOR
      ITERATIONS
4150  X=-1:IF Y=1 THEN X=1
4160  FOR I=1TO10:XX=FNY(X*SIN(R1)*TAN(OB)*TAN(LA)
      ):IF XX<0 THEN XX=XX+PI
4170  R2=RA+(XX/FF):IF Y=1 THEN R2=RA+PI-(XX/FF)
4180  R1=R2:NEXT I:L=ATN(TAN(R1)/COS(OB)):IF L<0 THEN
      L=L+PI
4190  IF SIN(R1)<0 THEN L=L+PI
4200  L=RD*L:RETURN
4210  REM RECTANGULAR CHART WHEEL FORMAT ROUTINE
4220  PRINT "[147]";:FOR I=1TO5
4230  PRINT K$"[18]"MID$(HS(11),I,1)"[146]"K$"[18]
      "MID$(HS(10),I,1)"[146]"K$;
4240  PRINT "[18]"MID$(HS(9),I,1)"[146]":NEXT I:PRINT
      "[18] "HS(12)"  "MID$(HS(11),6);
4250  PRINT K$MID$(HS(10),6,1)K$MID$(HS(9),6,1)"
      "HS(8)" [146]"
4260  FOR I=1TO5:PRINT TAB(9)"[18] [146]"TAB(29)"[18]
       [146]":NEXT I
4270  PRINT "[18] "HS(1)"   [146]"TAB(29)"[18]""
      "HS(7)" [146]"
4280  FOR I=1TO5:PRINT TAB(9)"[18] [146]"TAB(29)"[18]
       [146]":NEXT I
4290  PRINT "[18] "HS(2)"  "MID$(HS(3),1,1)HS$MID$
      (HS(4),1,1);
4300  PRINT " HOUSES  "MID$(HS(5),1,1)"  "HS(6)" [146]
      ":FOR I=1TO5:PRINT K$;
4310  PRINT "[18]"MID$(HS(3),I+1,1)"[146]"K$"[18]"
      MID$(HS(4),I+1,1)"[146]"K$;
4320  PRINT "[18]"MID$(HS(5),I+1,1)"[146]":NEXT I:
      PRINT OSTAB(15)E$
4330  REM REMOVE RETRO FLAG IF PRESENT
4340  FOR I=1TO11:K(I)=ABS(C(I)):NEXT I
4350  REM SORT PLANETS IN ZODIAC ORDER, STORE IN '
      K' ARRAY
4360  FOR I=1TO11-1:FOR J=I+1TO11:IF K(J)>=K(I) THEN
      4380
4370  K1=K(I):K(I)=K(J):K(J)=K1
4380  NEXT J:NEXT I
4390  REM MATCH SORTED PLANETS WITH PLANET NAMES A
      ND RETRO/DIRECT STATUS
4400  A=1:FOR I=1TO11:FOR J=1TO11
```

```
4410  IF K(A)=ABS(C(J)) THEN GOSUB 4950:H$(A)=LEFT$
      (C$(J),2)+R$
4420  NEXT J:A=A+1:NEXT I
4430  REM PLACEMENT ON PLANETS IN APPROPRIATE HOUS
      ES ROUTINE
4440  REM 'HH' IS SUBSEQUENT HOUSE CUSP
4450  AB=0:M(13)=M(1):FOR I=1TO12:HH=M(I+1)
4460  REM CHECK FOR ZERO ARIES POINT AND SET FLAG
      IF PRESENT
4470  IF M(I)>M(I+1) THEN HH=M(I+1)+360:AB=1
4480  REM 'GG', 'G' USED FOR HOUSE OVERFLOW
4490  I$=OS:GG=0:G=0
4500  REM POSITION CURSOR AT TOP OF APPROPRIATE HO
      USE
4510  PRINT LEFT$(QW$,R(I,2));
4520  REM ROUTINE TO CHECK PLANETS FOR EACH HOUSE
4530  FOR J=1TO11:CC=K(J)
4540  REM IF ZERO ARIES FLAG SET AND THIS PLANET <
       90 DEGREES, ADD 360
4550  IF AB=1 AND CC<90 THEN CC=CC+360
4560  REM HOUSE OVERFLOW FLAG SET HERE
4570  IF G>4 THEN GG=1
4580  REM PRINTS PLANET IF IN HOUSE
4590  IF CC>M(I) AND CC<HH THEN GOSUB 4980:G=G+1
4600  NEXT J:AB=0:NEXT I
4610  REM POSITION CURSOR FOR ASPECT ROUTINE
4620  PRINT LEFT$(QW$,16);:GOTO 4840
4630  REM PRINT ASPECT ROUTINE HEADER
4640  PRINT "[19][17][17][17][17][17]"TAB(13)"[18]
      "C$(I)"[146]"SPC(8)"[18]MIDPT[146]":L=L+1
4650  REM PLANET LOOP, IGNORES MATCHES
4660  FOR J=1TO11:IF C(I)=C(J) THEN 4820
4670  REM PRINT MENU PLANET KEY NUMBER AND NAME
4680  PRINT TAB(10)"[18]"+CHR$(J+48)+"[146]"C$(J)"
      ";
4690  REM 'AS' IS ANGULAR SEPARATION
4700  AS=ABS(C(I)-C(J)):IF AS>180 THEN AS=360-AS
4710  REM ASPECT LOOP
4720  FOR K=1TO8
4730  REM 'D' IS DIFFERENCE BETWEEN ANGULAR SEPARA
      TION AND PERFECT ASPECT
4740  D=ABS(AS-VAL(RIGHT$(A$(K),3))):XS="   *"
4750  REM IF WITHIN ASPECT ORB, PRINT ASPECT NAME
      AND LEAVE LOOP
4760  IF D<VAL(MID$(A$(K),4,1)) THEN PRINT "[157]*
      "LEFT$(A$(K),3);:K=9:X$="*":GOTO 4790
4770  NEXT K
4780  REM PRINT ROUNDED ANGULAR SEPARATION
4790  PRINT X$RIGHT$("   "+STR$(INT(AS+.5)),3)"[221]
      ";
4800  REM MIDPOINT ROUTINE

4810  GOSUB 3760:C=X:GOSUB 2110:PRINT A$
4820  NEXT J
4830  REM ASPECT MENU ROUTINE
4840  ZX=11:PRINT USTAB(12)"[18]A[146]SPECTS [18]N
      [146]EW [18]M[146]ORE":I=1
4850  GOSUB 3040
4860  REM ERASE PORTION OF SCREEN
4870  PRINT "[19][17][17][17][17][17][17][17]";:FOR K=
      1TO11:PRINT TAB(10)"                    ":NEXT
      K
4880  REM IF 'GET' CHARACTER ON MENU, SET 'I'
4890  IF ASC(Q$)>48 AND ASC(Q$)<60 THEN I=ASC(Q$)-
      48
4900  REM BRANCH TO OTHER OPTIONS
4910  IF Q$="M" THEN 2880
4920  REM BRANCH TO BEGINNING ASPECT ROUTINE
4930  GOTO 4640
4940  REM SET RETROGRADE/DIRECT STATUS
4950  R$=" ":IF C(J)<0 THEN R$="[18]R[146]"
4960  RETURN
4970  REM PRINT PLANET IN HOUSE ROUTINE
4980  C=K(J):GOSUB 2110
4990  REM OVERFLOW PRINTS EXTRA PLANETS IN HOUSE C
      ENTER
5000  IF GG=1 THEN PRINT I$;TAB(17);STR$(I);:GG=0:
      I$="":GOTO 5030
5010  REM PRINT PLANET NAME
5020  PRINT TAB(R(I,1));
5030  PRINT H$(J)A$:RETURN
```

```
5040  REM SIDEREAL 'AYANAHMSA' ROUTINE
5050  SD=(259205536*T+2013816)/3600
5060  SD=17.23*SIN(DR*C(11))+1.27*SIN(DR*SD)TAB((5
      025.64+1.11*T)*T
5070  SD=(SD-84038.27)/3600:RETURN
5080  REM KOCH HOUSE ROUTINE
5090  MO=360:A1=FNX(SIN(RA)*TAN(LA)*TAN(OB)):FOR I
      =1TO12:D=FNU(60+30*I)
5100  A2=D/90-1:KN=1:IF D>=180 THEN KN=-1:A2=D/90-
      3
5110  A3=DR*FNU(RD*RA+D+A2*RD*A1)
5120  X=ATN(SIN(A3)/(COS(A3)*COS(OB)-KN*TAN(LA)*SIN
      (OB))):IF X<0 THEN X=X+PI
5130  IF SIN(A3)<0 THEN X=X+PI
5140  REM ASSIGN HOUSE POSITION TO REAL AND STRING
       ARAYS
5150  C=FNU(RD*X+SD):M(I)=C:GOSUB 2110:H$(I)=AS:NEXT
      I:HS$="  KOCH   ":GOTO 4220
5160  REM RA & DECLINATION ROUTINE
5170  PRINT O$;:FOR I=1TO14:PRINT "
        ":NEXT I:RS="  "
5180  PRINT O$;"EQUATORIAL SPACE":PRINT "   R.A.
        DECL":PRINT
5190  REM TRANSFORM LONG & LAT TO RA & DECL
5200  REM LONG=C(I), LAT=M(I), RA=C, DECL=P
5210  EQ=1:O=OB:FOR I=1TO11:L=DR*FNU(ABS(C(I))-SD)
      :B=DR*M(I):GOSUB 2730
5220  P=RD*Q:C=RD*G:GOSUB 2420:PRINT :NEXT I:EQ=0:
      GOTO 2440
```

```
------------ ASPECTS ------------
SUN* 62* 18* 24*107* 44* 60* 56* 60*  8
-------------------------------------
 85*MON* 44* 86* 44* 18*  3*  6*122* 70
-------------------------------------
107* 75*MER* 43* 88* 26* 41* 38* 78* 26
-------------------------------------
128* 97*119*VEN*131* 68* 84* 81* 35* 16
-------------------------------------
 62* 31* 53* 75*MAR* 63* 47* 50*166*115
-------------------------------------
 94* 63* 85*106* 40*JUP* 16* 12*104* 52
-------------------------------------
 86* 55* 77* 98* 33* 64*SAT*  3*119* 68
-------------------------------------
 88* 56* 78*100* 34* 66* 58*URA*116* 64
-------------------------------------
146*114*136*158* 92*124*116*117*NEP* 52
-------------------------------------
120* 89*111*132* 66* 98* 90* 92*150*PLU
------------ MIDPOINTS ----------

MIDPT GRID CONT RUN
```

```
ZOD/360 MORE MIDPOINT SORT ---------
 TA       29 MO/PL  28 UR/NO  23 ME/AS
01 MO/MA  00 SA/PL  29 ME/VE  25 NE/MC
03 MA/SA   CA       00 SU/PL  26 NO/MC
04 MA/UR  02 UR/PL   LE       26 NE/NO
10 MA/JU  02 MA/MC  04 JU/MC   LI
23 ME/MA  02 MA/NE  04 JU/NE  02 SU/AS
25 MO/SA  02 MA/NO  04 JU/NO  06 PL/AS
26 MO/UR  04 SU/JU  08 SU/VE  14 VE/AS
28 SA/UR  07 MO/VE  12 VE/PL   SC
 GE       08 JU/PL  16 ME/MC  02 AS/MC
02 SU/MA  08 VE/SA  16 ME/NE  02 NE/AS
03 MO/JU  10 VE/UR  17 ME/NO  02 NO/AS
04 JU/SA  16 VE/JU  26 SU/MC   AQ
06 JU/UR  17 SU/ME  26 SU/NE  09 MA/AS
06 MA/PL  21 ME/PL  26 SU/NO   PI
15 VE/MA  24 MO/MC  00 PL/MC  01 MO/AS
15 MO/ME  24 MO/NE  00 NE/PL  02 SA/AS
17 ME/SA  25 MO/NO  00 PL/NO  04 UR/AS
18 ME/UR  26 SA/MC   VI
25 ME/JU  26 SA/NE  08 VE/MC
25 SU/MO  26 SA/NO  08 VE/NE
26 SU/SA  27 UR/MC  08 VE/NO
28 SU/UR  27 UR/NE  10 JU/AS
```

```
860 E$= 07.181941
860 X,Y,Z= 7  18  1941
880 A$= PM
900 U= 4.03
920 V= 5
940 C,L5= 76.18  76.3
960 C,LA= 40.02  .698713477
980 DT= 24
1000 U= 9.05
1020 U= 21.05
1040 JD= 2430193.5
1050 JD,C= 2430193.5  15174.3771
1070 T= .415451802
1090 RA= 3.06699085
2690 LN= 175.640562
1130 OB= .409225393
1170 T= .41545181
2780 X,MC=-.914877553  175.342552
2800 AS= 248.01248
2820 B= .872082848
2110 U,Z3= 175.342552  175
2130 Q= 6
2150 X$= 25
2170 ZZ$= 21
2190 B$= VI
2210 A$= +
2230 D$= +25 21
2270 Z$= EA 25VI21
1340 M= 3.39198033
1360 E= .0167333819
1380 EA= 3.38790032
1400 AU= 1
1420 E1= .0169273864
1440 AP= 1.77910366
1460 XW,YW= 4.12731539E-03 -.0164142077
1480 AN= 0
1500 IN= 0
2650 G,Y,X= 0  7.43261838E-03  .0152058255
2660 A= .454648106
1540 XH,YH,ZH= .0152058255  7.43261838E-03  0
1620 X,Y=-.986552696 -.24379059
2650 G,Y,X= 3.34572607E-09 -.914808864  .442543577
2660 A= 5.16295652
1640 XX,YY,ZZ= .442543571 -.914808867  3.34572607E-09
1660 XX,YY,ZZ= .442543571 -.914808867  3.34572607E-09
2310 X,Y= .442543571 -.914808867
2330 K,C=-1.12022879 -64.184465
2350 C=-64.184465
2370 C,SS= 295.815535  295.815535
2390 Y,X,A= 3.34572607E-09  1.01622836  3.7252903E-09
2400 P= 2.13443412E-07
2110 U,Z3= 295.815535  295
2130 Q= 10
2150 X$= 25
2170 ZZ$= 49
2190 B$= CP
2210 A$= +
2230 D$= +25 49
2270 Z$= EA 25CP49
1720 C(I)= 295.815535
1740 XK= .0166547373
1820 BR= 5.59370512E-03
2310 X,Y= .442543571 -.914808867
2330 K,C=-1.12022879 -64.1900587
2350 C= 115.809941
2370 C,SS= 115.809941  115.809941
2390 Y,X,A= 3.34572607E-09  1.01622836  3.7252903E-09
2400 P= 2.13443412E-07
2110 U,Z3= 115.809941  115
2130 Q= 4
2150 X$= 25
2170 ZZ$= 49
2190 B$= CA
2210 A$= +
2230 D$= +25 49
2270 Z$= SU 25CA49
```



```
1880 C(I),M(I)= 115.809941  2.13443412E-07
1980 LL,G= 720770570  1014966.23
1990 G1,L,D 7289335.01  198189.232  667215957
2000 L1,F,ML 14594.3462  200038.407 -3631.97341
2010 D,Y,ML= 185337.766  370675.532 -1860.70126
2030 ML=-2291.18202
2040 ML=-2129.11613
2060 P=-15773.8895
2070 P=-15695.96
2080 LT,M(2)=-4.33111566 -4.33111566
1340 M= 4.90274088
1360 E= .205618309
1380 EA= 4.69714646
1400 AU= .387098
1420 E1= .0712017823
1440 AP= .504533829
1460 XW,YW= .0275588658 -4.11122596E-04
1480 AN= .831444222
1500 IN= .122237379
2650 G,Y,X= 1.58050328E-03  .0128653239  .0243237652
2660 A= 1.31795921
1540 XH,YH,ZH= 6.88332398E-03  .0266417335  1.58050328E-03
1580 XA,YA,ZA=-.0152058255  -7.43261838E-03  0
1600 XW,YW,ZW=-8.32250158E-03  .0192091151  1.58050328E-03
1620 X,Y=-.0854945577 -.378782586
2650 G,Y,X=-.0454706261 -.370131692  .108261349
2660 A= 5.82838973
1640 XX,YY,ZZ= .346439764 -.169403305 -.0454706261
1660 XX,YY,ZZ= .346439764 -.169403305 -.0454706261
2310 X,Y= .346439764 -.169403305
2330 K,C=-.454795578 -26.0579505
2350 C=-26.0579505
2370 C,SS= 333.94205  333.94205
2390 Y,X,A=-.0454706261  .385639715 -.117367698
2400 P=-6.72467375
2110 U,Z3= 333.94205  333
2130 Q= 12
2150 X$= 03
2170 ZZ$= 57
2190 B$= PI
2210 A$= +
2230 D$= +03 57
2270 Z$= ME 03PI57
2110 U,Z3= 6.72467375  6
2130 Q= 1
2150 X$= 06
2170 ZZ$= 43
2190 B$= AR
2210 A$= -
2230 D$= -06 43
2270 Z$= ME 06AR43
1720 C(I)= 333.94205
1740 XK= .069902866
1760 X1,Y1,Z1= .442543571 -.914808867  3.34572607E-09
1780 XX,YY,ZZ=-.0961038078  .745405562 -.0454706295
1800 XK= 7.71435089E-03
1820 BR= 1.91971041E-03
2310 X,Y=-.0961038078  .745405562
2330 K,C= 7.98220251  457.344513
2350 C= 457.344513
2370 C,SS= 97.3445125  97.3445125
2390 Y,X,A=-.0454706295  .751575275 -.0604267779
2400 P=-3.46219935
2110 U,Z3= 97.3445125  97
2130 Q= 4
2150 X$= 07
2170 ZZ$= 21
2190 B$= CA
2210 A$= +
2230 D$= +07 21
2270 Z$= ME 07CA21
2110 U,Z3= 3.46219935  3
2130 Q= 1
2150 X$= 03
2170 ZZ$= 28
2190 B$= AR
2210 A$= -
2230 D$= -03 28
2270 Z$= ME 03AR28
1880 C(I),M(I)= 97.3445125 -3.46219935
1340 M= .766740218
1360 E= 6.79922741E-03
1380 EA= .771480622
1400 AU= .7233
1420 E1= .0281012438
```

ABOUT PRINTERS

Charles A. Jayne

There is a wide variety of printers that will enable you to output your microcomputer in hard copy. Line Printers print a whole line at a time and are fast to extremely fast. Pricewise they are more expensive than the serial printers that most owners of Microcomputers buy. A Serial Printer prints one character (byte) at a time. Usually the least expensive printers are the thermal ones that operate by a heat process. They tend to be rather slow and one can't make any copies of the original. A somewhat different process is used by COMPRINT, a fast printer (222 characters per second or 225 cps) which is limited to 80 columns. But it does require special silvery (aluminized) paper and one can only print the original. The print quality is fairly good as it is a 9x11 matrix printer.

A large number of printers are of the matrix type, the head varying from a low 5x7- typical of the cheaper ones- to as much as 18x24. With a 5x7 print head the matrix is so coarse that the dots that make up the characters do not give a very high quality of printing. On the other hand one can make several copies at the same time and many of them also have GRAPHIC capabilities such as is the case with the $795 Commodore Printer with the superior tractor feed for feeding the paper to the printer. As with nearly all of the less expensive printers below $1000 this is an 80 column printer. One puts 80 columns on a standard 8 1/2x11 inch wide sheet of paper. The full width of a larger printer is usually 132 columns for paper up to 13 1/2 inches wide.

The least expensive matrix printer with a better 9x7 print head is the MICROTEK, an 80 column printer selling at about $750. But it has yet no graphic capabilities. One of the least expensive 80 column matrix printers is the BASE2. There are also the EPSON from Japan and the EXCEL. The PAPER TIGER has a good reputation and a graphics option, but is more expensive. The least expensive 9x7 matrix printer with a full 132 columns and graphics is a model by ANADEX at about $1500. Prices vary as some printers can be bought from certain vendors at discounted prices. The TAM Line Printer sold by the Astrologer's Medium of Chicago at around $1000 has astrological symbols, but no lower case letters. It is an 80 column dot matrix printer. Using a program from Erlewine's MATRIX Software one can have not only lower case letters but also astrological symbols via the Commodore PET matrix printer.

Some may require a 'letter quality' printer. Under this special category there is the Diablo, Hytype I and II- the latter prints at 45 cps, the former at only 30 cps. The QUME has a special model with two heads at 75 cps, the fastest printer in this category. These printers sell from $2500 to $3500 plus the cost of the interface. More recent is the excellent Japanese Spinwriter by NEC at 55 cps, and most recent the ZYMEC at only 22 cps, but with more capabilities that the others. They are still having some initial production problems with this printer which is an adapted Olivetti typewriter. IBM's SELECTRIC has been widely adapted as a printer at different price levels and at different quality grades. It has been widely sold in spite of it's demerits. It operates at a slow 14.9 cps (only the 10 cps noisy teletype is slower). Even the heavy duty selectrics have more maintainance problems that they should. Most of these 'print quality' printers can be had with keyboards as well as without them. The ones with keyboards, which are 'terminals', can be used off-line as typewriters. The SELECTRICS (all of which are refurbished machines in the under $1000 price range) are less expensive than the others but it is dubious whether it pays to buy them.

An ideal printer would be a matrix serial printer which would be fast in one mode, would be slower but have letter quality in a second mode. The expensive ($5500) FLORIDA DATA BNY has all three options! It operates normally at a very fast 600 cps with a 7x7 dot matrix head for upper case and 8x7 for lower case letters. It operates at 150 cps with a close approximation to letter quality in a two-pass mode (15x16), will give letters two, four and eight times normal size and has a graphics capability at 128 individual addressable dots per inch. The SANDERS MEDIA 12/7 makes no less than four 'passes' to attain real letter quality at 50 cps from its dot matrix printer as well as having a much faster normal speed, but it does not have graphics. Its price is $4100. The MALIBU MODEL 165 sells for $2500 (all printer prices are without their interfaces; the Commodore one requires no interface to the PET). The 165 has a 10x9 dot matrix print head and operates normally at a good 165 cps. In two passes and an approximation to letter quality its speed is 90 cps. In its graphic mode it can individually address 60x70 dots per inch. CENTRONICS, the largest manufacturer of printers, has a new model 737 for about $900 which is an 80 column 9xN matrix printer. In one mode it prints 9x9 at 50 cps. In the other mode it more closely approximates to letter quality than any inexpensive matrix printer at 80 cps and proportional spacing. Most of the 132 column more expensive letter quality printers have this proportional spacing capability. Centronics sells many other models at very variable quality and price levels.

What to buy will depend on both your pocket book and your application. Before you buy BE SURE THAT YOU CAN OBTAIN SERVICE ON YOUR PRINTER WHEN IT BREAKS DOWN WHICH ITS BOUND TO DO ONE DAY.

[Editor's note: Charles Jayne knows whereof he speaks since he has spent almost two years trying to get a hi-speed ODEC printer operational.)

CONVERSATIONAL MATH

Buz Overbeck

"Al·gor·i·thm, who could ask for anything more"

George Gershwin

Admittedly, even I was underwhelmed by the response to Part One of this series! To the best of my knowledge, the piece was read by only two persons, neither of which needed it. James Neely enjoyed the article, and Michael Erlewine enjoyed the equations. He doesn't recall having read the article. And so, masochistically inspired by such thinly veiled apathy, I submit Part Two of this continuing, two part series, but first a word of caution concerning the subject of part one: Julian Day Numbers.

JULIAN/GREGORIAN CALENDAR

In Part One of this Series, Issacsons formula for converting dates to JD numbers was given. This algorithm is valid for the period: March 1, 1900 through February 28, 2100. There are, however, equations available which will compute JD numbers for any date since January 1st, 4713 BC (see Matrix Three, The Determination of the "Julian Day Number" by Alexander Borg; specifically the formulas by Singleton, Danby, and Fliegel & Van Flanderen.) These formulas are often given in two parts- the first for Julian Calendar computations and the second for Gregorian. However, in computer implementation, a 'trap' is built in so that the program itself decides whether a given date belongs to the Julian or Gregorian calendar, and then processes it accordingly, and it's instructive to see how this is done, because there are times when it is necessary to defeat it!

The date of adoption for the Gregorian Calendar is October 15, 1582, and equates to JD 2299171.0 (noon). A typical computer program will first compute the Julian JD Number of a given date, and then compare this JD Number with JD Number 2299171. If the computed JD Number is larger than 2299171, the program knows that the given date must be Gregorian, and so applies part two of the formula, which corrects the original JD Number for the Gregorian Calendar.

In other words, the computer 'assumes' that any date greater or equal than October 15, 1582 is given in terms of the Gregorian Calendar. This is a dangerous assumption.

Unfortunately, all countries did not adopt the Gregorian Calendar on October 15, 1582. For example, Great Britain and its Dominions changed in September 1752, Japan in January 1873, USSR in February 1918 and Turkey in January 1927. (For a complete list of dates of adoption, see the Explanatory Supplement to the AE and AENA, pages 414 to 416.)

This means that the above mentioned computer program would have processed all data given for these countries prior to the dates above as Grogorian dates, with the resulting charts being 10 to 12 days in error. One way to protect against this happening would be to have the program prompt for verification of all dates later than October 15, 1582, as being in fact, Gregorian. In any case, keep this in mind when implimenting JD routines on your computer.

WIERD "WHERES"

This issues mystery equation if for determining the Right Ascension of the Midheaven, and Local Sidereal Time. The 1st is abbreviated R.A.M.C. (and all the time you thought that stood for Russian American Countess, Right?) and the 2nd, LST.

The equations are deceptivly simple.

$$\underline{RAMC} = Rg + L \text{ (Mod 360) \& } \underline{LST} = RAMC \times 15$$

All you need to know is what Rg and L are, right? The complete equation with all the 'wheres' follow:

$$\underline{LST} = RAMC \times 15$$

Where RAMC = Rg + L

L = Geographic Longitude of the Event

Rg = GMST x 15

GMST = tg + (23925.836+8640184.542T+0.0929T²)/3600 (Mod 24)

T = (tg/24 + JD (1900) - 0.5)/36525

tg = GMT of Event

JD (1900) = JD - 2415020

JD = Well, see Part I, Matrix VI

If all of that intimidates you, you're in the right 'article', however, it is necessary for you to have read part one of this series in order to solve this one.

This is an important equation for, from the RAMC comes the MC, ASC, EP, Vertex, and all the houses regardless of which House System you're sporting this week. In keeping with the original intent of this series, the 'grammer' will be kept to a minimum. Solve now; pay later. It's probably a good idea to restate the rules of solving equations:

1. List and define all variables
2. Break down the formula into modules or "phrases"
3. Solve the individual modules
4. Reassemble individual solutions and solve the equation.

If you follow these rules, the above equation will fall into place. Before taking on this equation you will need to know two things:

1. How to convert minutes & seconds to decimals and back.
2. How to compute Julian Day Numbers.

Both were covered in Part One of this series so review if you have to.

The equations, and the sample data to follow, were adapted from MATRIX ONE, Astro 1, 2, & 3 by James Neely, page 9.

EXAMPLE DATA

Date:	April 20, 1976
GMT:	01:48
Longitude:	121° W 55'

"All roads lead to Gnome...Yukon bet on it"...Sgt. Preston

There are many ways to approach the solution of an equation, if you know how to solve it to begin with (?) But, if you don't know how to solve it where do you begin? At the end, of course. The RAMC equation "wheres" you to death, so one place to begin is with the last possible 'where' and work your way up the ladder. Further, Rule I says list and define all variables so we'll apply it as we go.

JD NUMBER

Using the techniques outlined in part one you will, of course, have determined that the JD Number for April 20, 1976 (noon) is:

JD = 2442889.0

JD (1900)

This is the number of days between noon January 0, 1900 and noon on the day of the Event:

JD (1900) = JD - 2415020 = 2442889.0 - 2415020.0 = 27869.0 Days

tg

This is the GMT of the Event in hours and decimals of an hour:

tg = 1h 48m = 1.8h

T

'T' is the number Julian Centuries from Greenwich Mean Noon, January 0, 1900.

T = (tg/24 + JD (1900) - 0.5)/36525

At this point, you want to do two things:

1. Plug in the known variables
2. Follow the "Order of Operations"

(If you've forgotten the order of operations, review Matrix VI, page 49.)

SO: T = (1.8/24 + 27869 - 0.5)/36525

Solve the parenthesis (division before addition)

(1.8/24 + 27869 - 0.5)
= (0.075 + 27869 - 0.5)
= (27868.575)

Then T = 27868.575/36525 = 0.7630

GMST

This is the next variable, and stands for Greenwich Mean Sidereal Time.

GMST = tg + (23925.836 + 8640184.252T + 0.0929T²)/3600 (Mod 24)

For now, ignore the (Mod 24).

If you haven't yet learned the "Order of Operations" you're sure to crash on this one. First, rewrite it with the variables thus defined.

GMST = 1.8 + (23925.836 + 8640184.252 X 0.7630 + 0.0929 x 0.7630²)/3600

The value within the parenthesis = 6616386.474

Try it and see what you get...

If you got a different answer, follow this:

a. 0.7630² = 0.58217
b. 0.0929 x 0.58217 = 0.05408
c. 8640184.252 x 0.7630 = 6592460.584

then d. 23925.836 + 6592460.584 + 0.05408 = 6616386.474

The equation now becomes:

GMST = 1.8 + 6616386.474/3600 (Mod 24)
= 1.8 + 1837.88513
= 1839.68513 (Mod 24)

OK, but 1839.68513 What!? Degrees? Days? Years? The answer is 1839.68513 hours, for we are seeking the Greenwich Mean Sidereal Time, and Sidereal Time is expressed as hours, minutes, and seconds. This serves as a clue to the (Mod 24). "Non-grammatically", (Mod 24) says "subtract 24 from the number of interest until you arrive at a remainder which is less than 24. With small numbers, this is no problem. For example, 26 (Mod 24) = 2, For 26-24 = 2. Similarly, 56 (Mod 24) = 56-24 = 32 which is still larger than 24, so do it again: 32-24 = 8 which is less than 24, so 56(Mod 24) = 8.

Obviously this method is unsatisfactory for a number such as 1839.68513. So another method is required.

The following method is the correct way of finding the Modulus (Mod) of any number:

1. Divide the number by the modulus (in this case, 24)
2. Multiply the Integer portion of the remainder by the Modulus.
3. Subtract this product from the original number.

In mathspeak: X(mod Y) = X -int(X/Y)xY

or 1839.68513 (Mod 24) = 1839.68513 -int (1839.68513/24)x24
= 1839.68513 -int (76.65355)x24
= 1839.68513 - 76x24
= 1839.68513 - 1824
= 15.68513h

So...GMST = 15.68513h
Or...GMST = 15h 41m 07s

The rest is almost anti-climatic.

Rg

This is the GMST expressed as Right Ascension

Rg = GMST x 15
= 15.68513h x 15
= 235.27698°

L

The Geographic Longitude of the Place (East = + West = -)
= 121 W 55 = -121° 55' = 121.91667°

And finally (pant!) RAMC

RAMC = Rg + L (Mod 360)
= 235.27698° + (-121.91667°)
Or = 235.27698° - 121.91667°
= 113.36031° = 113° 21' 37"

Or if you prefer LST

Which is the RAMC expressed as Sidereal Time

LST = RAMC/15
= 113.36031/15
= 7.55735 = 7h 33m 27s

Note that the (Mod 360) routine was not needed as the RAMC was already less than 360. However, if it wasn't, you would use the same algorithm used for the (Mod 24).

"What's your Sine?"...John Addey, overheard at a cocktail party.

In part three, we'll take up the Trigonometric functions and the calculation of the MC and Ascendent. In the meantime, here is some practice data to work with:

1. Date: Oct. 12, 1937 GMT: 7h 46m Long. 118° W 30'
= RAMC: 19° 28' 15" LST: 1h 17m 53s

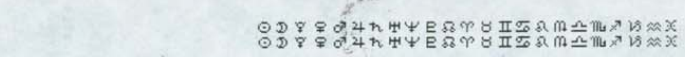
2. Date: July 2, 1925 GMT: 10h 00m Long. 95° W 51'
= RAMC: 334°04'30" LST: 22h 16m 18s

3. Date: Dec. 25, 7BC GMT: 19h 59m 08s Long: 35° E 13'
= RAMC: 66°40'15" LST: 4h 26m 41s

The last one is thrown in to test your resourcefullness! Give it a try and we'll work through it next time. Until then, I'll leave you with a great 'one liner' sent to me by James Neely:

AC=ATN (SQR(1-XxX)/(X-1E-9x(X=Ø)))-3.1416x(X<Ø)

That Neely's quite a kidder!



MATRIX GRAPHICS

by Michael Erlewine

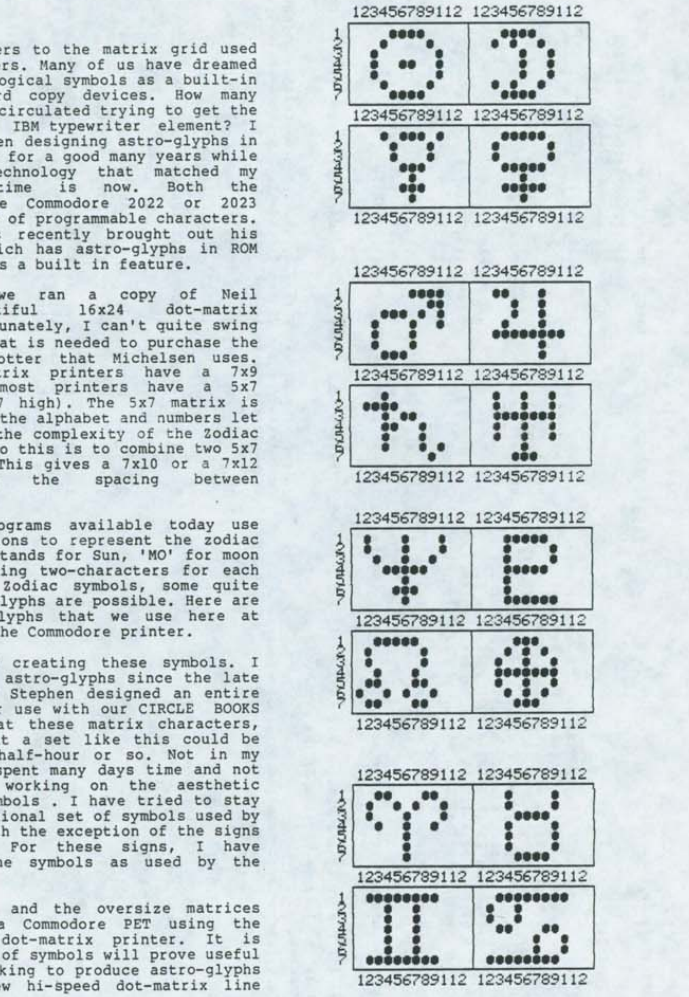
'Matrix' here refers to the matrix grid used in dot-matrix printers. Many of us have dreamed of having the astrological symbols as a built-in feature of our hard copy devices. How many petitions have been circulated trying to get the astro-glyphs on an IBM typewriter element? I know that I have been designing astro-glyphs in my mind and on paper for a good many years while waiting for a technology that matched my pocketbook. The time is now. Both the PAPER TIGER and the Commodore 2022 or 2023 printers are capable of programmable characters. David Horbovetz has recently brought out his TAM line printer which has astro-glyphs in ROM (READ ONLY MEMORY) as a built in feature.

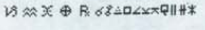
In MATRIX VI we ran a copy of Neil Michelsen's beautiful 16x24 dot-matrix astro-glyphs. Unfortunately, I can't quite swing the 8 grand or so that is needed to purchase the Versatec printer-plotter that Michelsen uses. While some dot-matrix printers have a 7x9 character matrix, most printers have a 5x7 matrix (5 wide by 7 high). The 5x7 matrix is barely adequate for the alphabet and numbers let alone symbols with the complexity of the Zodiac glyphs. The answer to this is to combine two 5x7 to form each glph. This gives a 7x10 or a 7x12 matrix (including the spacing between characters9.

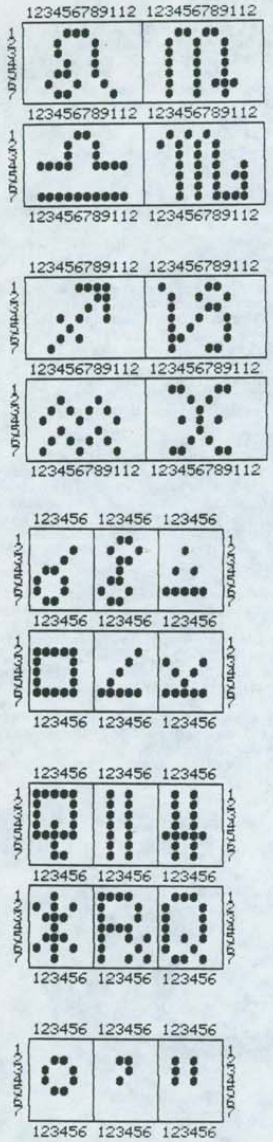
Most printing programs available today use two-letter combinations to represent the zodiac symbols. Thus 'SU' stands for Sun, 'MO' for moon and so forth. By using two-characters for each of the planet and Zodiac symbols, some quite nice looking astro-glyphs are possible. Here are the set of astro-glyphs that we use here at MATRIX Software on the Commodore printer.

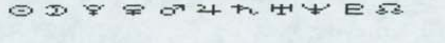
A few remarks on creating these symbols. I have been designing astro-glyphs since the late sixties. My brother Stephen designed an entire PRESS-TYPE sheet for use with our CIRCLE BOOKS CALENDAR. To look at these matrix characters, one might think that a set like this could be put together in a half-hour or so. Not in my experience. I have spent many days time and not a little anguish working on the aesthetic quality of these symbols . I have tried to stay close to the conventional set of symbols used by modern astrology with the exception of the signs Virgo and Pisces. For these signs, I have elected to give the symbols as used by the ancient Greeks.

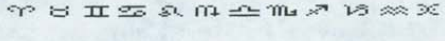
Both the regular and the oversize matrices were produced on a Commodore PET using the tractor-feed 2022 dot-matrix printer. It is hoped that this set of symbols will prove useful to those of you seeking to produce astro-glyphs on some of the new hi-speed dot-matrix line printers.

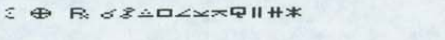












```
10    DATA 358.47584,35999.0498,-.00015,.016751,-.
      41E-4,0,1.00000013,101.22083
12    DATA 1.71918,.00045,0,0,0,0,0,102.27938,14
      9472.515,0,.205614,.2E-4,0
14    DATA .387098,28.75375,.37028,.00012,47.14594
      ,1.1852,.00017,7.00288,.00186
18    DATA -.1E-4,212.60322,58517.8039,.00129,.006
      82,-.4E-4,0,.723332
20    DATA 54.38419,.50819,-.00139,75.77965,.89985
      ,.00041,3.39363,.001,0,319.5293
22    DATA 19139.8585,.00018,.09331,.9E-4,0,1.5236
      9,285.43176,1.06977,.00013
28    DATA 48.78644,.77099,0,1.85033,-.00068,.1E-4
      ,225.32833,3034.69202
32    DATA -.00072,.04833,.00016,0,5.202561,273.27
      754,.59943,.0007,99.44338
34    DATA 1.01053,.00035,1.30874,-.005696,0,175.4
      6622,1221.55147,-.0005
38    DATA .05589,-.00035,0,9.55475,338.30777,1.08
      522,.00098,112.79039,.873195
39    DATA -.00015,2.49252,-.00392,-.2E-4,72.64882
      ,428.37911,.8E-4,.046344
44    DATA -.3E-4,0,19.21814,98.07155,.98577,-.001
      07,73.4771,.49867,.00131
46    DATA .77246,.00063,.4E-4,37.73067,218.46134,
      -.7E-4,.008997,0,0
48    DATA 30.10957,276.04597,.32564,.00014,130.68
      136,1.09894,.000249,1.77924
50    DATA -.00954,0,229.94722,144.91306,0,.24864,
      0,0,39.51774,113.52139,0,0
54    DATA 108.95444,1.39601,.00031,17.14678,0,0
```

AN INTRODUCTION TO MICROGRAPHICS

by Charles Paul Jones
Box 1500
Bath, Ontario, Canada, K0H-1G0

During the course of its history, many new and revolutionary things have appeared on the pages of this publication. We've had James Neely, the 'Wizard of California', show us how to save time and improve the accurcy of our charts. Many of us have been guided by Michael Erlewine, Rob Hand, Charles Jayne and many other unsung heroes into the Aquarian Age of calculators and small computers. We've read numerous articles written by all of these pioneers intended to increase our knowledge of Astrology and its related fields, improve the quality of life for ourselves and our clients, and remove the tedious elements from our path of greater knowledge.

With the advent of the new small computer systems, we can now generate hundreds of finished charts in the time it would have taken to do only one without them, not to mention the fact that research projects far too large to even consider a couple of years ago are now quite commonplace. Yes, the new micro computers can truly be a great blessing for an astrologer, but they have their drawbacks too.

How do we sort and store this new mountain of computer generated data??? The computers themselves are quite small, but their output is awesome piles of printout and tabulated results. With the cost of mass memory still so high, few of us can justify the expense of putting it ALL on floppy disk or other mass storage devices. Nor will our disk systems help with books, letters, publications, data sheets, completed charts, and all the other wonderful junk we seem to collect.

Almost every student of the art can clearly remember his great relief when he purchased his first filing cabinet, shortly after undertaking his study. It was a large investment, but now he could rid himself of the paper boxes under the furniture, and for the first time, find something when he wanted it. Then there was the second set of cabinets, the third, ... and on and on with no end in sight.

Most astrologers have reached the point where they are destroying data they would like to save for future reference, or are living with a wall of filing cabinets, and are still often unable to find the information they require when they need it. There must be a better way!!!

Enter the small world of micrographics. A world created by the dynamically increasing need on the part of commerce, industry, personal services, and the government to provide more and more information resources to more and more people.

Micrographics combines the science, the art, and the technology by which information can be quickly reduced to the medium of microfilm, stored conveniently, and then easily retrieved for reference use.

The total micrographics story is truly one of efficiency, speed, and economy. Microfilms in a few square feet of storage space replace the original documents that previously required a few thousand square feet. They may be retrieved, displayed, and reproduced in seconds for just pennies per copy. Microfilm enjoys its immense popularity because of its unmatched ability to store today's mountains of information and deliver the right data to the right place at the right time- at far lower over all costs than would otherwise be possible.

The wide variety of user needs and applications has given rise to a number of different forms in which microfilm is made, stored and used. Each has a range of applications designed to fulfill certain specific user requirements, and the most important planning consideration is to select the form to match the need. Primary factors to consider in selecting the appropriate form of microfilm include type of input, the nature of the information to be stored, how it is to be used, and overall system cost. Of the many systems available, I'm only going to cover briefly the forms I feel would be of greatest benefit to the astrological community.

Microfilm for all of these systems, regardless of its ultimate format for storage, is first produced on 16mm high contrast black and while roll film. Roll film is the least expensive form in which microfilm can be produced and duplicated. This is a special film, designed specifically for microfilm application.

REELS-

Microfilm on reels was one on the first microforms. It is still a popular choice because large quantities of information may be stored in very little space, at very low cost. Microfilm on reels provide a high measure of file integrity, are desirable where information is added continuously in sequence and updating is infrequent. 16mm reels are primarily used for alpha and numeric data, such as correspondance, checks, and similar information. 35mm reels are used for graphics and large documents such as engineering drawings, x-rays, newspapers and maps.



MICROFICHE-

The word 'microfiche' is a combination of the prefix 'MICRO' and the French word 'fiche' meaning a file index card. A microfiche, or 'fiche', is a sheet of film containing multiple microimages in a grid pattern. It usually contains identification information which can be read without magnification. Available in a variety of styles, microfiche usually permit unitized data storage and updating. They are easily duplicated for mailing, security or reference purposes. Microfiche may contain from a few to several hundred images in a reduction range of 18X to 48X.

This form is ideal for publications such as MATRIX. The standard format contains 98 pages of information on each fiche. An entire issue of MATRIX will easily fit on one fiche, and in fact adready has!! [Edators note: The authgr sent us all of MATRIX published to date on microfiche in a leter sized envelope!] Copies of these can be produced at a very small cost in volume. Already most magazines and many books are available in this form, and that number will grow in the coming years. Most libraries use this system as well.

CASSETTES-

Microfilm in cassettes gives added convenience to the handling of continuous rolls of microfilm. Each cassette contains two film cores- the feed and the take up-. There is no need to rewind a cassette when it is removed from the reader. Any frame may be held in viewing position for further reference at a later time.

CARTRIDGES-

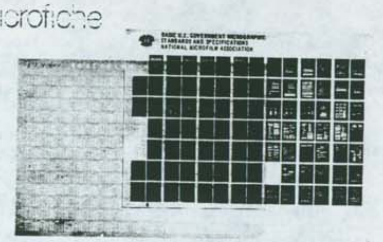
Microfilm catridges function as convenience packaging for rolls of microfilm. Unlike microfilm on reels, which require threading, cartridges can be self threading. Microfilm in cartridges is well protected, and not subject to fingerprints and other possible sources of damage.

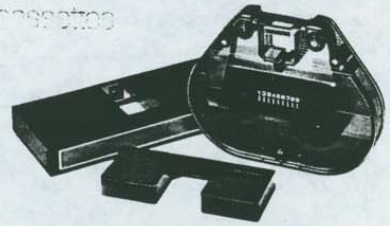
JACKETS-

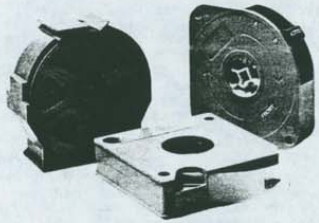
A jacket is a plastic carrier with single or multiple sleeves or channels designed to accept strips of 16mm or 35mm film. Jackets both protect the microfilm and also facilitate organization of material. Images may be copied or read directly from the jacket without removing the film. Jackets can be visibly titled for quick, easy file reference and update.

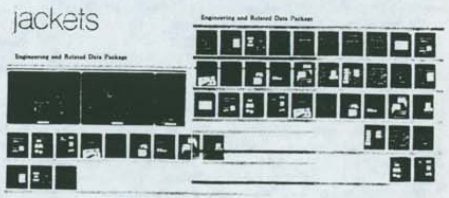
This form is the one I would choose in setting up a system. The cost is a bit more than roll film, but since jackets are formatted the same as microfiche, the two systems use the same readers and printers. Also, microfiche can be generated directly from jackets at any time, should more microfilm copies be desired. For the small scale user, this appears to be somewhat of a standard, and one I feel should be adopted by any new user in the astrological community. For once, perhaps a standard can be set before everyone runs out and wastes money on many different systems, only to later find that it is of use only to him, and that he can't trade information without a lot of bother.

Now that we have our information stored on microfilm, how do we get it back? There are many systems for this, but again I'll briefly cover those most applicable to the needs of the average astrologer.









READERS-

A variety of readers are available for viewing microfilms. The choice will depend upon the environment in which they will be used, the user's needs, the specific microfilm system in use, and the cost. Basic types of readers are:

1) LAP READERS. Designed for compactness and personal use, they are available at present only as microfiche and jacket readers.

2) PORTABLE READERS. Designed to be inserted or folded into a case similar to a portable typewriter case. Indicative of their portability, most lap and portable readers offer the option of AC, battery, or 12-volt operation.

3) DESK READERS. Designed for use on a desk, table, or stnd.

4) FREE-STANDING UNITS. Designed to stand alone as self contained units.

Many manufactures offer a list of accessories as well, such as extra lenses, floor stands, combination stands and microfilm storage units, adaptors for other types of microfilm, and other capabilities. The number of operating features, controls and accessories on any unit is directly related to its intended functions and affects costs.

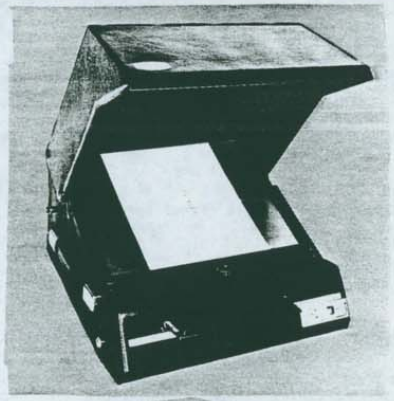
READER-PRINTERS-

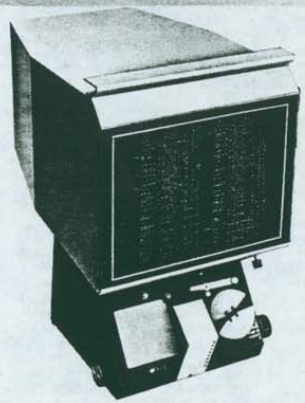
A reader-printer is a device both for viewing and producing occaisional hard copy reproductions from a microform. Several processes are used by manufacturers to reproduce microfilm information. With the exception of the transfer electrostatic printing process, which uses plain paper, all papers used in the printing processes are coated papers. The cost of supplies will vary with the manufacturer, the usage volume and the process.

There is a range of microfilm storage and retieval systems available, depending upon the user's specific microform and his subsequent retrieval requirements. The most cost effective and easiest to use for microfiche and jackets is a simple file drawer as illustrated here.

And now for the bottom line- what it all costs. There are many microfilm service companies that will take your documents and put them on microfilm for a fee. Their prices are not standard by any measure, and unfortunately, most are set up to do large volumes of data, such as hospital records. Your cost will depend directly on the number of documents to be filmed, what type they are, and what microform you choose to use. I hesitate to even quote a price here without knowing all of this information in advance, but I realize a ballpark figure is needed. Therefore I will hazard a guess. A estimate for an astrologer with 10,000 documents, all 8 1/2 x 11 in size, prepared for filming, and converted to jackets using all 98 frames, would be around $500. About what you could get for your used filing cabinets!! Once the system was set up, you could estimate a new client file cost of $4-$6. Little more than its present cost.



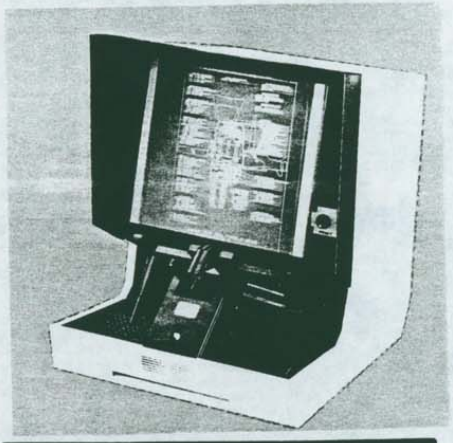




Readers and printers also vary greatly in cost, depending again on the type of microform you are using, and the features you are willing to pay for. A lap reader, such as the one illustrated, costs less than $100. Reader-printers are from $200 up to $6000 and more. All of these units can also be rented for a small montly charge.

Your editor has asked about setting up a microfilm service specifically for astrologers, to insure an understnding of the material, and a fair price. This is a workable idea, however it would have to be supported by the people who would use it. I'm open to the idea, now what about the rest of you?

So there you have it, a good, cheap solution to our growing mounds of files and information. On the surface it may seem to be a large investment, but over all it will end up saving both time and money, two items none of us seem to have enough of.





ERRATA

Here are the bugs from MATRIX past that have come to our attention:

MATRIX II, page 5, Planetary Velocity Program supposed to replace lines 270-490 in BASIC listing page 54 & 55. Some changes required.

```
275 GOSUB 900: M=FNR(FNU(S)): GOSUB 900: E=S

320 GOSUB 900 : AP=FNR(S) : GOSUB 900 : AN=FNR(S):
GOSUB900 :IN=FNR(S): X=XM1: Y=YM1: GOSUB3550

400 IF D>20 THEN D=D-360
```

MATRIX V, Perturbation Corrections, page 5 to 9. Page 9.

```
980 DATA EAR,MER,VEN, etc.

3115 IF I>4 THEN etc.

3270 K(5)=11:K(6)=5:K(7)=4:K(8)=4:K(9)=4

3275 FOR IK=1TO3:IFI=5ANDIK=3THENT(3)=0:RETURN
```

The Subroutine 1190 referenced in line 1190 accepts a planet position in degreee/decimal format and returns it in Degree-Sign-Minute format.

Page 8, line 62

```
62 DATA -.0016,2363.4,-141.4,.0001, etc.
```

MATRIX II, page 27, the steps should read:

```
#443 43 RCL
#444 30 30
#445 71 SBR
#446 95  =
```

MATRIX II, page 21

```
085  09 9  +29 SIN(
086  85 +  ℓ-ℓ'-2D)
```

page 42, last line under the Longitude para:

-29" sin(l-l'-2D) should read +29"sin(l-l'-2D)

page 48, correct line 97 to read:

```
97 ST+7  35-55 07
```

MATRIX V, second column on page 21

line 7: -24092523265 should be -24902523265

line 14: 936718 should be 936708

page 22, second column, BASIC line 508, third constant should be:

-3171471356 and not -3171471656

MATRIX VI, page 12 should be between pages 14 and 15

and last, but certainly not least, is from MATRIX II, page 57. The Alternate Set of Orbital Data for Other Centuries given there is not correct. The correct elements are as follows:

See PAGE 27

Notes on BASIC Dialect Differences

by Mark Pottenger

The BASIC I use is the 14 digit version from North Star. This is a somewhat different dialect than that available with most of the home computers.

Multiple statements on a line are separated by a backslash '/' rather than a colon ':'. If an IF statement is followed by other statements on the same line, all statements on the line will be executed whether the IF condition is true or false. The only time the rest of the line is not executed is when the IF executes a GOTO. The exclamation mark '!' is used as a single character form of 'PRINT'. The INT is a floor (next lower integer) rather than a truncate (drop decimals). This affects the modulus function for negative values. All numeric variables take 8 bytes of memory, which is reflected in the numbers used in disk access. No multiple letter variable names are permitted. The index variables in a FOR...NEXT loop is tested before executing the loop. Some BASICs don't test till after executing the loop once.

North Star string handling is all done with substrings rather than arrays of short strings. The DIMensioning of a string specifies how many characters long the string is allowed to get. Strings can read values from data statements or be assigned directly with a 'LET' statement. For example:

```
DIM P$(40)/P$="SUN
MOONMERCVENUMARSCEREPALLJUNOVESTJUPI"
```

In this string P$(1,4) is 'SUN ', p$(5,8) is the 'MOON', etc.

```
FOR I=1 to 10: PRINT P$(I*4-3,4*I): NEXTI
```

The above will print the ten planet names in the string.

The biggest difference I am aware of between North Star and other BASICs is the handling of user defined funcions. North Star BASIC permits multiple variable and multiple line functions. All such functions will have to be converted to subroutines in BASICs that do not permit this. Either leave such functions in place and put in a GOTO to skip them or move them all to the end of the program. Multiple line functions start with a DEF statement by itself on a line (not followed by an '=' expression). They end with a RETURN X/FNEND. Variables actually named in the function call are treated as local. Any other variables used in the functions are global. I use this to return multiple answers in several functions.

On Astro-Geography

by Mark Pottenger

Jim Lewis of San Francisco developed and sells a product he calls ASTRO*CARTOGRAPHY. This is a world map with lines drawn on it by a computer plotter to show where the planets were angular at a given instant. The program CARTOGRA following this introduction permits a microcomputer to print out the series of terrestrial coordinates necessary to produce an astrocartographic map by hand.

In drawing a map of planetary contacts to angles, the first decision you have to make is how you are going to define the contacts. The two most obvious kinds of angle contacts are ecliptic and mundane (ascensional). Jim Lewis' A*C*G gives the mundane contacts. He says he tried both when he was developing the A*C*G and the mundane contacts worked better. The mundane contact lines give you those places on earth at which the planets would be actually rising, culminating, or setting at the time in question. The ecliptic contacts give you those places on earth at which the planets would be conjunct the Ascendant, Midheaven, Descendant, or Immum Coeli in celestial longitude. Thus, ecliptic contacts are what you will see if you do a conventional relocation chart (erecting the chart for the new location, keeping the Greenwich time constant). The CARTOGRA program, because it is not actually producing a plot, is set up to give both ecliptic and mundane contacts and leave the choice of which to plot to the user.

The CARTOGRA program reads planetary positions stored on disk by my chart program. This section of code should be replaced by either an INPUT loop for manual input of planetary positions or statements to access positions in whatever form you store them in. You need the Greenwich Sidereal Time, the Obliquity of the ecliptic and the celestial longitudes, right ascensions, and declinations of all bodies you want to plot. If you want only mundane contacts you can leave out planetary longitudes. If you want only ecliptic contacts you can leave out RA and Declination. The Julian function is only used to get the obliquity, so if you store obliquity with natal positions it can be omitted. In the listing, GST is obtained from LST and birth longitude because that is what was included in the file. After getting obliquity, get the sine and cosine of it and leave them globally available.

To get the terrestrial longitude (E long) at which a planet will be on the meridian, subtract the RA of the planet from the GST (both in degrees). The result is West longitude-- if it is greater than 180 degrees, subtract 360 degrees to get east longitude as a negative number. This is the E long at which the planet is at upper culmination. To get the E Long of lower culmination, add or subtract 180 degrees if the E long is negative or positive, respectively. The terrestrial latitude (E Lat) at which the planet is at the zenith is the declination of the planet. The planet is at the zenith (straight overhead) for someone at the E long determined for upper culmination and the E lat just determined. The planet is at the nadir (straight underfoot) at the E Long of lower culmination and the E Lat opposite in sign to the planet's declination. (Note: IC and Nadir are not the same-- please dont confuse them.)

The above procedure for getting the E Long of meridian contacts is actually the core procedure used for all contacts. Get the RA (sidereal time) of whatever contact qou are interested if, subtract it from the GST, and convert to plus or minus 180 if necessary.

The next section of the program gets the earth longitudes of all 30 degree multiple ecliptic aspects to the midheaven. A relocation chart for a place at a longitude on the list will show the aspects.

The last loop gets the contacts to the horizon and the Ascendant-Descendant axis. The columns labelled 'ON ASC' and 'ON DES' are the ecliptic conjunctions to those angles. The columns labelled 'RISING' and 'SETTING' are the mundane contacts. The ecliptic contacts call a function which gets the sidereal time (RA) at

Fixed Stars

by Mark Pottenger

The 'fixed' stars are one of the oldest features of astrology, but one not much used these days. One reason for not using them is the large amount of time required just to determine what contacts there are between the stars and other features in a chart. As with any other technique for which time consumption is a critical factor, stars are ideal subject matter for microcomputer work.

First, the stars are not 'fixed'. They come close to being fixed for people who use a sidereal zodiac, but even then there are changes. The proper motions of the stars cause their relative positions to change slightly over long time periods. For users of the tropical zodiac (most of us), precession adds a much larger component of change. Precession is the change of orientation of the earth's axis with respect to the stars, and amounts to about 50 seconds of arc per year. This means if you use tropical positions from an atlas 72 years old, the positions will be a degree off. Since most work with stars limits the orb to 1 degree, this can be a serious problem. The positions in Vivian Robson's book are for 1920, so they are nearly a degree off by now. He gives annual variations for correcting the positions, which means considerably more work if you want to trust the positions. Also, correction by annual variation is only fully accurate within a decade or two of the epoch of the atlas.

For accurate star positions, proper motion should be applied first in the coordinate framework of the original atlas, then rigorous formulas used to precess the resulting positions to the coordinate framework of the date you want. The result is the mean position of the star. If you use apparant positions you must also include corrections for nutation and aberration.

Once you have accurate positions, there is still the lengthy process of comparing the positions to those of your planets. In addition to the conjunction in longitude looked for by most modern astrologers, ancient astrologers used ascensional contacts (parans). This involves checking if a star rises, culminates or sets at the same time a planet rises, culminates or sets-- a large number of comparisons.

Finally, once you have gotten accurate star positions and compared them in all desired ways to your planets, you know what stars contact your chart in what way. To know how to read the contacts you need some kind of meaning for each star. For this, Robson's and Ebertin's books are about the only available modern sources. They are at least partly organized by the names of the stars. Another possible way to get meanings is that suggested by George Noonan on the basis of his work with ancient astrology. He says there is a direct correlation between spectral type and planetary meaning (O=Moon, B=Jupiter, A=Venus, F=Mercury, G=Sun, K=Mars, M=Saturn).

Explanation of the Listings

There are two separate listings given here. The first is simply the list of stars and their positions and proper motions. The name field stars with the star's proper name, and has its constellation designation, spectrum, magnitude, and General Catalog number. The Right Ascension is given in hours, minutes, seconds and its proper motion in seconds of time. The declination is given in degree, minute, second and its proper motion in seconds of arc. Some of the commoner alternate names are also given with a reference to the preferred name (if I couldnt find out what form was most preferred, I decided arbitrarily). The spectral class, magnitude, GC#, coordinates, and proper motions are from the Bevcar Atlas of the Heavens (a gift from Rob Hand that helped this project immensely). A few of the nebulae and clusters were not in the Bevcar Atlas and are from a variety of sources.

The star names are from a variety of sources. Vivian Robson's complete list is included (with some corrections). A list handed out at a couple of conferences by George Noonan is included. The lists from the Becvar Atlas and about 20 popular astronomy books and articles were used. I used R H Allen's Star Names to resolve conflicts wherever possible, but did not try to include all stars he lists (too many). A few conflicts I settled from star maps. A number of special problem areas are listed at the beginning of the list of names and positions. I generally tried to stick to occidental names. Most of the star names we use are english transliterations of arabic words and phrases which were translations of Ptolemy's descriptions of the positions of the stars in terms of the constellation figures. (E.g. Deneb Adige is the Hen's Tail-- the tail of Cygnus the Swan.) The list as given here has 290 stars with 427 names. I would appreciate it if any readers of MATRIX who spot any errors or important omissions would write.

This list is used to create a disk file with star names and positions. Duplicate names are left out of the file. RA and RA proper motion are multiples by 15 to store them in degrees. Since the whole list is in DATA statements, any corrections are just made in the data statements and the file re-written.

The second program actually gets the stars' positions for someones date of birth and compares them to the chart. The person's date and time of birth and planetary positions are read from a data file and the star data from the file created by the first program. The star positions are corrected for proper motion and precessed by the rigorous trigonometric formulas from the Explanatory Supplement. The resulting positions are mean positions for the ecliptic and equator of date. If you want to work with apparent positions, add corrections for nutation and aberration. The main loop compares these positions with the longitudes of the planets and does a full set of parens(rise-rise, rise-culm, rise-set, rise-low culm, culm-rise, culm-culm, culm-set, culm-low culm, etc.). The test in line 2580 finds circumpolar stars and forces values out gf 360 range for the cgeparasons of rise and set time. All the values are sidereal times in degrees.

A couple possible re-writes have come to mind since I first wrote the program. The parens could be put in a loop if the sidereal times of rising, culminating, etc were all in one multi-dimensional array instead of in separate one dimensional arrays. If computer memory is a problem, the main comparison loop can be put inside the loop that reads the star data from the disk file. I did them separately to avoid a lot of on and off disk activity. Short forms of the program, omitting the parans or parts of the printout, are also easy changes.

Editors Note: Included below are the actual listings for the two programs as received from Mark Pottenger. The list of Fixed Stars was sent in two forms: (1) a program containing the information and (2) a print-out of this same information formatted. There is not room (nor reason) to include both lists. Pottenger suggests that we present the complete printed list of stars and the final page of the program that stores this information. In this way, readers can see a sample showing how the star list is stored in data statements as well as how those statements are accessed. In addition, three sample outputs are included: Astrocartographic points (2 pages) and Fixed Star output (one page). Readers may contact the program author:

Mark Pottenger
838 5th Ave
Los Angeles, CA 90005

```
4350 DATA "VFSPEPTILIO     SEE ANTAPES"
4360 DATA "VINDEMIATRIX    EPSILO VIR G6 3.0 17687",12,59,41.2,-.019,11,13,39,.02
4370 DATA "WASAT           DELTA  GEM A8 3.5  9755",7,17,8.3,-.001,22,4,34,-.02
4380 DATA "WAZN            BETA   COL K1 3.2  7364",5,49,11.7,.004,-35,-47,-10,.40
4390 DATA "WEGA            SEE VEGA"
4400 DATA "WEZEN           DELTA  CMA G3 2.0  9443",7,6,21.5,0,-26,-18,-45,0
4410 DATA "YED POSTERIOR   EPSILO OPH G8 3.3 21920",16,15,40.4,.006,-4,-34,-20,.04
4420 DATA "YED PRIOR       DELTA  OPH M1 3.0 21838",16,11,43.3,-.003,-3,-34,-2,-.15
4430 DATA "YILDUN          DELTA  UMI A0 4.4 24236",17,48,18.5,.012,86,36,35,.05
4440 DATA "ZANIAH          ETA    VIR A0 4.0 16813",12,17,20.8,-.004,0,-23,-21,-.02
4450 DATA "ZAURAK          GAMMA  ERI M0 3.2  4778",3,55,41.7,.004,-13,-38,-58,-.11
4460 DATA "ZAVIJAH         SEE ZAVIJAVA"
4470 DATA "ZAVIJAVA        BETA   VIR F8 3.8 16215",11,48,5.4,.050,2,2,47,-.28
4480 DATA "ZIBAL           ZETA   ERI A3 4.9  3899",3,13,24.1,0,-9,0,-15,.05
4490 DATA "ZIBEL           SEE ZIBAL"
4500 DATA "ZOSMA           DELTA  LEO A2 2.6 15438",11,11,27.1,.010,20,47,52,-.14
4510 DATA "ZUBEN ELAKRAB   GAMMA  LIB G6 4.0 20949",15,32,43.5,.004,-14,-37,-28,0
4520 DATA "ZUBEN ELAKRIBI  DELTA  LIB A1 VAR 20195",14,58,17.8,-.004,-8,-19,-18,-.01
4530 DATA "ZUBEN ELGENUPI  ALPHA2 LIB A3 2.9 19975",14,48,6.5,-.007,-15,-50,-7,-.07
4540 DATA "ZUBENELSCHEMALIBETA    LIB B8 2.7 20539",15,14,18.7,-.007,-9,-11,-59,-.03
4550 DATA "ZUBENESCH       SEE ZUBEN ELSCHEMALI"
4560 DATA "ZUBENESCHEMALI  SEE ZUBEN ELSCHEMALI"
4570 DATA "ZUBEN HAKRABI   NU     LIB K5 5.3 20311",15,3,49.9,-.003,-16,-3,-51,-.03
4580 DIM S$(38)
4590 !
4600 !"STAR NAME      CONSTELLAT SP MAG  GC #       RA          PM     DEC         PM"
4610 OPEN #1,"STARFILE"
4620 WRITE#1#0,0
4630 N=0
4640 FOR I=1 TO 427
4650   IF (I+30)/80<>INT((I+30)/80) THEN 4680
4660   !CHR$(12)
4670   !"STAR NAME      CONSTELLAT SP MAG  GC #       RA          PM     DEC         P
4680   READ S$
4690   !S$,
4700   IF S$(16,18)="SEE" THEN 4790
4710   READ H,M,S,P,D0,M0,S0,P0
4720   !%5I,H,%3I,M,%5F1,S,%7F3,P,%5I,D0,%4I,M0,S0,%6F2,P0,
4730   R=H+M/60+S/3600
4740   R=R*15
4750   P=P*15
4760   D=D0+M0/60+S0/3600
4770   WRITE#1,S$,R,P,D,P0
4780   N=N+1
4790   !
4800 NEXT I
4810 WRITE#1#0,N,NOENDMARK
4820 CLOSE#1
4830 !
4840 !N," RECORDS WRITTEN TO FILE"
4850 FILL 3328,0
4860 !FPEE(0)
4870 END
```

SAMPLE DATA PAGE

FROM FIXED STAR PROGRAM


```
10 REM CARTOGRA--PRINT COORDINATES ON EARTH OF ANGLE CONTACTS
20 REM BY MARK POTTENGER
30 REM DATE 4/18/79
40 REM REV 7/30/79 ECLIPTIC ASPECTS REFORMATTED
50 REM REV 9/19/79 TO ALLOW FOR NON-RISING (AT HIGH LATITUDES) PLANETS
60 REM REV 9 DEC 79 UPGRADED JULIAN ROUTINE, ADDED WARNING ON ASC ROUTINE
70 DIM D1(20), L(20), L1(20), R1(20)
80 DIM E$(2), N$(2), W$(10), N1$(30), P$(10), T$(10)
90 REM STRINGS FOR DIRECTION OF LONGITUDE & LATITUDE
100 E$="WE"
110 N$="NS"
120 REM PLANET NAMES
130 P$(1,40)="SUN MOONMERCVENUMARSCERESPALLJUNOVESTJUPI"
140 P$(41,80)="SATURANNEPTPLUTMC  ASC ANVXEP  N NDS ND"
150 REM TYPE OF TIME STRING
160 T$=" S D WLMDD"
170 REM PI, DEGREES TO RADIANS, RADIANS TO DEGREES
180 P1= 3.1415926535898
190 P2=P1/180
200 P3=180/P1
210 REM SINE OF DEGREES
220 DEF FNS(U)=SIN(U*P2)
230 REM COSINE OF DEGREES
240 DEF FNC(U)=COS(U*P2)
250 REM TANGENT OF DEGREES
260 DEF FNT(U)=SIN(U*P2)/COS(U*P2)
270 REM ARCSIN IN DEGREES
280 DEF FNA1(U)=ATN(U/SQRT(1-U*U))*P3
290 REM QUADRANT CHECKING ARCTAN IN DEGREES--ALTERS U1 WITHOUT RESTORING
300 DEF FNA4(U,U0)
310 U1=ATN(U/U0)*P3
320 IF U1<0 THEN U1=U1+180
330 IF U<0 THEN U1=U1+180
340 RETURN U1
350 FNEND
360 REM GET DEGREE, MINUTE, & DIRECTION FLAG FROM LONGITUDE OR LATITUDE
370 REM ALTERS W1,W2,W9--GLOBALLY AVAILABLE ANSWERS
380 REM PUTS ZERO WITH POSITIVE FLAG
390 DEF FND1(U)
400 IF U<0 THEN W9=2 ELSE W9=1
410 W1=INT(ABS(U))
420 W2=INT((ABS(U)-W1)*60+.5)
430 IF W2<>60 THEN 460
440 W2=0
450 W1=W1+1
460 RETURN W1
470 FNEND
480 REM JULIAN DATE, OBLIQUITY OF ECLIPTIC
490 REM ARGUMENTS ARE MONTH, DAY, YEAR, UNIVERSAL TIME
500 REM ALTERS U3,D1,E,J,O0,O1,T WITHOUT RESTORING
510 REM RETURNS J (JULIAN DAY #)
520 REM GLOBALLY AVAILABLE ARE D1 (DAYS FROM 1900 JAN 0.5),
530 REM T (JULIAN CENTURIES FROM 1900 JAN 0.5)
540 REM E (OBLIQUITY OF ECLIPTIC), O0 (COS OBL), O1 (SIN OBL)
550 DEF FNJ(U,U0,U1,U2)
560 IF U<3 THEN U1=U1-1
570 U3=U1+4712
580 U=U+1
590 IF U<4 THEN U=U+12
600 J=INT(U*365.25)+INT(30.6*U)+U0+U2/24-63.5
610 J=J-((INT(ABS(U1)/100)-INT(ABS(U1)/400))*SGN(U1))+2
620 IF U1<0 AND U1/100=INT(U1/100) AND U1/400<>INT(U1/400) THEN J=J-1
630 D1=J-2415020
640 T=D1/36525
650 E=23.45229444+(-.0130125+(-.000001644-.000000503*T)*T)*T
660 O0=FNC(E)
670 O1=FNS(E)
680 RETURN J
690 FNEND
700 REM MODULUS 360 (CIRCULARLY CORRECT FOR MINUS BECAUSE INT IS FLOOR)
710 DEF FNM0(U)=(U/360-INT(U/360))*360
720 REM GET RIGHT ASCENSION OF POINT ON ECLIPTIC (0 CELESTIAL LATITUDE)
730 DEF FNR0(U2)=FNA4(FNS(U2)*O0,FNC(U2))
740 REM GET SIDEREAL TIME (IN DEGREES=RA) AT WHICH ECLIPTIC POINT IS ASC
750 REM ALTERS V1,V2,V3,V4 WITHOUT RESTORING
760 REM ARGUMENTS ARE CELESTIAL LONGITUDE, TERRESTRIAL LATITUDE
770 REM FORMULA FOR RISING TIME IS RA-ASCENSIONAL DIFF-90
780 REM = RA ASC - ARCSIN (TAN LAT*TAN DEC) - 90
790 REM = ATAN2(SIN ASC*COS OBL,COS ASC)-ARCSIN(TAN LAT*
800 REM   TAN(ARCSIN(SIN ASC*SIN OBL)))-90
810 REM ATAN2 (FNA4) IS QUADRANT CHECKING ARCTAN
820 REM **IF WARNING--CAN BLOW UP IN ARCTIC REGIONS (IF ABS(V3)>1)
830 REM **IF LATITUDE LOOP IS EXTENDED TO ARCTIC REGIONS ADD CHECK
840 DEF FNR2(V,V0)
850 V1=FNS(V)
860 V2=FNC(V)
870 V3=FNT(FNA1(V1*O1))*FNT(V0)
880 V4=FNA4(V1*O0,V2)-FNA1(V3)-90
890 IF V4<0 THEN V4=V4+360
900 RETURN V4
910 FNEND
920 REM READ DATA FROM POSITION FILE WRITTEN BY CHART
930 INPUT #1, "GIVE FILE ID ",N0$(1,10)
940 OPEN #1, "POSITION"
950 REM B SAYS WHERE NEXT BLANK IS IN FILE
960 READ #1 %0, B
970 REM FIRST RECORD IS AT ADDRESS OF 10
980 P=10
990 READ #1 %P, N1$
1000 IF N0$(1,10)=N1$(1,10) THEN 1100
1010 REM RECORD LENGTH IS 1418 BYTES
1020 P=P+1418
1030 REM IF POINTER IS LESS THAN BLANK (END OF ENTRIES), TRY AGAIN
1040 IF P<B THEN 990
1050 CLOSE #1
1060 ! #1, 'NO SUCH ENTRY"
1070 GOTO 930
1080 REM NAME,MONTH,DAY,YEAR,TIME,ZONE,TIME TYPE,COMPRESSED GREENWICH DATE,
1090 REM GREENWICH TIME,LONGITUDE,LATITUDE,LOCAL LAT,LOC LONG,LOC SIDEREAL TIME
1100 READ #1 %P, N1$
1110 READ #1, M,D,Y,H,Z,T1,G0,G4,L0,L1,L2,L3,S9
1120 REM LONGITUDE, LATITUDE, RIGHT ASCENSION, DECLINATION
1130 FOR I=1 TO 19
1140   READ #1, L(I),L1(I),R1(I),D1(I)
1150 NEXT I
1160 CLOSE #1
1170 REM SWITCH FROM SCREEN TO PRINTER
1180 FILL 3328, 255
1190 REM !=PRINT
1200 !"ASTROCARTOGRAPHIC POINTS FOR ",N1$(11,30)
1210 W1=FND1(H)
1220 !"BORN",%2I,M,"/",D,"/",%4I,Y," AT",%3I,W1,":",%2I,W2,
1230 !" ",T$((T1+1)*2-1,(T1+1)*2),". TIME IN ZONE",%7F2.2
1240 W1=FND1(L1)
```

```
1250 !"AT LATITUDE",%3I,W1," ",N$(W9,W9),W2,
1260 W1=FND1(L0)
1270 !" AND LONGITUDE",%4I,W1," ",E$(W9,W9),%3I,W2
1280 REM UNPACK GREENWICH DATE (G1=MONTH,G2=DAY,G3=YEAR)
1290 G3=INT(G0/10000)
1300 F=G0-G3*10000
1310 G1=INT(F/100)
1320 G2=F-G1*100
1330 REM CALL JULIAN FUNCTION SO OBLIQUITY WILL BE AVAILABLE
1340 J=FNJ(G1,G2,G3,G4)
1350 REM GET GREENWICH SIDEREAL TIME IN DEGREES (FROM LST IN HOURS FROM FILE)
1360 G5=FNM0(S9*15+L0)
1370 !
1380 !"PLANET  ON UPPER MERIDIAN  ZENITH        LOWER MERIDIAN   NADIR"
1390 !"                LONGITUDE  LATITUDE          LONGITUDE  LATITUDE"
1400 REM L=LONGITUDE ON EARTH OF CONTACT
1410 REM GREENWICH RA (ST) MINUS RA OF PLANET GIVES WEST LONGITUDE
1420 REM AT ZENITH WHEN ON MERIDIAN & EARTH LATITUDE = DECLINATION
1430 FOR I=1 TO 19
1440   REM SKIP FROM PLUTO TO NORTH NODE
1450   IF I>14 AND I<19 THEN 1600
1460   L=FNM0(G5-R1(I))
1470   REM CONVERT LONGITUDE TO +/- 180
1480   IF L>180 THEN L=L-360
1490   !P$(I*4-3,4*I),
1500   W1=FND1(L)
1510   !%15I,W1," ",E$(W9,W9),%3I,W2,
1520   W1=FND1(D1(I))
1530   !%5I,W1," ",N$(W9,W9),%3I,W2,
1540   REM GO OPPOSITE FOR LOWER MERIDIAN & NADIR
1550   IF SGN(L)=1 THEN L=L-180 ELSE L=L+180
1560   W1=FND1(L)
1570   !%15I,W1," ",E$(W9,W9),%3I,W2,
1580   W1=FND1(-D1(I))
1590   !%5I,W1," ",N$(W9,W9),%3I,W2
1600 NEXT I
1610 !
1620 !"LONGITUDES ON EARTH OF ECLIPTIC ASPECTS TO MIDHEAVEN"
1630 !"0 IS CONJUNCT MIDHEAVEN, 180 IS CONJUNCT IC"
1640 !
1650 REM DO TWO PASSES TO GET ASPECTS
1660 REM SET LIMITS OF ASPECTS FOR 1ST PASS
1670 I1=-150
1680 I2=0
1690 !"ASPECTS",
1700 FOR I0=I1 TO I2 STEP 30
1710   !%8I,I0,"  ",
1720 NEXT I0
1730 !
1740 !"PLANETS"
1750 REM LOOP PLANETS, INNER LOOP ASPECTS
1760 REM A=ECLIPTIC ASPECT POINT, R=RA OF POINT
1770 FOR I=1 TO 19
1780   IF I>14 AND I<19 THEN 1890
1790   !P$(I*4-3,4*I),"   ",
1800   FOR I0=I1 TO I2 STEP 30
1810     A=FNM0(L(I)+I0)
1820     R=FNR0(A)
1830     L=FNM0(G5-R)
1840     IF L>180 THEN L=L-360
1850     W1=FND1(L)
1860     !%5I,W1," ",E$(W9,W9),%3I,W2,
1870   NEXT I0
1880   !
1890 NEXT I
1900 !
1910 REM SET LIMITS FOR SECOND PASS ON ASPECTS
1920 IF I1=30 THEN 1970
1930 I1=30
1940 I2=180
1950 GOTO 1690
1960 REM FORM FEED
1970 !CHR$(12)
1980 !"PLANETS ON ASC, RISING, ON DESC, & SETTING FOR ",N1$(11,30)
1990 !
2000 REM A4 IS ASCENSIONAL DIFFERENCE + 90, R IS RA
2010 REM LOOP PLANETS, INNER LOOP LATITUDES
2020 REM IF LATITUDE INCREMENT IS CHANGED, FORM FEED PAGING MUST CHANGE
2030 REM DITTO IF PICA INSTEAD OF ELITE PRINTER
2040 REM T2 TEST IS CHECK FOR PLANET NOT RISING AT HIGH LATITUDE
2050 FOR I=1 TO 19
2060   IF I>14 AND I<19 THEN 2360
2070   !P$(I*4-3,4*I),"    ON ASC      RISING      ON DESC     SETTING"
2080   !"LAT    LONGITUDE   LONGITUDE   LONGITUDE   LONGITUDE"
2090   FOR I0=-60 TO 60 STEP 10
2100     !%3I,I0,
2110     T2=FNT(D1(I))*FNT(I0)
2120     IF ABS(T2)>1 THEN 2150
2130     A4=FNA1(T2)+90
2140     REM ON ASCENDANT
2150     R=FNR2(L(I),I0)
2160     GOSUB 2430
2170     REM RISING
2180     IF ABS(T2)<=1 THEN 2210
2190     !"          ",
2200     GOTO 2240
2210     R=FNM0(R1(I)-A4)
2220     GOSUB 2430
2230     REM ON DESCENDANT
2240     R=FNR2(FNM0(L(I)+180),I0)
2250     GOSUB 2430
2260     REM SETTING
2270     IF ABS(T2)<=1 THEN 2300
2280     !
2290     GOTO 2330
2300     R=FNM0(R1(I)+A4)
2310     GOSUB 2430
2320     !
2330   NEXT I0
2340   !
2350   IF I=5 OR I=10 THEN !CHR$(12),"RISINGS & SETTINGS FOR ",N1$(11,30)
2360 NEXT I
2370 !CHR$(12)
2380 REM SWITCH BACK TO SCREEN
2390 FILL 3328, 0
2400 END
2410 REM SUBROUTINE TO GET & PRINT EARTH LONGITUDES
2420 REM CALLED FROM ASC-RISE-DESC-SET LOOP
2430 L=FNM0(G5-R)
2440 IF L>180 THEN L=L-360
2450 W1=FND1(L)
2460 !%7I,W1," ",E$(W9,W9),%3I,W2,
2470 RETURN
```



```
1290 CLOSE #1
1300 ! #1, "NO SUCH ENTRY"
1310 GOTO 1170
1320 REM NAME,MONTH,DAY,YEAR,TIME,ZONE,TIME TYPE,COMPRESSED GREENWICH DATE,
1330 REM GREENWICH TIME,LONGITUDE,LATITUDE,LOCAL LAT,LOC LONG,LOC SIDEREAL TIME
1340 READ #1 %P, N1$
1350 READ #1, M,D,Y,H,Z,T1,G0,G4,L0,L1,L2,L3,S9
1360 REM LONGITUDE, LATITUDE, RIGHT ASCENSION, DECLINATION
1370 FOR I=1 TO 19
1380   READ #1, L(I),L1(I),R1(I),D1(I)
1390 NEXT I
1400 CLOSE #1
1410 REM SWITCH FROM SCREEN TO PRINTER
1420 FILL 3328, 255
1430 REM !=PRINT
1440 !"FIXED STARS FOR ",N1$(11,30)
1450 W1=FNH(H)
1460 !"BORN",%2I,M,"/",D,"/",%4I,Y," AT",%3I,W1,":",%2I,W2,
1470 !" ",T$((T1+1)*2-1,(T1+1)*2)," TIME IN ZONE",%7F2,Z
1480 W1=FND4(L1)
1490 !"AT LATITUDE",%3I,W1," ",N$(W9,W9),W2,
1500 W1=FND4(L0)
1510 !" AND LONGITUDE",%4I,W1," ",E$(W9,W9),%3I,W2
1520 REM UNPACK GREENWICH DATE (G1=MONTH,G2=DAY,G3=YEAR)
1530 G3=INT(G0/10000)
1540 F=G0-G3*10000
1550 G1=INT(F/100)
1560 G2=F-G1*100
1570 REM CALL JULIAN FUNCTION SO OBLIQUITY WILL BE AVAILABLE
1580 J=FNJ(G1,G2,G3,G4)
1590 !
1600 W1=FNH(S9)
1610 !"NATAL SIDEREAL TIME IS",%3I,W1,W2
1620 REM GET SIDEREAL TIME IN DEGREES
1630 S9=S9*15
1640 !
1650 REM T0 IS TAN OF EARTH LATITUDE
1660 T0=FNT(L1)
1670 REM GET ALL PLANETS' RISE, SET, & LOWER CULMINATE TIMES
1680 REM PRINT ALL COORDINATES & TIMES FOR PLANETS IN GOSUB
1690 !"PLANET LONGITUDE    LAT       DEC       RISE    R A     SET  LOW CULM"
1700 FOR I=1 TO 19
1710   IF I>14 AND I<19 THEN 1890
1720   !P$(I*4-3,4*I),
1730   L4=L(I)
1740   L5=L1(I)
1750   D=D1(I)
1760   R1=R1(I)
1770   REM A4 IS ASCENSIONAL DIFFERENCE + 90
1780   A4=FNA1(FNT(D)*T0)+90
1790   REM RISING
1800   R0(I)=FNM0(R1-A4)
1810   R0=R0(I)
1820   REM SETTING
1830   S(I)=FNM0(R1+A4)
1840   S=S(I)
1850   REM LOWER CULMINATION
1860   R2(I)=FNM0(R1+180)
1870   R2=R2(I)
1880   GOSUB 3500
1890 NEXT I
1900 REM PUT IN NATAL SIDEREAL TIME AS PLANET 0
1910 R1(0)=S9
1920 L(0)=800
1930 R0(0)=800
1940 S(0)=800
1950 R2(0)=800
1960 REM SET COUNT OF NON-RISING STARS TO ZERO
1970 N0=0
1980 REM SET COUNTS OF CONTACTS TO ZERO
1990 N1=0
2000 N2=0
2010 OPEN #1, "STARFILE"
2020 READ #1 %0, N
2030 DIM R(N), P0(N), D(N), P1(N), S1$(N*38)
2040 !
2050 !"STAR CONTACTS OUT OF A LIST OF",%4I,N," STARS"
2060 !"ALL ORBS GIVEN IN MINUTES OF ARC"
2070 !
2080 !"STAR NAME      CONSTELLAT SP MAG   ",
2090 !"LONGITUDE    LAT       DEC       RISE    R A     SET  LOW CULM"
2100 !
2110 FOR I=1 TO N
2120   READ #1, S1$(I*38-37,38*I),R(I),P0(I),D(I),P1(I)
2130 NEXT I
2140 CLOSE #1
2150 REM SET # OF LINES PRINTED ON PAGE SO FAR
2160 N3=28
2170 REM SET # OF PAGES
2180 N4=1
2190 REM GET PRECESSIONAL CONSTANTS
2200 REM TROPICAL CENTURIES
2210 T1=36524.21988
2220 REM REDEFINE T FOR TROPICAL CENTURIES FROM 1950.0
2230 T=(J-2433282.423)/T1
2240 T2=T*T
2250 T3=T2*T
2260 REM ZETA SUB ZERO IN SUPPLEMENT
2270 C=2304.948*T+.302*T2+.0179*T3
2280 REM Z IN SUPPLEMENT
2290 Z=2304.948*T+1.093*T2+.0192*T3
2300 REM THETA IN SUPPLEMENT
2310 C0=2004.255*T-.426*T2-.0416*T3
2320 C=C/3600
2330 Z=Z/3600
2340 C0=C0/3600
2350 REM SINE THETA
2360 C1=FNS(C0)
2370 REM COSINE THETA
2380 C2=FNC(C0)
2390 REM START MAIN LOOP--ADD PROPER MOTION, PRECESS, GET LONGITUDE
2400 REM & LATITUDE, RISE, SET, LOWER CULMINATE TIMES, & COMPARE TO PLANETS
2410 REM R1=RA, D=DEC, L4=LONG, L5=LAT, R0=RISE, S=SET, R2=LOWER CULMINATION
2420 REM FORCE OUT OF RANGE TIME FOR STARS THAT DON'T RISE OR SET
2430 FOR I=1 TO N
2440   R(I)=R(I)+(P0(I)*(T*100))/3600
2450   D(I)=D(I)+(P1(I)*(T*100))/3600
2460   C3=R(I)+C
2470   C4=FNC(D(I))
2480   C5=FNS(D(I))
2490   C6=FNC(C3)
2500   D=FNA1(C2*C5+C1*C4*C6)
2510   C7=C4*FNS(C3)
2520   C8=C2*C4*C6-C1*C5
2530   C9=FNA4(C7,C8)
2540   P1=C9+Z
2550   R1=FNM0(P1)
2560   L4=FNL(P1,D)
```

```
10 REM FIXSTAR--FIXED STARS COMPARED TO NATAL PLANETS
20 REM STAR COORDINATES PRECESSED & CORRECTED FOR PROPER MOTION
30 REM DATE 5/6/79 REV 7/17
40 REM REV 7/30/79 SECONDS DROPPED TO FIT COORDS ON ONE LINE WITH NAME
50 REM REV 18 DEC 79 TO PUT PROPER MOTION CORRECTION BEFORE PRECESSION
60 LINE 110
70 DIM M(13), D1(20), L(20), L1(20), R1(20)
80 DIM R0(20), R2(20), S(20)
90 DIM C$(55), C1$(55), E$(2), N$(2), N0$(10), N1$(30), P$(80), S$(24), T$(10)
100 REM TYPES OF CONTACT
110 C$="CONJUNCT    RISING     CULMINATINGSETTING    AT LOW CULM"
120 C1$="IN LONGITUDRISING     CULMINATINGSETTING    AT LOW CULM"
130 REM STRINGS FOR DIRECTION OF LONGITUDE & LATITUDE
140 E$="WE"
150 N$="NS"
160 REM PLANET NAMES
170 P$(1,40)="SUN MOONMERCVENUMARSCEREPALLJUNOVESTJUPI"
180 P$(41,80)="SATURANNEPTPLUTMC  ASC ANVXEP  N NDS ND"
190 REM SIGNS
200 S$="ArTaGeCnLeViLiScSaCpAcPi"
210 REM TYPE OF TIME STRING
220 T$=" S D WLMDD"
230 REM PI, DEGREES TO RADIANS, RADIANS TO DEGREES
240 P1= 3.1415926535898
250 P2=P1/180
260 P3=180/P1
270 REM SINE OF DEGREES
280 DEF FNS(U)=SIN(U*P2)
290 REM COSINE OF DEGREES
300 DEF FNC(U)=COS(U*P2)
310 REM TANGENT OF DEGREES
320 DEF FNT(U)=SIN(U*P2)/COS(U*P2)
330 REM ARCSIN IN DEGREES
340 DEF FNA1(U)=ATN(U/SQRT(1-U*U))*P3
350 REM ARCCOS IN DEGREES
360 DEF FNA2(U)=(P1/2-ATN(U/SQRT(1-U*U)))*P3
370 REM QUADRANT CHECKING ARCTAN IN DEGREES--ALTERS U1 WITHOUT RESTORING
380 DEF FNA4(U,U0)
390 U1=ATN(U/U0)*P3
400 IF SGN(U1)=-1 THEN U1=U1+180
410 IF SGN(U)=-1 THEN U1=U1+180
420 RETURN U1
430 FNEND
440 REM GET ANGULAR SEPARATION (0-180) BETWEEN TWO FACTORS
450 REM OUTEP ABSOLUTE IS TO GET AROUND VALUES > 360 FORCED WHEN STARS DON'T RISE
460 REM NOT NEEDED WITH NORMAL 0 TO 360 VALUES
470 DEF FNA(U,U0)=ABS(180-ABS(180-ABS(U-U0)))
480 REM DEGREE TO DEGREE, SIGN, MINUTE
490 REM ALTERS U0 WITHOUT RESTORING
500 REM ANSWERS ARE W1,W2,W3 (DEG, SIGN, MIN)
510 DEF FND2(U)
520 U0=INT(U/30)
530 W1=INT(U-U0*30)
540 W2=U0+1
550 IF W2=13 THEN W2=1
560 W3=INT((U-INT(U))*60+.5)
570 RETURN W1
580 FNEND
590 REM GET DEGREE, MINUTE & DIRECTION FLAG
600 REM ANSWERS ARE W1,W2,W9
610 DEF FND4(U)
620 IF SGN(U)=-1 THEN W9=2 ELSE W9=1
630 W1=INT(ABS(U))
640 W2=INT((ABS(U)-W1)*60+.5)
650 RETURN W1
660 FNEND
670 REM HOURS TO HOURS, MINUTES
680 REM ANSWERS ARE W1,W2
690 DEF FNH(U)
700 W1=INT(U)
710 W2=INT((U-W1)*60+.5)
720 RETURN W1
730 FNEND
740 REM JULIAN DATE, OBLIQUITY OF ECLIPTIC
750 M(1)=0\M(2)=31\M(3)=59\M(4)=90\M(5)=120
760 M(6)=151\M(7)=181\M(8)=212\M(9)=243
770 M(10)=273\M(11)=304\M(12)=334\M(13)=365
780 REM ARGUMENTS ARE MONTH, DAY, YEAR, UNIVERSAL TIME
790 REM ALTERS U3,U4,U5,U6,U7,D1,E,J,O0,O1,T WITHOUT RESTOPING
800 REM RETURNS J (JULIAN DAY 0)
810 REM GLOBALLY AVAILABLE ARE D1 (DAYS FROM 1900.0), E (OBLIQUITY OF ECL),
820 REM O0 (COS OBL), O1 (SIN OBL), T (JULIAN CENTURIES FROM 1900.0)
830 DEF FNJ(U,U0,U1,U2)
840 U3=U2/24
850 U4=INT(U1/100)
860 U5=U1-U4*100
870 J=(U4+47)*36524+4435.5
880 U6=U5/4
890 U7=U5*365+INT(U6)+M(U)+U0+U3
900 IF (U6=INT(U6)) AND (U<3) AND ((U5<>0) OR (U4/4=INT(U4/4))) THEN U7=U7-1
910 J=J+U7
920 D1=J-2415020
930 T=D1/36525
940 E=23.45229444+(-.0130125+(-.00000164+.000000503*T)*T)*T
950 O0=FNC(E)
960 O1=FNS(E)
970 RETURN J
980 FNEND
990 REM LONGITUDE AND LATITUDE FROM RIGHT ASCENSION AND DECLINATION
1000 REM U1 IS ALTERED BY CALL TO FNA4, U2,U3,U4,U6,U7,U8,U9 ALTERED HERE
1010 REM U2 IS LONGITUDE, U4 IS LATITUDE
1020 DEF FNL(U,U0)
1030 U9=FNS(U)
1040 U8=FNS(U0)
1050 U7=FNC(U)
1060 U6=FNC(U0)
1070 U=U9*U6*O0+U8*O1
1080 U0=U6*U7
1090 U2=FNA4(U,U0)
1100 U3=U8*O0-U6*U9*O1
1110 U4=FNA1(U3)
1120 RETURN U2
1130 FNEND
1140 REM MODULUS 360 (CIRCULARLY CORRECT FOR MINUS BECAUSE INT IS FLOOR)
1150 DEF FNM0(U)=(U/360-INT(U/360))*360
1160 REM READ DATA FROM POSITION FILE WRITTEN BY CHART
1170 INPUT #1, "GIVE FILE ID ",N0$(1,10)
1180 OPEN #1, "POSITION,2"
1190 REM B SAYS WHERE NEXT BLANK IS IN FILE
1200 READ #1 %0, B
1210 REM FIRST RECORD IS AT ADDRESS OF 10
1220 P=10
1230 READ #1 %P, N1$
1240 IF N0$(1,10)=N1$(1,10) THEN 1340
1250 REM RECORD LENGTH IS 1418 BYTES
1260 P=P+1418
1270 REM IF POINTER IS LESS THAN BLANK (END OF ENTRIES), TRY AGAIN
1280 IF P<B THEN 1230
```

```
2570   L5=U4
2580   IF (90-ABS(D))<ABS(L1) THEN 2650
2590   A4=FNA1(FNT(D)*T0)+90
2600   R0=R1-A4
2610   IF R0<0 THEN R0=R0+360
2620   S=R1+A4
2630   IF S>=360 THEN S=S-360
2640   GOTO 2680
2650   R0=1000
2660   S=1000
2670   N0=N0+1
2680   R2=FNM0(R1+180)
2690   P0(I)=0
2700   GOSUB 3490
2710   FOR I0=0 TO 19
2720     IF I0>14 AND I0<19 THEN 3230
2730     A=FNA(L(I0),L4)
2740     S6=1
2750     S7=1
2760     IF A<=1 THEN GOSUB 3370
2770     A=FNA(P0(I0),R0)
2780     S6=2
2790     S7=2
2800     IF A<=1 THEN GOSUB 3370
2810     A=FNA(R1(I0),R0)
2820     S7=3
2830     IF A<=1 THEN GOSUB 3370
2840     A=FNA(S(I0),R0)
2850     S7=4
2860     IF A<=1 THEN GOSUB 3370
2870     A=FNA(R2(I0),R0)
2880     S7=5
2890     IF A<=1 THEN GOSUB 3370
2900     A=FNA(R0(I0),R1)
2910     S6=3
2920     S7=2
2930     IF A<=1 THEN GOSUB 3370
2940     A=FNA(R1(I0),R1)
2950     S7=3
2960     IF A<=1 THEN GOSUB 3370
2970     A=FNA(S(I0),R1)
2980     S7=4
2990     IF A<=1 THEN GOSUB 3370
3000     A=FNA(R2(I0),R1)
3010     S7=5
3020     IF A<=1 THEN GOSUB 3370
3030     A=FNA(R0(I0),S)
3040     S6=4
3050     S7=2
3060     IF A<=1 THEN GOSUB 3370
3070     A=FNA(R1(I0),S)
3080     S7=3
3090     IF A<=1 THEN GOSUB 3370
3100     A=FNA(S(I0),S)
3110     S7=4
3120     IF A<=1 THEN GOSUB 3370
3130     A=FNA(R2(I0),S)
3140     S7=5
3150     IF A<=1 THEN GOSUB 3370
3160     A=FNA(R0(I0),R2)
3170     S6=5
3180     S7=2
3190     IF A<=1 THEN GOSUB 3370
3200     A=FNA(S(I0),R2)
3210     S7=4
3220     IF A<=1 THEN GOSUB 3370
3230   NEXT I0
3240 NEXT I
3250 FOR I=1 TO N
3260 N1=N1+P0(I)
3270 NEXT I
3280 !
3290 !"THERE WERE CONTACTS WITH",%4I,N1," OF THE STARS ON THE LIST"
3300 !"THERE WERE",%5I,N2," CONTACTS ALTOGETHER"
3310 !%3I,N0," OF THE STARS ON THE LIST NEITHER RISE NOR SET"
3320 REM SWITCH BACK TO SCREEN
3330 FILL 3328, 0
3340 !FREE(0)
3350 END
3360 REM PRINT NATURE AND ORB OF CONTACT
3370 P0(I)=1
3380 IF I0<>0 THEN 3410
3390 !"   ",C$(S6*11-10,11*S6)," AT NATAL SIDERL TIME ",
3400 GOTO 3430
3410 !"   ",C$(S6*11-10,11*S6)," WITH ",P$(I0*4-3,4*I0),
3420 !" ",C1$(S7*11-10,11*S7),
3430 !" WITH ORB",%5F1,A*60
3440 N2=N2+1
3450 N3=N3+1
3460 IF N3=80 THEN GOSUB 3680
3470 RETURN
3480 REM PRINT STAR NAME & COORDINATES & TIMES
3490 !S1$(I*38-37,I*38-6),
3500 W1=FND2(L4)
3510 !%5I,W1," ",S$(W2*2-1,2*W2),%3I,W3,
3520 W1=FND4(L5)
3530 !%5I,W1," ",N$(W9,W9),%3I,W2,
3540 W1=FND4(D)
3550 !%5I,W1," ",N$(W9,W9),%3I,W2,
3560 W1=FNH(R0/15)
3570 IF W1<=24 THEN !%5I,W1,%3I,W2, ELSE !"        ",
3580 W1=FNH(R1/15)
3590 !%5I,W1,%3I,W2,
3600 W1=FNH(S/15)
3610 IF W1<=24 THEN !%5I,W1,%3I,W2, ELSE !"        ",
3620 W1=FNH(R2/15)
3630 !%5I,W1,%3I,W2
3640 N3=N3+1
3650 IF N3=80 THEN GOSUB 3680
3660 RETURN
3670 REM FORM FEED & REPEAT HEADERS FOR NEW PAGES
3680 !CHR$(12)
3690 N4=N4+1
3700 !"FIXED STARS FOR ",N1$(11,30),"          PAGE",%3I,N4
3710 !"STAR NAME      CONSTELLAT SP MAG    ",
3720 !"LONGITUDE    LAT       DEC      RISE    R A     SET  LOW CULM"
3730 !
3740 N3=4
3750 RETURN
```

STARLIST--NAMES, CONSTELLATION DESIGNATIONS, SPECTRAL CLASSES,
MAGNITUDES, AND GC #S OF NAMED STARS IN ALPHA FIELD
(IF SPECTRUM IS TWO LETTERS STAR IS VERY CLOSE DOUBLE)
(P IS A PECULIAR SPECTRUM, N IS A NEBULA, C IS A CLUSTER)
(FOR NEBULAS & CLUSTERS, NGC # IS GIVEN INSTEAD OF GC #)
1950.0 RIGHT ASCENSION (HOUR, MINUTE, SECOND) & PROPER MOTION (FOR 1 YR),
1950.0 DECLINATION (DEGREE, MINUTE, SECOND) & PROPER MOTION (FOR 1 YR)
IF DEC IS MINUS, ALL THREE VALUES ARE MADE MINUS
PROPER MOTIONS ARE IN SECONDS (TIME FOR RA, ARC FOR DEC)
IF STAR NAME IS FOR PARTICULAR COMPONENT OF MULTIPLE, # IS 5TH CHARACTER
OF GREEK LETTER
IF NAME DOESN'T INDICATE WHICH COMPONENT OF MULTIPLE, # IS 6TH CHARACTER
OF GREEK LETTER--INDICATES WHICH STAR WAS USED (USUALLY THE BRIGHTER)
FOR STARS WITH MORE THAN ONE NAME, ONLY ONE GIVES ALL DATA
OTHERS REFER TO THAT NAME (WITH 'SEE' IN 1ST 3 CHAR OF GREEK LETTER)

PROBLEMS:
'DENEB' MEANS TAIL AND IS APPLIED TO MANY STARS--THE BRIGHT ONE IS
DENEB ADIGE IN CYGNUS (I HAVE SPELLED ROBSON'S PLAIN DENEB AS DHENEB).
LESATH IS UPSILON SCO, JABBAH IS NU SCO--NU FOR LESATH IS A MISREAD.
MARKEB IS KAPPA VELA--NOT PUPPIS AS GIVEN IN SEVERAL PLACES (THERE IS NO KAPPA PUP)
MENKIB IS XI PERSEUS, NOT ZETA AS GIVEN SOME PLACES.
MUSCIDA HAS BEEN USED FOR BOTH OMICRON & PI 2 URSA MAJOR,
BUT THE CASE FOR OMICRON SEEMS BETTER
SPICULUM FROM ROBSON IS THREE THINGS SPREAD OVER 45' RA & 2 DEG DEC
I USED THE BRIGHTEST OF THE THREE (M8--THE LAGOON NEBULA)
ROBSON MESSED UP IN GEMINI ON IOTA, MU, & ETA. ETA SHOULD BE PROPUS,
MU IS TEJAT POSTERIOR, & IOTA DOESN'T HAVE A LEGITIMATE NAME.
THERE IS SOME UNCERTAINTY ABOUT THE ZUBENs IN LIBRA-SCORPIO.

STAR NAME	CONSTELLAT	SP	MAG	GC #	RA	PM	DEC	PM
ACAMAR	THETA1 ERI	A2	3.4	3584	2 56 21.9	-.005	-40 -30 -15	.03
ACAMER	SEE ACAMAR							
ACHERNAR	ALPHA ERI	B9	0.6	1979	1 35 51.2	.011	-57 -29 -25	-.03
ACHIRD	ETA CAS	F9	3.6	962	0 46 3.4	.137	57 33 3	-.52
ACRAB	BETA 1 SCO	B1	2.9	21609	16 2 31.5	.000	-19 -40 -13	-.03
ACRUX	ALPHA1 CRU	B1	1.6	16952	12 23 48.0	-.005	-62 -49 -20	-.03
ACUBENS	ALPHA CNC	F0	4.3	12406	8 55 45.3	.002	12 3 9	-.04
ACULEUS	M6 SCO	C	5.3	6405	17 36 48.0	.000	-32 -11 0	.00
ACUMEN	M7 SCO	C	3.2	6475	17 50 42.0	.000	-34 -48 0	.00
ADARA	EPSILO CMA	B1	1.6	9188	6 56 39.6	.000	-28 -54 -10	.00
ADHAFERA	ZETA LEO	F0	3.6	14107	10 13 54.8	.001	23 40 2	-.01
ADHARA	SEE ADARA							
ADHIL	XI AND	G9	5.0	1647	1 19 23.1	.003	45 16 3	.01
AGENA	BETA CEN	B3	0.9	18971	14 0 16.5	-.003	-60 -7 -58	-.03
AIN	EPSILO TAU	G8	3.6	5430	4 25 41.6	.008	19 4 16	-.04
ALAMAK	SEE ALMACH							
ALARAPH	SEE ZAVIJAVA							
ALBALDAH	PI SGR	F3	3.0	26386	19 6 47.4	.000	-21 -6 -18	-.04
ALBALI	EPSILO AQR	A1	3.8	28978	20 44 58.2	.002	-9 -40 -48	-.03
ALBIREO	BETA 1 CYG	K1	3.2	26953	19 28 42.2	.000	27 51 12	-.01
ALBIREOR	SEE ALBIREO							
ALCHIBA	SEE ALCHITA							
ALCHITA	ALPHA CRV	F2	4.2	16586	12 5 49.8	.006	-24 -27 0	-.05
ALCOR	80 UMA	A1	4.0	18155	13 23 13.5	.014	55 14 53	-.02
ALCYONE	ETA TAU	B7	3.0	4541	3 44 30.4	.002	23 57 8	-.04
ALDEBARAN	ALPHA TAU	KM	1.1	5605	4 33 2.9	.005	16 24 37	-.19
ALDERAMIN	ALPHA CEP	A7	2.6	29848	21 17 23.2	.021	62 22 24	.05
ALDIB	SEE NODUS II							
ALFARD	ALPHA HYA	K3	2.2	13044	9 25 7.8	-.001	-8 -26 -27	.03
ALFIRK	SEE ALPHIRK							
ALGEDI	SEE GIEDI							
ALGIEDI	SEE GIEDI							
ALGIFBA	SEE ALGIEPA							
ALGENIB	GAMMA PEG	P2	2.9	238	0 10 39.4	.000	14 54 20	-.01
ALGENIB(AL PER)	SEE MIRFAK							
ALGENUBI	SEE RAS ELASED AUSTRALI							
ALGIEBA	GAMMA1 LEO	K0	2.6	14177	10 17 13.1	.022	20 5 43	-.15
AL GIEDI	SEE GIEDI							
ALGOL	BETA PER	B8	VAR	3733	3 4 54.4	.000	40 45 52	.00
ALGORAB	DELTA CRV	A0	3.1	17029	12 27 16.4	-.015	-16 -14 -14	-.14
ALHAJOTH	SEE CAPELLA							
AL HECKA	ZETA TAU	B2	3.0	6985	5 34 39.3	.000	21 6 58	-.02
ALHENA	GAMMA GEM	A1	1.9	8633	6 34 49.4	.003	16 26 37	-.05
ALIOTH	EPSILO UMA	A0	1.7	17518	12 51 50.1	.014	56 13 51	-.01
AL JABHAH	ETA LEO	A0	3.6	13899	10 4 36.6	.000	17 0 26	-.01
ALKAID	ETA UMA	B3	1.9	18643	13 45 34.3	-.012	49 33 44	-.02
ALKALUROPS	MU 1 BOO	A7	4.5	20724	15 22 36.0	-.012	37 33 5	.08
ALKAUROPS	SEE ALKALUROPS							
ALKES	ALPHA CRT	K1	4.2	15106	10 57 20.2	-.032	-18 -1 -56	.12
ALMACH	GAMMA1 AND	K2	2.3	2477	2 0 49.2	.004	42 5 27	-.05
ALMAK	SEE ALMACH							
ALMUREDIN	SEE VINDEMIATRIX							
ALNAIR	ALPHA GRU	B5	2.2	30942	22 5 5.4	.012	-47 -12 -15	-.15
ALNASL	GAMMA SGR	K0	3.1	24632	18 2 35.7	-.004	-30 -25 -36	-.19
AL NATH	SEE EL NATH							
ALNILAM	EPSILO ORI	B0	1.8	6960	5 33 40.5	.000	-1 -13 -56	.00
ALNITAK	ZETA ORI	B0	2.0	7089	5 38 14.1	.000	-1 -58 -3	.00
ALPHARD	SEE ALFARD							
ALPHECCA	ALPHA CRB	A0	2.3	20947	15 32 34.2	.009	26 52 54	-.10
ALPHERATZ	ALPHA AND	B8	2.2	127	0 5 47.8	.010	28 48 52	-.16
AL PHERG	ETA PSC	G3	3.7	1839	1 28 48.2	.002	15 5 19	-.01
ALPHIRK	BETA CEP	B2	3.3	30118	21 28 1.4	.002	70 20 20	.01
ALPAI	GAMMA CEP	K1	3.4	32875	23 37 16.6	-.020	77 21 12	.15
ALRAKIS	SEE ARRAKIS							
ALRAMI	SEE RUKBAT							
ALRISHA	ALPHA PSC	A2	3.9	2452	1 59 27.4	.002	2 31 23	.00
ALRUCCABA	SEE POLARIS							
ALSHAIN	BETA AQL	G8	3.9	27587	19 52 51.4	.003	6 16 50	-.48
ALSHAT	NU CAP	A0	4.8	28282	20 17 53.5	.001	-12 -55 -5	-.02
ALSUHAIL	LAMBDA VEL	K4	2.2	12623	9 6 9.3	-.002	-43 -13 -48	.01
ALTAIR	ALPHA AQL	A7	0.9	27470	19 48 20.6	.036	8 44 5	.38
ALTAIS	SEE NODUS II							
AL TARF	BETA CNC	K4	3.8	11254	8 13 48.3	-.003	9 20 28	-.05
ALTERF	LAMBDA LEO	K5	4.5	13143	9 28 52.3	-.002	23 11 22	-.04
ALUDRA	ETA CMA	B5	2.4	9886	7 22 7.0	.000	-29 -12 -16	.00
ALULA AUSTRALE	XI UMA	G0	3.9	15537	11 15 31.2	-.034	31 48 39	-.59
ALULA BOREALE	NU UMA	K3	3.7	15547	11 15 47.0	-.002	33 22 2	.02
ALWAID	BETA DRA	G2	3.0	23741	17 29 18.1	-.002	52 20 15	.01
AL WAZOR	SEE WEZEN							
ALYA	THETA1 SER	A5	4.5	25991	18 53 44.0	.003	4 8 13	.03
ALZIRR	XI GEM	F5	3.4	8823	6 42 29.0	-.008	12 57 4	-.20
ANCHA	THETA AQR	G6	4.3	31152	22 14 11.8	.008	-8 -1 -59	-.02
ANGETENAR	TAU 2 ERI	K0	4.8	3429	2 48 46.2	-.004	-21 -12 -33	-.01
ANKAA	ALPHA PHE	G5	2.4	519	0 23 49.0	.018	-42 -34 -39	-.40
ANTARES	ALPHA SCO	MB	1.2	22157	16 26 20.2	-.001	-26 -19 -22	-.03
ANTILICUS	SEE KOPNEPHOROS							
ARCTURUS	ALPHA BOO	K2	0.2	19242	14 13 22.8	-.070	19 26 31	-2.00
ARICH	SEE PORRIMA							
ARIDED	SEE DENEB ADIGE							
ARKAB POSTERIOR	BETA2 SGR	A9	4.5	26718	19 19 36.6	.009	-44 -53 -45	-.06

STAR NAME	CONSTELLAT	SP	MAG	GC #	RA	PM	DEC	PM
ARKAB PRIOR	BETA1 SGR	B8	4.2	26703	19 19 2.8	.000	-44 -33 -18	-.02
ARKEB POSTERIOR	SEE ARKAB POSTERIOR							
ARKEB PRIOR	SEE ARKAB PRIOR							
ARMUS	ETA CAP	A4	4.9	29419	21 1 33.7	-.003	-20 -3 -14	-.04
ARNEB	ALPHA LEP	F0	2.7	6875	5 30 31.4	.000	-17 -51 -24	.00
ARRAI	SEE ALRAI							
ARRAKIS	MU DRA	F6	5.1	23092	17 4 17.4	-.009	54 32 8	.08
ASCELLA	ZETA SGR	A4	2.7	26161	18 59 25.9	-.002	-29 -57 -13	.00
ASELLUS AUSTRAL	DELTA CNC	K0	4.2	12022	8 41 50.8	-.001	18 20 22	-.24
ASELLUS BOREALI	GAMMA CNC	A0	4.7	11982	8 40 23.7	-.007	21 38 59	-.04
ASPIDISKE	SEE TUREIS							
ASTERION	BETA CVN	G0	4.3	17127	12 31 22.3	-.063	41 37 44	.28
ASTEROPE	21 TAU	B9	5.8	4502	3 42 55.4	.001	24 24 0	-.04
ATIKS	OMICRO PER	B1	3.8	4461	3 41 10.6	.001	32 7 53	-.01
ATLAS	27 TAU	B9	3.8	4586	3 46 11.0	.001	23 54 7	-.04
ATRIA	ALPHA TRA	K5	1.9	22558	16 43 21.0	.004	-68 -56 -20	-.04
AUVA	DELTA VIR	M3	3.7	17543	12 53 5.0	-.031	3 40 7	-.06
AVIOR	EPSILO CAR	KP	1.7	11463	8 21 29.4	-.004	-59 -20 -53	.01
AZELFAFAGE	PI 1 CYG	P3	4.8	30391	21 40 19.0	.000	50 57 39	.00
AZHA	ETA ERI	K2	4.0	3539	2 53 59.0	.005	-9 -5 -46	-.21
AZIMECH	SEE SPICA							
AZMIDISKE	XI PUP	G6	3.5	10562	7 47 11.4	.000	-24 -43 -59	.00
BAHAM	SEE BIHAM							
BATEN KAITOS	ZETA CET	K0	3.9	2249	1 48 59.4	.002	-10 -34 -53	-.04
BECRUX	SEE MIMOSA							
BEID	OMIC1 ERI	F1	4.1	5056	4 9 25.4	.001	-6 -58 0	.09
BELLATRIX	GAMMA ORI	B2	1.7	6668	5 22 26.9	.000	6 18 22	-.01
BENETNASH	SEE ALKAID							
BETELGEUSE	ALPHA ORI	M2	VAR	7451	5 52 27.8	.002	7 23 58	.01
BIHAM	THETA PEG	A2	3.7	31013	22 7 40.6	.018	5 57 4	.03
BOS	RHO CAP	F1	5.0	28481	20 26 .6	-.001	-17 -58 -50	-.02
BOTEIN	DELTA ARI	K2	4.5	3805	3 8 45.9	.011	19 32 20	-.01
BUNGULA	SEE TOLIMAN							
CANICULA	SEE SIRIUS							
CANOPUS	ALPHA CAR	F0-0.9		8302	6 22 50.5	.002	-52 -40 -4	.02
CAPELLA	ALPHA AUR	GG	0.2	6427	5 12 59.5	.008	45 56 58	-.43
CAPH	BETA CAS	F2	2.4	147	0 6 29.8	.068	58 52 27	-.18
CAPHIR	SEE POPRIMA							
CAPULUS	33Hvi PEP	C	4.4	869	2 15 30.8	.000	56 55 0	.00
CASTOR	ALPHA GEM	AA	1.6	10120	7 31 24.7	-.013	31 59 58	-.11
CASTRA	EPSILO CAP	B5	4.7	30252	21 34 17.0	.001	-19 -41 -28	.00
CEBALRAI	SEE KELB ALRAI							
CEGINUS	PHI POO	G5	5.4	21032	15 36 1.8	.005	40 30 55	.05
CELAENO	16 TAU	B7	5.4	4475	3 41 49.5	.001	24 8 1	-.04
CHAPA (AL CVN)	SEE COR CAROLI							
CHAPA (BE CVN)	SEE ASTEPION							
CHELEB	SEE KELB ALRAI							
CHEPTAN	SEE COXA							
CHOPT	SEE COXA							
CIH	GAMMA CAS	B0	VAR	1117	0 53 40.3	.004	60 26 47	.00
COPULA	M51 CVN	N	8.1	5194	13 27 48.0	.000	47 27 0	.00
COR CAROLI	ALPHA2 CVN	A0	2.9	17557	12 53 41.5	-.020	38 35 17	.05
COR HYDRAE	SEE ALFARD							
COR LEONIS	SEE REGULUS							
COR SCORPII	SEE ANTARES							
COR SERPENTIS	SEE UNUKALHAI							
COXA	THETA LEO	A4	3.4	15441	11 11 37.1	-.004	15 42 11	-.08
CUJAM	SEE KAJAM							
CURSA	BETA ERI	A3	2.9	6274	5 5 23.4	-.006	-5 -8 -58	-.08
CYNOSURA	SEE POLARIS							
DABIH	BETA CAP	FB	3.2	28295	20 18 12.2	.003	-14 -56 -27	.00
DENEB (AL CYG)	SEE DENEB ADIGE							
DENEB (ZE AQL)	SEE DHENEB							
DENEB ADIGE	ALPHA CYG	A2	1.3	28846	20 39 43.5	.000	45 6 3	.00
DENEB ALGEDI	DELTA CAP	A5	3.0	30491	21 44 17.0	.010	-16 -21 -19	-.29
DENEB CYGNI	SEE DENEB ADIGE							
DENEB KAITOS	BETA CET	K0	2.2	865	0 41 4.8	.016	-18 -15 -39	.04
DENEB OKAB	DELTA AQL	A5	3.4	26816	19 22 58.6	.017	3 0 49	.08
DENEBOLA	BETA LEO	A4	2.2	16189	11 46 30.6	-.034	14 51 6	-.12
DHENEB	ZETA AQL	B9	3.0	26270	19 3 6.7	-.001	13 47 15	-.10
DIADEM	ALPHA COM	F4	4.3	17833	13 7 33.3	-.030	17 47 36	.13
DIFDA	SEE DENEB KAITOS							
DIPHDA	SEE DENEB KAITOS							
DIRAH	SEE TEJAT POSTERIOR							
DORSUM	THETA CAP	A0	4.2	29460	21 3 8.3	.006	-17 -25 -58	-.06
DSCHUBBA	DELTA SCO	B0	2.5	21489	15 57 22.3	-.001	-22 -28 -52	-.03
DUBHE	ALPHA UMA	K0	2.0	15185	11 0 39.5	-.017	62 1 17	-.07
DUHR	SEE ZOSMA							
DZIBAN	PSI 1 DRA	F5	4.9	24089	17 42 49.3	.004	72 10 26	-.27
EDASICH	IOTA DRA	K2	3.5	20747	15 23 40.8	-.001	59 8 26	.01
ELACRAB	SEE ACRAB							
ELECTRA	17 TAU	B5	3.8	4477	3 41 54.1	.002	23 57 28	-.04
ELGOMAISA	SEE PROCYON							
EL KOPHRAH	CHI UMA	K1	3.8	16137	11 43 25.0	-.014	48 3 24	.02
EL NATH	BETA TAU	B7	1.8	6681	5 23 7.8	.002	28 34 2	-.18
ELTANIN	SEE ETAMIN							
ENIF	EPSILO PEG	K2	2.5	30431	21 41 43.7	.002	9 38 41	.00
ENSIS	M42 ORI	N	4.0	1976	5 32 49.0	.000	-5 -25 -16	.00
ERAKIS	MU CEP	M2	VAR	30440	21 41 58.5	.000	58 33 0	.00
ERRAI	SEE ALRAI							
ETAMIN	GAMMA DRA	K5	2.4	24432	17 55 26.6	-.001	51 29 38	-.02
FACIES	M22 SGR	C	5.9	6656	18 33 18.0	.000	-23 -58 0	.00
FOM	SEE ENIF							
FOMALHAUT	ALPHA PSA	A2	1.3	32008	22 54 53.5	.025	-29 -53 -16	-.16
FORAMEN	ETA CAP	P	VAR	14799	10 43 6.9	.000	-59 -25 -16	.00
FURUD	ZETA CMA	B5	3.1	8170	6 18 23.6	.000	-30 -2 -24	.00
GACRUX	GAMMA CRU	M4	1.6	17052	12 28 22.7	.003	-56 -50 -1	-.27
GEMMA	SEE ALPHECCA							
GIANFAR	SEE GIANSAR							
GIANSAR	LAMBDA DRA	M0	4.1	15799	11 28 27.5	-.008	69 36 26	-.02
GIAUSAR	SEE GIANSAR							
GIEDI PRIMA	ALPH1 CAP	G5	4.6	28189	20 14 52.6	.001	-12 -39 -51	.00
GIEDI SECUNDA	ALPH2 CAP	G8	3.8	28200	20 15 16.9	.004	-12 -42 -5	.00
GIENAH (CRV)	GAMMA CRV	B8	2.8	16748	12 13 13.9	-.011	-17 -15 -52	.02
GIENAH (CYG)	EPSILO CYG	K0	2.6	28959	20 44 11.2	.028	33 46 55	.32
GNOSIA	SEE ALPHECCA							
GOMEISA	BETA CMI	B8	3.1	9947	7 24 26.4	-.003	8 23 30	-.04
GORGONA	SEE ALGOL							
GRAFIAS	ZETA 2 SCO	K5	3.8	22751	16 51 3.6	-.011	-42 -16 -40	-.24
GRAFFIAS	SEE ACRAB							
GREDI	SEE GIEDI							
GRUMIUM	XI DRA	K3	3.9	24364	17 52 39.7	.011	56 52 47	.07
HADAR	SEE AGENA							
HAMAL	ALPHA ARI	K2	2.2	2538	2 4 20.9	.014	23 13 37	-.15
HAN	ZETA OPH	O9	2.7	22332	16 34 24.1	.001	-10 -28 -3	.02
HAPIS	SEE SEGINUS							
HASSELEH	IOTA AUR	K3	2.9	6029	4 53 44.0	.001	33 5 20	-.02
HATSYA	IOTA ORI	O9	2.9	6937	5 32 59.2	.000	-5 -56 -28	.00
HEKA	SEE MEISSA							
HEZE	ZETA VIR	A2	3.4	18351	13 32 8.6	-.019	0 -20 -28	.03

STAR NAME	CONSTELLAT	SP	MAG	GC #	RA	PM	DEC	PM
HOEDUS I	ZETA AUR	KB	VAR	6137	4 58 58.7	.001	41 0 18	-.02
HOEDUS II	ETA AUR	B3	3.3	6226	5 3 .2	.003	41 10 8	-.07
HOMAN	ZETA PEG	B8	3.6	31664	22 38 58.0	.005	10 34 11	-.01
HYADUM I	SEE PRIMA HYADUM							
HYADUM II	DELTA TAU	G8	3.9	5304	4 20 2.9	.008	17 25 37	-.03
ISIDIS	SEE DSCHUBBA							
IZAR	EPSILO BOO	K0	2.7	19856	14 42 48.2	-.004	27 17 2	.01
JABBAH	NU SCO	B2	4.3	21773	16 9 5.1	-.001	-19 -19 -57	-.03
KAFFA	SEE MEGREZ							
KAFFALJIDHMA	GAMMA CET	AF	3.6	3276	2 40 42.4	-.009	3 1 34	-.15
KAITAIN	SEE ALRISHA							
KAJAM	OMEGA HER	A2	4.5	22090	16 23 6.4	.003	14 8 49	-.06
KALB	SEE REGULUS							
KAUS AUSTRALIS	EPSILO SGR	B9	2.0	25100	18 20 51.2	-.003	-34 -24 -37	-.13
KAUS BOREALIS	LAMBDA SGR	K1	2.9	25180	18 24 53.0	-.004	-25 -27 -4	-.19
KAUS MEDIUS	DELTA SGR	K2	2.8	25024	18 17 47.6	.003	-29 -51 -5	-.03
KEID	OMIC2 ERI	K0	4.5	5138	4 12 58.2	-.150	-7 -43 -46	-3.42
KELB ALPAI	BETA OPH	K1	2.9	24048	17 41 .0	-.003	4 35 11	.15
KEPP	TAU PEG	A5	4.6	32503	23 18 9.5	.002	23 27 59	-.01
KHAMBALIA	LAMBDA VIR	A2	4.6	19311	14 16 24.0	-.001	-13 -8 -31	.02
KIFFA AUSTRALIS	SEE ZUBEN ELGENUBI							
KIFFA BOREALIS	SEE ZUBEN ELSCHEMALI							
KITALPHA	ALPHA EQU	FA	4.1	29735	21 13 19.4	.004	5 2 24	-.09
KOCHAB	BETA UMI	K4	2.2	20029	14 50 49.7	-.008	74 21 35	.01
KORNEPHOROS	BETA HER	G8	2.8	22193	16 20 4.1	-.007	21 35 50	-.02
KRAZ	BETA CRV	G4	2.8	17133	12 31 45.4	.000	-23 -7 -14	-.06
KSORA	SEE RUCHA							
KUMA	NU 1 DRA	A8	5.0	23797	17 31 11.3	.017	55 13 4	.05
KURDAH	XI CEP	FG	4.6	30877	22 2 20.5	.032	64 23 2	.09
KURHAH	SEE KURDAH							
KURSA	SEE CURSA							
LABRUM	DELTA CRT	K0	3.8	15567	11 16 50.3	-.009	-14 -30 -28	-.20
LESATH	UPSILO SCO	B3	2.8	23693	17 27 21.7	.000	-37 -15 -29	-.04
MAASYM	LAMBDA HER	K4	4.5	23726	17 28 43.0	.001	26 8 49	.02
MAIA	20 TAU	B9	4.0	4500	3 42 50.8	.002	24 12 47	-.04
MANUBRIUM	OMICRO SGR	G8	3.9	26224	19 1 41.2	.006	-21 -49 0	-.06
MARFIK	LAMBDA OPH	A1	3.8	22203	16 28 23.4	-.002	2 5 31	-.00
MARKAB	ALPHA PEG	B9	2.6	32149	23 2 16.1	.004	14 56 9	-.04
MARKEB	KAPPA VEL	B3	2.6	12938	9 20 33.9	-.001	-54 -47 -48	.00
MARSIK	KAPPA HER	G4	5.3	21696	16 5 49.0	-.003	17 10 43	-.02
MATAR	ETA PEG	G2	3.1	31706	22 40 39.3	.001	29 57 33	-.02
MEBSUTA	EPSILO GEM	G8	3.2	8786	6 40 51.4	.000	25 10 57	-.02
MEGREZ	DELTA UMA	A3	3.4	16736	12 12 57.6	.013	57 18 37	.00
MEISSA	LAMBDA ORI	O8	3.7	6915	5 32 22.9	.000	9 54 8	-.01
MEKAR	SEE MENKAR							
MEKPUDA	ZETA GEM	G0	VAR	9313	7 1 8.7	.000	20 38 43	.00
MELLELAH	SEE METALLAH							
MENKALINAN	BETA AUR	A2	VAR	7543	5 55 51.6	-.005	44 56 41	.00
MENKAR	ALPHA CET	M2	2.8	3643	2 59 39.8	-.001	3 53 41	-.07
MENKENT	THETA CEN	G9	2.3	19033	14 3 43.9	-.043	-36 -7 -30	-.52
MENKHIB	SEE MENKIB							
MENKIB	XI PER	O7	4.0	4779	3 55 42.9	.001	35 38 56	.00
MERAK	BETA UMA	A1	2.4	15145	10 58 50.3	.010	56 39 3	.03
MEREZ	SEE NEKKAR							
MERGA	38 BOO	F4	5.8	19959	14 47 31.7	.000	46 19 25	-.08
MEROPE	23 TAU	B5	4.2	4512	3 43 21.2	.002	23 47 39	-.04
MESARTHIM	GAMMA1 ARI	A0	4.8	2290	1 50 46.9	.005	19 3 6	-.11
METALLAH	ALPHA TRI	F2	3.6	2272	1 50 13.4	.001	29 20 10	-.23
MIAPLACIDUS	BETA CAR	A0	1.8	12764	9 12 39.7	-.029	-69 -30 -40	.10
MIMOSA	BETA CRU	B1	1.5	17374	12 44 47.1	-.005	-59 -24 -57	-.03

STAR NAME	CONSTELLAT	SP	MAG	GC #	RA	PM	DEC	PM
MINELAUVA	SEE AUVA							
MINKAR	EPSILO CRV	K3	3.2	16618	12 7 32.9	-.005	-22 -20 -30	.01
MINTAKA	DELTA ORI	O9	2.5	6847	5 29 27.0	.000	0 -20 -4	.00
MIPA	OMICRO CET	M6	VAR	2796	2 16 49.0	-.001	-3 -12 -13	-.23
MIPACH	PETA AND	M0	2.4	1400	1 6 55.5	.014	35 21 22	-.11
MIPAK	SEE IZAR							
MIPAM	ETA PER	K4	3.9	3390	2 47 2.0	.002	55 41 22	-.01
MIPPAK	ALPHA PER	F5	1.9	4041	3 20 44.4	.003	49 41 6	-.02
MIRZAM	BETA CMA	B1	2.0	8223	6 20 29.8	.000	-17 -55 -47	.00
MISAM	KAPPA PER	G8	4.0	3755	3 6 6.8	.017	44 40 10	-.16
MIZAR	ZETA UMA	A2	2.4	18133	13 21 55.0	.014	55 11 9	-.03
MOTHALLAH	SEE METALLAH							
MUFRID	ETA BOO	G0	2.8	18805	13 52 18.2	-.004	18 38 51	-.36
MULIPHEIN	GAMMA CMA	B8	4.1	9320	7 1 29.8	.000	-15 -33 -29	-.01
MURZIM	SEE MIRZAM							
MUSCIDA	OMICRO UMA	G1	3.5	11593	8 26 7.7	-.018	60 53 14	-.11
MUSEIDA	SEE MUSCIDA							
NAOS	ZETA PUP	O5	2.3	10947	8 1 49.6	-.003	-39 -51 -41	.01
NASH	SEE ALNASL							
NASHIRA	GAMMA CAP	F2	3.8	30320	21 37 19.4	.013	-16 -53 -21	-.02
NATH	SEE EL NATH							
NEKKAR	BETA BOO	G5	3.6	20226	15 0 3.7	-.004	40 35 12	-.04
NIHAL	BETA LEP	G2	3.0	6762	5 26 6.1	.000	-20 -47 -53	-.09
NODUS I	ZETA DRA	B5	3.2	23182	17 8 38.2	-.003	65 46 34	.02
NODUS II	DELTA DRA	G8	3.2	26520	19 12 32.9	.016	67 34 25	.09
NORTH ASELLUS	SEE ASELLUS BOREALIS							
NORTH SCALE	SEE ZUBEN ELSCHEMALI							
NUNKI	SIGMA SGR	B3	2.1	25941	18 52 9.9	.001	-26 -21 -39	-.06
NUSAKAN	BETA CRB	A8	3.7	20795	15 25 46.0	-.014	29 16 37	.08
NUSHABA	SEE NASH							
OCULUS	PI CAP	B8	5.2	28442	20 24 27.6	.001	-18 -22 -38	-.01
OKDA	SEE ALRISHA							
PALILICIUM	SEE ALDERAMAN							
PEACOCK	ALPHA PAV	B3	2.1	28374	20 21 42.2	.001	-56 -53 -50	-.09
PELAGUS	SEE NUNKI							
PHACT	ALPHA COL	B8	2.8	7078	5 37 50.2	.000	-34 -5 -59	-.03
PHAD	SEE PHECDA							
PHAKT	SEE PFACT							
PHECDA	GAMMA UMA	A0	2.5	16268	11 51 12.6	.011	53 58 22	.00
PHERKAD	GAMMA UMI	A2	3.1	20692	15 20 47.4	-.004	72 0 43	.02
PHERKARD	SEE YILDUN							
PLEIONE	28 TAU	B8	VAR	4587	3 46 12.4	.001	23 59 7	-.05
POLARIS	ALPHA UMI	F8	2.1	2243	1 48 48.5	.181	89 1 44	.00
POLIS	MU SGR	B8	VAR	24856	18 10 46.3	.000	-21 -4 -26	.00
POLLUX	BETA GEM	K0	1.2	10438	7 42 15.6	-.047	28 8 55	-.05
PORRIMA	GAMMA VIR	FF	2.9	17270	12 39 7.5	-.038	-1 -10 -32	.00
PRAECIPUA	OMICRO LMI	K2	3.9	14961	10 50 31.3	.007	34 29 5	-.29
PRAESAEPE	M44 CNC	C	3.7	2632	8 37 30.0	.000	19 52 0	.00
PRIMA HYADUM	GAMMA TAU	G9	3.9	5226	4 16 56.7	.008	15 30 31	-.02
PRINCEPS	DELTA BOO	G4	3.5	20523	15 13 29.1	.007	33 30 1	-.12
PROCYON	ALPHA CMI	F5	0.5	10277	7 36 41.1	-.047	5 21 16	-1.03
PROPUS	ETA GEM	M3	VAR	7969	6 11 51.5	-.005	22 31 23	-.02
PULCHERRIMA	SEE IZAR							
RANA	DELTA ERI	K0	3.7	4450	3 40 51.1	-.006	-9 -55 -53	.74
RAS ALGETHI	ALPHA1 HER	M5	VAR	23277	17 12 22.0	-.001	14 26 45	.03
RAS ALHAGUE	ALPHA OPH	A5	2.1	23837	17 32 36.7	.008	12 35 42	-.23
RAS ELASED AUSTE	PSILO LEO	G3	3.1	13443	9 43 1.0	-.003	24 0 19	-.02
RAS ELASED POPE	MU LEO	K3	4.1	13590	9 49 55.4	-.016	26 14 36	-.06
RASSALAS	SEE RAS ELASED BOREALIS							
RASTABAN(B DRA)	SEE ALWAID							

STAR NAME	CONSTELLAT	SP	MAG	GC #	RA	PM	DEC	PM
RASTABAN(G DRA)	SEE ETAMIN							
REDA	SEE TARAZED							
REGULUS	ALPHA LEO	B7	1.3	13926	10 5 42.7	-.017	12 12 44	.00
RESCHA	SEE ALRISHA							
RIGEL	BETA ORI	B8	0.3	6410	5 12 8.0	.000	-8 -15 -29	.00
RIGEL KENT	SEE TOLIMAN							
ROTANEV	BETA DEL	F3	3.7	28709	20 35 12.2	.007	14 25 12	-.03
RUCHA	DELTA CAS	A5	2.8	1715	1 22 31.5	.040	59 58 34	-.05
RUCHBAH	SEE RUCHA							
RUCKBAR	SEE RUCHA							
RUKBAT	ALPHA SGR	B9	4.1	26737	19 20 25.5	.003	-40 -42 -43	-.12
RUTICULUS	SEE KORNEPHOROS							
SAAK	SEE MUFRID							
SABIK	ETA OPH	A2	2.6	23158	17 7 30.5	.002	-15 -39 -53	.09
SADACHBIA	SEE SADALACHBIA							
SADALACHBIA	GAMMA AQR	A0	4.0	31257	22 19 4.4	.008	-1 -38 -24	.01
SADALBARI	MU PEG	G6	3.7	31851	22 47 35.2	.011	24 20 14	-.04
SADALMELEK	ALPHA AQR	G1	3.2	30896	22 3 12.9	.001	8 -33 -49	.00
SADALSUUD	BETA AQR	G0	3.1	30137	21 28 55.6	.001	-5 -47 -32	-.01
SADATONI	SEE HOEDUS I							
SADIR	SEE SADOR							
SADOR	GAMMA CYG	F8	2.3	28338	20 20 25.9	.000	40 5 44	.00
SADP	SEE SADOR							
SAIPP	KAPPA ORI	B0	2.2	7264	5 45 23.0	.000	-9 -41 -9	.00
SALM	SEE KEPP							
SAPGAS	THETA SCO	F0	2.0	23857	17 33 43.4	.001	-42 -58 -5	.00
SARIN	DELTA HER	A3	3.2	23294	17 12 58.6	-.002	24 53 48	-.16
SCEPTRUM	53 ERI	K4	4.0	5657	4 35 53.3	-.005	-14 -24 -2	-.16
SCHEAT	BETA PEG	M2	2.6	32135	23 1 20.8	.014	27 48 40	.14
SCHEAT (DE AQR)	SEE SKAT							
SCHEDDI	SEE DENEB ALGEDI							
SCHEDAR	SEE SCHEDIR							
SCHEDIR	ALPHA CAS	K0	2.5	792	0 37 39.3	.006	56 15 49	-.03
SEGIN	EPSILO CAS	B3	3.4	2289	1 50 46.4	.005	63 25 30	-.02
SEGINUS	GAMMA BOO	A7	3.0	19607	14 30 3.9	-.010	30 31 34	.15
SERTAN	SEE ACUBENS							
SHAM	ALPHA SGE	F8	4.4	27215	19 37 51.6	.001	17 53 51	-.02
SHARATAN	SEE SHERATAN							
SHAULA	LAMBDA SCO	B2	1.7	23769	17 30 12.6	.000	-37 -4 -10	-.03
SHELIAK	BETA LYR	BB	VAR	25847	18 48 14.0	.000	33 18 12	-.01
SHERATAN	BETA ARI	A5	2.7	2389	1 51 52.3	.007	20 33 52	-.11
SINISTRA	NU OPH	K0	3.5	24468	17 56 16.3	-.001	-9 -46 -9	-.12
SIRIUS	ALPHA CMA	A1	-1.4	8833	6 42 56.7	-.037	-16 -38 -46	-1.21
SIRRAH	SEE ALPHERATZ							
SITULA	KAPPA AQR	K1	5.3	31581	22 35 10.0	-.005	-4 -29 -11	-.11
SKAT	DELTA AQR	A2	3.5	31943	22 51 59.9	-.003	-16 -5 -14	-.02
SOUTH ASELLUS	SEE ASELLUS AUSTRALIS							
SOUTH SCALE	SEE ZUBEN ELGENUBI							
SPICA	ALPHA VIR	B2	1.2	18144	13 22 33.3	-.003	-10 -54 -4	-.04
SPICULUM(M20M21M8)		SGR	N	6.0 6523	18 1 36.0	.000	-24 -20 0	.00
STEROPE	SEE ASTEROPE							
SUALOCIN	ALPHA DEL	B8	3.9	28780	20 37 18.9	.004	15 44 4	.00
SUPPA	OMICRO LEO	FA	3.8	13366	9 38 29.0	-.010	10 7 15	-.04
SUHAIL	SEE ALSUHAIL							
SUHEL	SEE CANOPUS							
SULAPHAT	GAMMA LYR	B9	3.3	26086	18 57 4.3	.000	32 37 11	.00
SVALOCIN	SEE SUALOCIN							
SYRMA	IOTA VIR	F5	4.2	19244	14 13 23.3	-.001	-5 -45 -46	-.43
TABIT	PI 3 ORI	F5	3.3	5875	4 47 7.4	.031	6 52 32	.02
TALITHA	IOTA UMA	AM	3.1	12407	8 55 47.6	-.044	48 14 22	-.24

STAR NAME	CONSTELLAT	SP	MAG	GC #	RA	PM	DEC	PM
TANIA AUSTRALIS	MU UMA	M0	3.2	14232	10 19 21.5	-.007	41 45 6	.02
TANIA BOREALIS	LAMBDA UMA	A2	3.5	14113	10 14 5.4	-.015	43 9 53	-.04
TARAZED	GAMMA AQL	K3	2.8	27354	19 43 52.9	.001	10 29 24	.00
TAYGETA	19 TAU	B7	4.4	4486	3 42 13.6	.002	24 18 43	-.04
TEJAT POSTERIOR	MU GEM	M3	3.2	8208	6 19 56.1	.004	22 32 28	-.11
TEJAT PRIOR	SEE PROPUS							
TEREBELLUM	OMEGA SGR	G5	4.8	27583	19 52 46.7	.015	-26 -26 -2	.08
THEEMIN	UPSI2 ERI	K0	3.9	5614	4 33 36.3	-.004	-30 -39 -49	-.01
THUBAN	ALPHA DRA	A0	3.6	19019	14 3 2.0	-.008	64 36 51	.01
TOLIMAN	ALPHA CEN	GK	0.1	19728	14 36 11.2	-.490	-60 -37 -49	.70
TUREIS	IOTA CAR	F0	2.2	12831	9 15 45.1	-.002	-59 -3 -54	.00
TYL	EPSILO DRA	G3	4.0	27471	19 48 21.1	.015	70 0 26	.04
UNUKALHAI	ALPHA SER	K2	2.8	21158	15 41 48.2	.009	6 34 53	.04
VEGA	ALPHA LYR	A1	0.1	25466	18 35 14.7	.017	38 44 9	.28
VEPTEX	M31 AND	N	4.8	224	0 40 .0	.000	41 0 0	.00
VESPERTILIO	SEE ANTARES							
VINDEMIATRIX	EPSILO VIR	G6	3.0	17687	12 59 41.2	-.019	11 13 39	.02
WASAT	DELTA GEM	A8	3.5	9755	7 17 8.3	-.001	22 4 34	-.02
WAZN	BETA COL	K1	3.2	7364	5 49 11.7	.004	-35 -47 -10	.40
WEGA	SEE VEGA							
WEZEN	DELTA CMA	G3	2.0	9443	7 6 21.5	.000	-26 -18 -45	.00
YED POSTERIOR	EPSILO OPH	G8	3.3	21920	16 15 40.4	.006	-4 -34 -20	.04
YED PRIOR	DELTA OPH	M1	3.0	21838	16 11 43.3	-.003	-3 -34 -2	-.15
YILDUN	DELTA UMI	A0	4.4	24236	17 40 18.5	.012	86 36 35	.05
ZANIAH	ETA VIR	A0	4.0	16813	12 17 20.8	-.004	0 -23 -21	-.02
ZAURAK	GAMMA ERI	M0	3.2	4778	3 55 41.7	.004	-13 -38 -58	-.11
ZAVIJAH	SEE ZAVIJAVA							
ZAVIJAVA	BETA VIR	F8	3.8	16215	11 48 5.4	.050	2 2 47	-.28
ZIBAL	ZETA ERI	A3	4.9	3899	3 13 24.1	.000	-9 0 -15	.05
ZIBEL	SEE ZIBAL							
ZOSMA	DELTA LEO	A2	2.6	15438	11 11 27.1	.010	20 47 52	-.14
ZUBEN ELAKRAB	GAMMA LIB	G6	4.0	20949	15 32 43.5	.004	-14 -37 -28	.00
ZUBEN ELAKRIBI	DELTA LIB	A1	VAR	20195	14 58 17.8	-.004	-8 -19 -18	-.01
ZUBEN ELGENUBI	ALPHA2 LIB	A3	2.9	19975	14 48 6.5	-.007	-15 -50 -7	-.07
ZUBENELSCHEMALI	BETA LIB	B8	2.7	20539	15 14 18.7	-.007	-9 -11 -59	-.03
ZUBENESCH	SEE ZUBEN ELSCHEMALI							
ZUBENESCHEMALI	SEE ZUBEN ELSCHEMALI							
ZUBEN HAKRABI	NU LIB	K5	5.3	20311	15 3 49.9	-.003	-16 -3 -51	-.03

290 RECORDS WRITTEN TO FILE

ASTROCARTOGRAPHIC POINTS FOR MICHAEL ERLEWINE
BORN 7/18/1941 AT 16: 3 S TIME IN ZONE 5.00
AT LATITUDE 40 N 2 AND LONGITUDE 76 W 18

PLANET	ON UPPER MERIDIAN LONGITUDE	ZENITH LATITUDE	LOWER MERIDIAN LONGITUDE	NADIR LATITUDE
SUN	134 W 14	20 N 59	45 E 46	20 S 59
MOON	160 E 12	14 N 25	19 W 48	14 S 25
MERC	154 W 14	19 N 47	25 E 46	19 S 47
VENU	109 W 10	16 N 21	70 E 50	16 S 21
MARS	117 E 47	0 N 13	62 W 13	0 S 13
CERE	14 E 6	27 S 41	165 W 54	27 N 41
PALL	10 W 39	22 N 29	169 E 21	22 S 29
JUNO	85 W 7	7 N 38	94 E 53	7 S 38
VEST	82 W 50	10 N 55	97 E 10	10 S 55
JUPI	178 E 24	21 N 32	1 W 36	21 S 32
SATU	162 E 17	17 N 15	17 W 43	17 S 15
URAN	165 E 12	19 N 49	14 W 48	19 S 49
NEPT	75 W 45	2 N 59	104 E 15	2 S 59
PLUT	124 W 57	23 N 29	55 E 3	23 S 29
N ND	76 W 2	1 N 44	103 E 58	1 S 44

LONGITUDES ON EARTH OF ECLIPTIC ASPECTS TO MIDHEAVEN
0 IS CONJUNCT MIDHEAVEN, 180 IS CONJUNCT IC

ASPECTS / PLANETS	-150	-120	-90	-60	-30	0
SUN	76 E 2	104 E 8	131 E 54	161 E 27	166 W 36	134 W 14
MOON	10 E 53	43 E 19	73 E 47	102 E 0	129 E 42	159 E 4
MERC	57 E 43	87 E 1	114 E 43	142 E 58	173 E 30	154 W 2
VENU	98 E 43	126 E 22	155 E 27	172 W 59	140 W 28	109 W 41
MARS	35 W 19	4 W 38	27 E 52	59 E 30	88 E 40	116 E 20
CERE	133 W 26	103 W 14	75 W 11	47 W 33	17 W 46	14 E 14
PALL	169 W 26	136 W 59	106 W 29	78 W 16	50 W 34	21 W 13
JUNO	121 E 47	150 E 30	178 W 19	145 W 45	114 W 34	85 W 51
VEST	122 E 31	151 E 18	177 W 27	144 W 54	113 W 46	85 W 6
JUPI	30 E 50	62 E 16	91 E 13	118 E 51	147 E 22	178 E 18
SATU	13 E 44	46 E 5	76 E 20	104 E 24	132 E 11	161 E 46
URAN	17 E 18	49 E 31	79 E 29	107 E 25	135 E 18	165 E 9
NEPT	131 E 31	161 E 2	167 W 3	134 W 40	104 W 22	76 W 15
PLUT	83 E 33	111 E 21	139 E 24	169 E 38	158 W 1	126 W 2
N ND	131 E 44	161 E 17	166 W 47	134 W 24	104 W 7	76 W 2

ASPECTS / PLANETS	30	60	90	120	150	180
SUN	103 W 58	75 W 52	48 W 6	18 W 33	13 E 24	45 E 46
MOON	169 W 7	136 W 41	106 W 13	78 W 0	50 W 18	20 W 56
MERC	122 W 17	92 W 59	65 W 17	37 W 2	6 W 30	25 E 58
VENU	81 W 17	53 W 38	24 W 33	7 E 1	39 E 32	70 E 19
MARS	144 E 41	175 E 22	152 W 8	120 W 30	91 W 20	63 W 40
CERE	46 E 34	76 E 46	104 E 49	132 E 37	162 E 14	165 W 46
PALL	10 E 34	43 E 1	73 E 31	101 E 44	129 E 26	158 E 47
JUNO	58 W 13	28 W 30	1 E 41	34 E 15	65 E 26	94 E 9
VEST	57 W 29	28 W 42	2 E 33	35 E 6	66 E 14	94 E 54
JUPI	149 W 10	117 W 44	88 W 47	61 W 9	32 W 38	1 W 42
SATU	166 W 16	133 W 55	103 W 40	75 W 36	47 W 49	18 W 14
URAN	162 W 42	130 W 29	100 W 31	72 W 35	44 W 42	14 W 51
NEPT	48 W 29	18 W 58	12 E 57	45 E 20	75 E 38	103 E 45
PLUT	96 W 27	68 W 39	40 W 36	10 W 22	21 E 59	53 E 58
N ND	48 W 16	18 W 43	13 E 13	45 E 36	75 E 53	103 E 58

PLANETS ON ASC, RISING, ON DESC, & SETTING FOR MICHAEL ERLEWINE

SUN LAT	ON ASC LONGITUDE	RISING LONGITUDE	ON DESC LONGITUDE	SETTING LONGITUDE
-60	177 E 25	177 E 25	85 W 53	85 W 53
-50	162 E 59	162 E 59	71 W 26	71 W 26
-40	154 E 33	154 E 33	63 W 1	63 W 1
-30	148 E 34	148 E 34	57 W 2	57 W 2
-20	143 E 48	143 E 48	52 W 16	52 W 16
-10	139 E 39	139 E 39	48 W 7	48 W 7
0	135 E 46	135 E 46	44 W 14	44 W 14
10	131 E 53	131 E 53	40 W 21	40 W 21
20	127 E 44	127 E 44	36 W 12	36 W 12
30	122 E 58	122 E 58	31 W 26	31 W 26
40	116 E 59	116 E 59	25 W 27	25 W 27
50	108 E 34	108 E 34	17 W 1	17 W 1
60	94 E 7	94 E 7	2 W 35	2 W 35

MOON LAT	ON ASC LONGITUDE	RISING LONGITUDE	ON DESC LONGITUDE	SETTING LONGITUDE
-60	104 E 51	96 E 39	146 W 42	136 W 15
-50	92 E 47	88 E 2	134 W 39	127 W 39
-40	85 E 31	82 E 39	127 W 33	122 W 16
-30	80 E 18	78 E 44	122 W 10	118 W 21
-20	76 E 8	75 E 34	117 W 59	115 W 11
-10	72 E 29	72 E 48	114 W 20	112 W 24
0	69 E 4	70 E 12	110 W 56	109 W 48
10	65 E 40	67 E 36	107 W 31	107 W 12
20	62 E 1	64 E 49	103 W 52	104 W 26
30	57 E 50	61 E 39	99 W 42	101 W 16
40	52 E 37	57 E 44	94 W 29	97 W 21
50	45 E 51	52 E 21	87 W 13	91 W 58
60	33 E 18	43 E 45	75 W 9	83 W 21

MERC LAT	ON ASC LONGITUDE	RISING LONGITUDE	ON DESC LONGITUDE	SETTING LONGITUDE
-60	164 E 2	154 E 19	112 W 6	102 W 47
-50	146 E 45	141 E 9	94 W 49	89 W 37
-40	137 E 6	133 E 20	85 W 9	81 W 48
-30	130 E 20	127 E 45	78 W 23	76 W 13
-20	124 E 58	123 E 17	73 W 2	71 W 46
-10	120 E 19	119 E 24	68 W 23	67 W 52
0	115 E 58	115 E 46	64 W 2	64 W 14
10	111 E 37	112 E 8	59 W 41	60 W 36
20	106 E 58	108 E 14	55 W 2	56 W 43
30	101 E 37	103 E 47	49 W 40	52 W 15
40	94 E 51	98 E 12	42 W 54	46 W 40
50	85 E 11	90 E 23	33 W 15	38 W 51
60	67 E 54	77 E 13	15 W 58	25 W 41

VENU LAT	ON ASC LONGITUDE	RISING LONGITUDE	ON DESC LONGITUDE	SETTING LONGITUDE
-60	172 W 22	168 W 37	47 W 1	49 W 43
-50	178 E 43	178 W 42	38 W 6	39 W 38
-40	173 E 9	175 E 5	32 W 32	33 W 25
-30	169 E 7	170 E 35	28 W 30	28 W 55
-20	165 E 51	166 E 58	25 W 14	25 W 18
-10	162 E 59	163 E 48	22 W 22	22 W 8
0	160 E 19	160 E 50	19 W 41	19 W 10
10	157 E 38	157 E 52	17 W 1	16 W 12
20	154 E 46	154 E 42	14 W 9	13 W 2
30	151 E 30	151 E 5	10 W 53	9 W 25
40	147 E 28	146 E 35	6 W 51	4 W 55
50	141 E 54	140 E 22	1 W 17	1 E 18
60	132 E 59	130 E 17	7 E 38	11 E 23

MARS LAT	ON ASC LONGITUDE	RISING LONGITUDE	ON DESC LONGITUDE	SETTING LONGITUDE
-60	32 E 36	28 E 9	159 W 56	152 W 35
-50	30 E 38	28 E 2	157 W 59	152 W 28
-40	29 E 22	27 E 58	156 W 42	152 W 24
-30	28 E 25	27 E 54	155 W 45	152 W 21
-20	27 E 39	27 E 52	154 W 59	152 W 18
-10	26 E 58	27 E 49	154 W 18	152 W 15
0	26 E 20	27 E 47	153 W 40	152 W 13
10	25 E 42	27 E 45	153 W 2	152 W 11
20	25 E 1	27 E 42	152 W 21	152 W 8
30	24 E 15	27 E 39	151 W 35	152 W 6
40	23 E 18	27 E 36	150 W 38	152 W 2
50	22 E 1	27 E 32	149 W 22	151 W 58
60	20 E 4	27 E 25	147 W 24	151 W 51

FIXED STARS FOR MICHAEL ERLEWINE
BORN 7/18/1941 AT 16: 3 S TIME IN ZONE 5.00
AT LATITUDE 40 N 2 AND LONGITUDE 76 W 18

NATAL SIDEREAL TIME IS 11 43

PLANET	LONGITUDE	LAT	DEC	RISE	R A	SET	LOW	CULM
SUN	25 Cn 48	0 N 0	20 N 59	0 36	7 51	15 6	19	51
MOON	23 Ta 29	4 S 22	14 N 25	20 39	3 29	10 19	15	29
MERC	7 Cn 20	3 S 28	19 N 47	23 21	6 31	13 42	18	31
VENU	19 Le 55	1 N 36	16 N 21	3 34	9 31	16 29	21	31
MARS	9 Ar 6	3 S 41	0 N 13	18 39	0 39	6 40	12	39
CERE	26 Sa 34	4 S 17	27 S 41	13 29	17 45	21 60	5	45
PALL	23 Sc 12	42 N 21	22 N 29	8 44	16 5	23 27	4	5
JUNO	14 Vi 60	1 N 52	7 N 38	4 42	11 8	17 34	23	8
VEST	15 Vi 47	5 N 46	10 N 55	4 39	11 17	17 54	23	17
JUPI	11 Ge 50	0 S 41	21 N 32	21 24	4 42	11 59	16	42
SATU	26 Ta 6	2 S 6	17 N 15	20 37	3 37	10 38	15	37
URAN	29 Ta 23	0 S 13	19 N 49	20 38	3 49	10 59	15	49
NEPT	25 Vi 24	1 N 15	2 N 59	5 35	11 46	17 55	23	46
PLUT	3 Le 40	4 N 16	23 N 29	1 3	8 28	15 54	20	28
N ND	25 Vi 38	0 N 0	1 N 44	5 38	11 44	17 50	23	44

STAR CONTACTS OUT OF A LIST OF 290 STARS
ALL ORBS GIVEN IN MINUTES OF ARC

STAR NAME	CONSTELLAT SP MAG	LONGITUDE	LAT	DEC	RISE	R A	SET	LOW	CULM
ACAMAR	THETA1 ERI A2 3.4	22 Ar 27	53 S 45	40 S 32	23 60	2 56	5 52	14	56
ACHERNAR	ALPHA ERI B9 0.6	14 Pi 29	59 S 23	57 S 32		1 36		13	36
ACHIRD	ETA CAS F9 3.6	9 Ta 25	47 N 1	57 N 30		0 46		12	46
ACRAB	BETA 1 SCO B1 2.9	2 Sa 22	1 N 1	19 S 39	11 12	16 2	20 52	4	2
CULMINATING	WITH PALL CULMINATING WITH ORB	51.7							
ACRUX	ALPHA1 CRU B1 1.6	11 Sc 4	52 S 52	62 S 47		12 23		0	23
ACUBENS	ALPHA CNC F0 4.3	12 Le 50	5 S 5	12 N 5	2 14	8 55	15 37	20	55
SETTING	WITH SATU AT LOW CULM WITH ORB	7.1							
ACULEUS	M6 SCO C 5.3	24 Sa 55	8 S 50	32 S 11	13 44	17 36	21 29	5	36
RISING	WITH MERC SETTING WITH ORB	35.5							
SETTING	WITH VENU AT LOW CULM WITH ORB	42.3							
CULMINATING	WITH JUNO SETTING WITH ORB	40.8							
AT LOW CULM	WITH NEPT RISING WITH ORB	17.9							
AT LOW CULM	WITH N ND RISING WITH ORB	28.8							
ACUMEN	M7 SCO C 3.2	27 Sa 56	11 S 22	34 S 48	14 13	17 50	21 27	5	
CULMINATING	WITH VEST SETTING WITH ORB	59.2							
SETTING	WITH JUPI RISING WITH ORB	45.7							
CULMINATING	WITH N ND SETTING WITH ORB	4.7							
ADARA	EPSILO CMA B1 1.6	19 Cn 57	51 S 22	28 S 53	2 47	6 56	11 6	18	56
SETTING	WITH JUNO CULMINATING WITH ORB	27.0							
ADHAFERA	ZETA LEO F0 3.6	26 Le 45	11 N 52	23 N 43	2 47	10 13	17 40	22	13
ADHIL	XI AND G9 5.0	7 Ta 3	33 N 50	45 N 13	15 27	1 19	11 10	13	19
RISING	WITH MOON AT LOW CULM WITH ORB	21.0							
SETTING	WITH JUNO CULMINATING WITH ORB	39.6							
AGENA	BETA CEN B3 0.9	22 Sc 59	44 S 8	60 S 6		13 60		1	60
CONJUNCT	WITH PALL IN LONGITUD WITH ORB	13.3							
AIN	EPSILO TAU G8 3.6	7 Ge 39	2 S 34	19 N 3	21 18	4 25	11 33	16	25
AT LOW CULM	WITH VENU SETTING WITH ORB	49.7							
ALBALDAH	PI SGR F3 3.0	15 Cp 26	1 N 27	21 S 7	14 22	19 6	23 51	7	6
ALBALI	EPSILO AQR A1 3.8	10 Aq 54	8 N 5	9 S 43	15 18	20 45	2 11	8	45
AT LOW CULM	WITH PALL RISING WITH ORB	6.6							
ALBIREO	BETA 1 CYG K1 3.2	0 Aq 26	48 N 58	27 N 50	11 43	19 28	3 14	7	28
RISING	AT NATAL SIDERL TIME WITH ORB	1.9							
RISING	WITH NEPT CULMINATING WITH ORB	30.9							
RISING	WITH N ND CULMINATING WITH ORB	14.6							
ALCHITA	ALPHA CRV F2 4.2	11 Li 26	21 S 45	24 S 24	7 35	12 5	16 36	0	5
ALCOR	80 UMA A1 4.0	15 Vi 3	56 N 33	55 N 18		13 23		1	23
CONJUNCT	WITH JUNO IN LONGITUD WITH ORB	3.0							
CONJUNCT	WITH VEST IN LONGITUD WITH ORB	44.8							
ALCYONE	ETA TAU B7 3.0	29 Ta 11	4 N 3	23 N 56	20 16	3 44	11 12	15	44
SETTING	WITH JUNO CULMINATING WITH ORB	58.4							
CONJUNCT	WITH URAN IN LONGITUD WITH ORB	12.6							
ALDEBARAN	ALPHA TAU KM 1.1	8 Ge 58	5 S 28	16 N 24	21 35	4 33	11 30	16	33
RISING	WITH VENU AT LOW CULM WITH ORB	58.5							
ALDERAMIN	ALPHA CEP A7 2.6	11 Ar 59	68 N 55	62 N 20		21 17		0	17
ALFARD	ALPHA HYA K3 2.2	26 Le 28	22 S 23	8 S 24	3 53	9 25	14 56	21	25
AT LOW CULM	WITH JUPI RISING WITH ORB	7.7							
ALGENIB	GAMMA PEG B2 2.9	8 Ar 20	12 N 36	14 N 52	17 19	0 10	7 2	12	
CONJUNCT	WITH MARS IN LONGITUD WITH ORB	45.3							
ALGIEBA	GAMMA1 LEO K0 2.6	28 Le 48	8 N 49	20 N 8	3 5	10 17	17 29	22	17
CULMINATING	WITH MOON SETTING WITH ORB	30.5							
ALGOL	BETA PER B8 VAR	25 Ta 21	22 N 25	40 N 44	17 59	3 4	12 10	15	4

THE NEW ASTEK I ASTROLOGICAL COMPUTER

-Editor's notes

The ASTEK I computer is a new chapter in the continuing story of astrological computing machines. Most readers can well remember that less than four years ago we had no small astrological computers. That was before the PETs, APPLEs, TRS-80s and DIGICOMPs appeared. Here now is a hand-held unit, weighing less than two pounds, that will perform a wide variety of very accurate astrological tasks and yet costs less than $400!

I am sure what this little machine can do in the way of astrological calculations since MATRIX wrote the software that is being used in the new ASTEK I. What follows are excerpts taken from a detailed presentation of the ASTEK I by EURO AMERICAN ASTROLOGY, the machine's designers. EURO-AM is a california based outfit that is headed by Richard Fairbairn and Carolyn Wesenberg. Fairbairn is a professional businessman while Wesenberg is a graphics designer and amateur astrologer.

EURO-AM approached MATRIX about the possibility of our providing software for a new astrological computer being designed that could be sold for under $400. While the new computer would not have all of the bells and whistles to be found on the home computer systems (PET, APPLE, etc.), it could provide all of the astrological basics and even a little more. Here was the perfect machine for the student of astrology. A portable cosmos that was about as expensive as a television set. Here are some details on the new computer.

WHAT IT DOES

The ASTEK I accepts the standard birth or event information (DATE, TIME, ZONE, GEOGRAPHIC LONG & LAT) and outputs a complete natal chart that includes the nine planets, Moon, Lunar Node and the Placidus House cusps listed in Degrees-Sign-Minutes notation (25AR40= 25 degrees Aries 40 minutes). The ASTEK I has an alpha-numeric 16-digit display panel that is larger than but similar to an LED display.

The ASTEK I provides aspect analysis and angular separations for all planets. In addition, secondary charts are availble. Transit and Progressed charts are provided. Progression is by Solar Arc Direction. Any number of transit or Solar Arc charts are possible...with provision for cross-aspects between the secondary charts and the natal horoscope (which remains in memory). Secondary charts include house cusps too.

The program uses the planetary elements (MATRIX AA1) developed by James Neely of California. They are accurate for dates in this century to within 2-3 minutes for the outer planets and about one minute or so for the inner planets- usually better. The terrestrial planets (Sun thru Mars) can be used for dates outside of this century with very little loss of accuracy. Both James Neely and Charles Jayne were consulted while writing this software. The program developed by MATRIX will be implemented in machine language in the final product. This insures great speed.

TECHNICALLY SPEAKING

The planned design of the ASTEK I astrological calculator is based on a 32-key mylar membrane keyboard, a 16-digit alphanumeric vacuum florescent display, a control micro-processor and an external play-mounted transformer power supply. Estimates assume a 6502 microprocessor with 16K bytes of masked programmed ROM for program and constant data storage. The initial five prototypes of the ASTEK I will have commercially available cases which are similar to the production unit.

Mylar membrane switches are used as the keyboard because they are low cost and widely used in calculator applications. The conventional calculator appearance in the application is achieved by using a plastic button over each key. Also a good tactile feel is received by molding a plastic dome into the upper mylar layer, giving definite switch action.

A vacuum florescent display was chosen mainly because of its quality appearance, readability and low cost. An alphanumeric display is required for the identifying messages accompanying the numbers displayed by the calculator. A 16-digit alphanumeric display was chosen. It should be noted, fo example, that the Craig language translator display is a multi-digit vacuum florescent alphanumeric. Liquid crystal displays are an alternative at this time.

A conventional, high volume 6502 microprocessor was chosen as the control device. The 6502 is the largest selling, multi-sourced, 8-bit microprocessor, and is used in the PET, APPLE and ATARI computers. The program fits into 16K bytes of mask programmed ROM. The actual amount of ROM required will be determined during the software conversion phase of the prototype unit.

An external plug-mounted power transformer and rectifier unit is used to supply power to the calculator. This technique is inexpensive and the devices are available from several sources in volume production. Since this transformer is UL approved and supplies low voltage to the calculator, the calculator body will not have to be UL approved. These transformer units are available for both the USA and European power sources. The unit is small, measuring 6" x 6 1/2" x 1 1/2" and weighs two pounds.

ASTEK I : THE IDEA

Carolyn Wesenberg, who often answers to "Candy" had this to say about the idea for the new machine. "For the past several years I had been looking to buy something to calculate charts for me. I'd seen a hand-held biorhythm calculator which convinced me that there must be something similar for astrology buffs. When it became apparent that such a product was not available, it occurred to me that perhaps I could make one available, convinced that there must be many would-be astrologers like myself who would benefit."

"The notion was mostly fantasy until my friend Richard visited me from the east coast last summer. An astrological non-believer, he was curious about the astrological tape I'd had done for him by professional astrologer, Robert Cole. Robert had asked for feedback so, a luncheon meeting was arranged among the three of us."

"It was at that meeting that Richard mentioned the computer unit idea to Robert Cole. I feel it was Robert's enthusiasm that actually launched ASTEK I. Richard returned to his business Euro American Technology, in Washington D.C. We pursued the investigation of our astro-computer concept independently on opposite sides of the country. The situation became inefficient at best. Richard relocated to California to open a branch office of Euro American Technology in November 1979. The astrol-computer project intensified. A business partnership, EURO AMERICAN Astrology, was formalized on Feb. 20, 1980 to enable us to function appropriately in turning ASTEK I into reality."

"Getting a new product to market is an incredible process. ASTEK I is the most intense and exciting adventure I've ever attempted. EURO-AM is making ASTEK I happen. And thanks to the fantastic support and production of MATRIX Software, and Mike Erlewine in particular, ASTEK I will be introduced at the 1980 AFA Convention in New Orleans in August."

Euro-American Astrology
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EURO·AMERICAN
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following day, and thus the Sun is said to rule the second day of the week. After elements of the sequence have been assigned for 24 more hours we find that the Moon rules the third day of the week. So for the first three days of the week we have Saturday, Sunday and Monday. The remaining days of the week have also been named after their planetary rulers, the Norse and Anglo-Saxon names having merely been substituted for the Latin names, i.e., Tyr=Mars, Woden=Mercury, Thor=Jupiter and Freya=Venus, to give us Tuesday, Wednesday, Thursday and Friday.

Following the sequence through Friday we find that sunrise of the following or eighth day is once again ruled by Saturn, thus establishing the seven day week. We see, therefore, that the seven day week and the names of the days are based on the ancient method of the planetary hours.

Each hour may be further subdivided into 15 "degrees", each ruled in succession by a planet in the sequence. The total subdivisions of the day established by the seven planet sequence are thus 24X15=360. The planetary "degrees" are subordinate to the planetary hours. They are rarely used and will not be referred to further in this article.

The planetary hours are used in electional astrology to determine suitable times to initiate certain actions based on a principle of affinity with the planets. For example, an activity requiring aggressive energy would most suitably be initiated in a Mars hour, a letter begun in a Mercury hour or a gift given to one's sweetheart in a Venus hour. The ruler of the day and the ruler of the hour may be combined together as, for example, by writing a love letter on a

Calculating the Day of the Week and the Planetary Ruler of the Hour

by Dwight William Johnson

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The planetary hours method for assigning a planetary ruler to any moment of time during the day has come down to us from ancient times and is based on the inverse geocentric order of the seven visible planets, namely, (1) Saturn, (2) Jupiter, (3) Mars, (4) Sun, (5) Venus, (6) Mercury and (7) the Moon.

Using this method the interval of time between sunrise and sunset is divided into 12 equal subinterval hours and the time between sunset and sunrise is divided into 12 equal subinterval hours. The first day of the week and the first hour following sunrise on that day are said to be ruled by Saturn. The next hour is said to be ruled by Jupiter, the next by Mars, the next by the Sun, and so on in inverse geocentric order of the planets. After the hour ruled by the Moon, the next hour is ruled by Saturn and the sequence is repeated.

After elements of the sequence have been assigned for 24 hours it turns out that the Sun rules the hour following sunrise of the

Mercury hour of a Venus day, i.e., on a Friday.

The approximate determination of the planetary hour at a True Solar Time z is a simple problem in spherical astronomy. We may assume that the right ascension a_S and the declination d_S of the Sun are known. In figure 1 SD represents an arc of the parallel of declination of the Sun at time z, the celestial north pole is represented by P, the zenith by Z and the approximate point of setting of the Sun by D, neglecting the change in the Sun's declination.

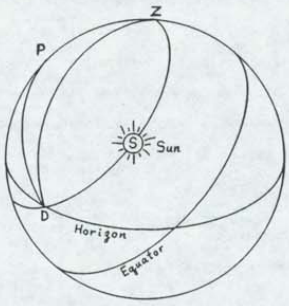


figure 1

From the cosine formula of spherical trigonometry we have

$$\cos ZD=\cos PZ\cos PD+\sin PZ\sin PD\cos ZPD \qquad ...(I)$$

But D is on the horizon so that $ZD=90^\circ$, and D is also on the declination circle of the Sun so that $PD=90^\circ-d_S$. Also, if f is the latitude of the observer, then $PZ=90^\circ-f$. Let the angle $ZPD=H$. Then the above equation becomes

$$\cos 90^\circ=\cos(90^\circ-f)\cos(90^\circ-d_S)+\sin(90^\circ-f)\sin(90^\circ-d_S)\cos H,$$

$$0=\sin(f)\sin(d_S)+\cos(f)\cos(d_S)\cos H,$$

$$\cos H=-\tan(f)\tan(d_S),$$

$$H=\arccos(-\tan(f)\tan(d_S)) \qquad ...(II)$$

Now H is the approximate hour angle between noon and sunset, so let $Z_D=2H$ be the approximate number of hours between sunrise and sunset and let $Z_N=24-Z_D$ be the approximate number of hours between sunset and sunrise on the true solar day in which z occurs, neglecting the change in the Sun's declination.

Whether the Sun is above or below the horizon is easily determined. We may assume that we know the right ascension of the M.C. which is simply the sidereal time expressed in hours. Let a_{MC} be the right ascension of the M.C., and let $a_A=a_{MC}+H$ and $a_D=a_{MC}-H$ be the right ascensions of the rising and setting points respectively of the Sun's declination circle at time z. Now if $a_D<a_S<a_A$, the Sun is above the horizon. Otherwise, the Sun is below the horizon.

Suppose the Sun is above the horizon. Then we subtract increments of $Z_D/12$ from a_A until we find an $i=1,2,\cdots,12$, such that $a_A-iZ_D/12<a_S$. If the Sun is below the horizon, we subtract increments of $Z_N/12$ from a_D until we find an $i=13,14,\cdots,24$, such that $a_D-(i-12)Z_N/12<a_S$. The integer i gives us the hour of the day from 1 to 24.

To determine the day of the week, it is necessary to establish an epoch when the day of the week was known. Let the epoch be Saturday, December 31, 1949 at noon TLT, and let t be the interval of time in true solar days which has elapsed from the epoch to true local noon on the day of z. Then $t/7=I_0+F_0$ is the number of true solar weeks

which have elapsed since the epoch, where I_0 is the integer part and F_0 is the fractional part, and also $7F_0=I_1$ is the number of days which have elapsed within the current week, where I_1 is an integer.

The method of planetary hours sets the start of each day at sunrise rather than at noon or midnight. We may, therefore, determine the day of the week if $i>12$ and the Local Mean Time is before noon by $j=7$ for $I_1=0$, or $j=I_1$ otherwise. In all other cases $j=I_1+1$.

Here, when j=1 it is Saturday and Saturn is the 1st planet,
" "=2 " " Sunday " Sun " " 4th " ,
" "=3 " " Monday " Moon " " 7th " ,
" "=4 " " Tuesday " Mars " " 3rd " ,
" "=5 " " Wednesday " Mercury " " 6th " ,
" "=6 " " Thursday " Jupiter " " 2nd " ,
" "=7 " " Friday " Venus " " 5th "

in inverse geocentric order of the planets. We now use j to define the integer $k=A_j$, where the ordered set A=(1,4,7,3,6,2,5).

Finally, the planetary ruler of the hour is determined from the hour of the day i and the integer k by the smallest integer $n=(k+i-1) \bmod 7$.

Here, when n=1 the ruler is Saturn,
" "=2 " " " Jupiter,
" "=3 " " " Mars,
" "=4 " " " Sun,
" "=5 " " " Venus,
" "=6 " " " Mercury,
" "=7 " " " Moon.

We now summarize the method of calculating the day of the week and

planetary ruler of the hour at a True Local Time z. We are given:

1) the days of the week are numbered consecutively from 1 to 7 with Saturday=1, Sunday=2, Monday=3, Tuesday=4, Wednesday=5, Thursday=6, Friday=7;
2) the planets are numbered consecutively from 1 to 7 in inverse geocentric order with Saturn=1, Jupiter=2, Mars=3, Sun=4, Venus=5, Mercury=6, Moon=7;
3) the ordered set A=(1,4,7,3,6,2,5) gives the number of the planet ruling each day of the week;
4) the epoch is December 31, 1949 at noon TLT; this is a Saturday;
5) a_S is the right ascension of the Sun at z;
6) d_S is the declination of the Sun at z;
7) f is the latitude of the observer;
8) a_{MC} is the sidereal time and right ascension of the M.C. at z;
9) t is the number of true solar days from the epoch to true local noon on the day of z.

We compute:

1) $H=\arccos(-\tan(f)\tan(d_S))$ is the approximate hour angle between noon and sunset on the true solar day in which z occurs;
2) $Z_D=2H$ is the approximate number of true solar hours between sunrise and sunset, and $Z_N=24-Z_D$ is the approximate number of true solar hours between sunset and sunrise;
3) $a_A=a_{MC}+H$ and $a_D=a_{MC}-H$ are respectively the rising and setting

right ascensions of the Sun's declination circle at time z (if $a_A \geq 24$, then $a_A = a_A - 24$, and, if $a_D < 0$, then $a_D = a_D + 24$);

4) if $a_D < a_S \leq a_A$, the Sun is above the horizon; otherwise, it is below the horizon;

5) find the smallest $t = 1, 2, \ldots, 12$, such that $a_A - tZ_D/12 < a_S$, if the Sun is above the horizon, or find the smallest $t = 13, 14, \ldots, 24$, such that $a_D - (t-12)Z_N/12 < a_S$, if the Sun is below the horizon; t is the number of the hour of the day from 1 to 24;

6) $t_W = t/7 = I_0 + F_0$ is the number of true solar weeks elapsed since the epoch where I_0 is the integer part and F_0 is the fractional part;

7) $I_1 = 7F_0$ is the number of true solar days elapsed within the current week, where I_1 is an integer;

8) if $t > 12$ and the LMT is before noon, $j = I_1$ (if $I_1 = 0$, then $j = 7$), or, otherwise, $j = I_1 + 1$ gives the number of the day of the week;

9) $k = A_j$ gives the number of the planet ruling the day of the week;

10) the smallest integer n such that $n = (k+i-1) \bmod 7$ gives the the number of the planet ruling the hour.

Practical notes:

1) If $f + |d_S| > 90°$, there is no solution to computation step 1), since then $|-\tan(f)\tan(d_S)| > 1$. This condition may arise only above the artic circle and indicates a day in which either the Sun never sets or else it never rises.

2) In computation steps 4 and 5), the correct solution of the inequality $a < x \leq b$ depends upon noting the position of the $24^h = 0^h$ boundary. The following logical procedure may be employed to determine if $a < x \leq b$:

1: $m = 1$;

2: if $a > b$, go to 5;

3: if $a < x$ and $x \leq b$, go to 6;

4: $m = 0$ and go to 6;

5: if $a \geq x$ and $x > b$, go to 4;

6 if $m = 1$, then $a < x \leq b$.

3) For south latitudes and declinations we have $f < 0$ and $d_S < 0$.

4) To convert x degrees into y hours, use the relation $y^h = x°(24^h/360°)$; for radians, use $y^h = x(24^h/\pi)$.

5) Equation (II) given above computes the approximate hour angle of sunset from the estimated position of the solar center as it passes below the horizon with the observer on the same altitude as the horizon. If it is considered desirable to compute from the upper limb of the solar disk (figure 2) or to allow for the horizontal refraction of the Sun's light or the altitude of the observer above the horizon, then the zenith distance of the Sun, that is, ZD, does not equal 90°, and the hour angle H between noon and sunset must be computed from the relation

$$H = \arccos(-\tan(f)\tan(d_S) + \cos(z)/(\cos(f)\cos(d_S))) \quad \ldots(III)$$

developed directly from equation (I) with $z = ZD$. Equation (III) will then replace equation (II) in computation step 1).

Figure 2

For example, the American Ephemeris and Nautical Almanac is tabulated for z=90°50', where 34' is allowed for the Sun's horizontal refraction and 16' for the Sun's semi-diameter. For an altitude h feet above the horizon the Explanatory Supplement, p. 401, gives the formula $z = 90°\,50' + 1'.17\sqrt{h}$. This correction is developed in Woolard and Clemens, Spherical Astronomy, pp. 211-219.

6) More precise procedures for determining the times of sunrise and sunset which allow for the change in declination of the Sun are given in the Explanatory Supplement, pp. 403-406.

Example: What is the day of the week and ruler of the hour at Oceanside, California on December 13, 1950 at 8:00a.m. Pacific Standard Time?

1) The latitude of Oceanside, California is $f = 33°\,12'$ N and the GMT is midnight. The declination of the Sun for this time is $d_S = -23°\,6'\,4''$. So,
$H = \arccos(-\tan(33°\,12')\tan(-23°\,6'\,4'')) = 73°.79(24/360) = 4^h.92$;

2) $Z_D = 2H = 9^h.84$ and $Z_N = 24^h - Z_D = 14^h.16$;

3) The sidereal time at Oceanside at z is $a_{MC} = 13^h.64$, so $a_A = a_{MC} + H = 13.64 + 4.92 = 18^h.56$ and $a_D = a_{MC} - H = 13.64 - 4.92 = 8^h.72$;

4) $a_S = 17^h.30$ and $a_D = 8^h.72 < a_S = 17^h.30 \leq 18^h.56$, so the Sun is above the horizon;

5) $18^h.56 - 2(9^h.84)/12 = 16^h.92 < a_S = 17^h.30$, making $t = 2$ the smallest t such that $a_A - tZ_D/12 < a_S$;

6) $t = 347.0$ days, so $t_W = t/7 = 49.57 = I_0 + F_0$, where $I_0 = 49$ and $F_0 = 0.57$;

7) $I_1 = 7F_0 = 7(0.57) = 4$;

8) $t = 2 < 12$, so $j = I_1 + 1 = 5$;

9) $k = A_j = 6 = $Mercury, i.e., Wednesday;

10) The planet ruling the hour is the smallest integer $j = (k+i-1) \bmod 7$, or $j = (6+2-1) \bmod 7 = 7 = $Moon.

Thus it was a Mercury day and a Moon hour in Oceanside, California on December 13, 1950 at 8:00 a.m. Pacific Standard Time.

References:

1) The American Ephemeris and Nautical Almanac for 1950;

2) Explanatory Supplement to the Astronomical Ephemeris and The American Ephemeris and Nautical Almanac, H.M.S., 1977;

3) W.M. Smart, Spherical Astronomy, Cambridge, 1977;

4) Woolard and Clemens, Spherical Astronomy, Academic Press, 1966.

THE FIRST A.C.T

Astrological Conference on Techniques

August 4 thru 8 1980

Part of the A.F.A. Convention

ACT (Astrological Conference on Techniques) is a attempt to unify modern astro-research on a worldwide basis. The ACT convention includes a distinguished group of astro-researchers devoted to opening new lines of communication with one another and with the astrological community. Act is under the direction of a group of American Astrologers that include Michael Erlewine, Robert Hand and Charles Jayne. The first ACT conference will be held at the convention of the American Federation of Astrologers (AFA) located at the Marriott Hotel in New Orleans from August 4 thru 8 of 1980. The ACT conference will not be separate from the AFA convention. It will exist simultaneoulsy with the AFA convention in every respect.

This first ACT conference will be comprised of thirty well known technical experts from six countries. ACT will be given two lecture halls at the AFA convention which will be put to constant use. Our goal will be to establish an international information cooperative concerned with the theory and techniques necessary to a modern astrology.

Speakers at the ACT Conference

David B. Black
Dr. Alexander Borg
David Cochrane
Dr. Zipporah Dobyns
Roger Elliot
Michael Erlewine
Axel Harvey
Charles Jayne
Ian McKinnon
Michael Munkasey
Buz Overbeck
Count Guy de Pengern
Maritha Pottenger MA
Caroline Rupert
John Townley
Dr. Joseph Vidmar
Dr. William Whisenant

Arthur Blackwell
Dr. Miquel Charneco
Malcolm Dean
Dr. Robert Donat
Charles Emerson
Robert Hand
Lee Holt
John McCormick
Neil Michelsen
Dr. Kenneth Negus
Ann Parker
Doug Pierce MA
Mark Pottenger
Dr. Thomas Shanks
Noel Tyl
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ACT Program Schedule

Monday August 4 [8:30am - 10:00am]

Dr. Thomas Shanks (USA): One of the leading astrological researchers in the world and research director of Michelsen's ASTRO-COMPUTING Services.
TOPIC: Computer Implementation of the Helio Work of John Nelson

Robert Hand (USA): Hand is a well known author and practicing astrologer.
TOPIC:House Systems- A New View.

Monday August 4 [10:15am - 11:45am]

Dr. Alexander Borg (Switzerland): With a PHD in Physics (Celestial Mechanics), Borg is one of astrologys most expert programmers. His ASTRODATA chart service is the most advanced in Europe.
TOPIC: The Realization of an Ephemeris of True Angles

Mark Pottenger (USA): A leading programmer and expert on asteroid ephemeris generation.
TOPIC: Programming Formulas for Popular Astrological Techniques (returns, etc.)

Monday August 4 [1:15pm - 2:45pm]

PANEL DISCUSSION: ASTROLOGY & PSYCHOLOGY: The current relationship between Astrology and Psychology will be the subject.
Panel Members: Dr. Miguel Charneco, Dr. Zipporah Dobyns, Caroline Rupert (moderator), Noel Tyl, Dr. William Whisenant

PANEL DISCUSSION: THE REIGN OF QUANTITY: Is it necessary for astrologers to use the scientific method?
Panel Members: David B. Black (moderator), Michael Erlewine, Charles Jayne, Dr. Kenneth Negus

Monday August 4 [3:00pm - 4:30pm]

Charles Emerson (USA): Emerson is a well known uranian astrologer and a director of NCGR
TOPIC: Techniques of Medical Astrology

Arthur Blackwell (USA): A leading siderealist and radical thinker.
TOPIC: Modern Sidereal Astrology

Tuesday August 5 [8:30am - 10:00am]

Noel Tyl (USA): Well known astrological author, lecturer and editor of The Source (telecomuting network)
TOPIC: An Astrological Information Network

Charles Jayne (USA): Well known author, lecturer and practicing astrologer.
TOPIC: The Technique of the Conception Chart

Tuesday August 5 [10:15am - 11:45am]

David Cochrane (USA): Cochrane, one of the brightest of the younger astrologers, is an accomplished programmer, harmonic researcher, author and editor of the magazine SIRIUS.
TOPIC: The Use of Harmonics in Synastry

Dr. Joseph Vidmar (USA): Vidmar received a Doctorate in Education by repeating the Vernon-Clark experiment with astrologers.
TOPIC: The Vernon-Clark Experiment

Tuesday August 5 [1:15pm- 2:45pm]

Panel Discussion: COUNSELING TECHNIQUES
Panel Members: Dr. Miguel Charneco, Roger Elliot, Charles Emerson, Michael Erlewine (moderator), Buz Overbeck, Maritha Pottenger

Panel Discussion: NEW COMPUTER GRAPHIC TECHNIQUES
Panel Members: Robert Hand (Moderator), Axel Harvey, Neil Michelsen, John Townley

Tuesday August 5 [3:00pm - 4:30pm]

Dr. Kenneth Negus (USA): Assistant director of German Language Literature at Rutgers University, Education director of NCGR and driving force behind the new curiculum of the NCGR
TOPIC: A New Method of Using the 90-Degree Dial and the Fifth Harmonic

Caroline Rupert (USA): Former head of NCGR in Chicago, Rupert is a practicing astrologer with a degree in psychology.
TOPIC: Correlation of Personality Assessment by Astrological Evaluation and Psychological Testing

Wednesday August 6 [8:30am - 10:00am]

Buz Overbeck (USA): A well known siderealist, expert computer programmer and uranian astrolgger
TOPIC: Modern Uranian Techniques

Dr. William Whisenant (USA): A degree in clinical psychology plus extensive original astrological research makes Dr. Whisenant one of our most distinguished speakers.
TOPIC: Astropsychology- A Resume

Wednesday August 6 [10:15am - 11:45am]

John Townley (USA): Former president of the Astrologers Guild of America, Research astrologer and original thinker
TOPIC: Planetary Cycles- New Concepts

Dr. Miquel Charneco (Puerto Rico): Clinical psychologist with extensive experience as a consultant
TOPIC: Clinical Psychology and Astrology

Wednesday August 6 [1:15pm - 2:45pm]

Panel Discussion: ASTRO-TALK: ADVANCES IN COMPUTERISED INTERPRETATION
Panel members: Roger Elliot, Michael Erlewine, Lee Holt (Moderator), Doug Pierce, John Townley

Panel Discussion: CELESTIAL MECHANICS: The Leading Edge of Planetary Theory
Panel Members: Alexander Borg, Robert Hand, Charles Jayne (moderator), Ian McKinnon, Neil Michelsen, Mark Pottenger

Wednesday August 6 [3:00pm - 4:30pm]

Axel Harvey (Canada): A Leading Canadian astro-technician with many innovative techniques and articles to his credit
TOPIC: An Objective Method of Rectification

David B. Black (USA): Expert Programmer, practicing astrologer and one of astrology's leading theorists
TOPIC: What Constitutes Valid Astrological Research

Thursday August 7 [8:30am - 10:00am]

Roger Elliot (UK): Well Known English astrologer and theorist
TOPIC: Similes of Nature- Astrology Reflects The Structure of the Universe

Michael Erlewine (USA): Computer programmer, theorist and editor of MATRIX Magazine
TOPIC: Heliocentric Research: The Archetypes

Thursday August 7 [10:15am - 11:45am]

Neil Michelsen (USA): Well known researcher, lecturer and Director of Astro-Computing Services
TOPIC: The Gauquelin 'KEYWORD' Research Results

Dr. Robert Donat (USA): Research astrologer with a doctorate in mechanical engineering
TOPIC: 250 Engineer/Scientist Work at Same Laboratory- Astrologically Why?

Thursday August 7 [1:15pm - 2:45pm]

Panel Discussion: HARMONICS 1980
Panel members: David Cochrane, Marc Joseph Cohen, Michael Munkasey, Dr. Kenneth Negus, Buz Overbeck (moderator), Ann Parker

Panel Discussion: ASTROLOGY VS THE ESTABLISHMENT- Does Astrology belong in the Establishment?
Panel members: David Black, Malcolm Dean (moderator), Robert Hand, John McCormick, Dr. Kenneth Negus, Dr. Joseph Vidmar, Dr. William Whisenant

Thursday August 7 [3:00pm - 4:30pm]

Maritha Pottenger (USA): M.A. in psychology and prominent consultant astrologer
TOPIC: Astropsychology and the Client

Count Guy de Pengern (FRANCE): French researcher and theoretician
TOPIC: Humano-Cosmic-Time: A Radical Technique

Friday August 8 [8:30am - 10:00am]

John McCormick (USA): Well known lecturer and author
TOPIC: Circadian Rhythms

Michael Munkasey (USA): Advanced programmer, researcher and a Director of NCGR
TOPIC: Compatibility: Using Harmonic Aspects between Planets in the Charts

Friday August 8 [10:15am - 11:45am]

Henry Weingarten (USA): Well known lecturer and publisher
TOPIC: The Technique of Forecasting

Panel Discussion: MODERN ASTROLOGICAL RESEARCH
Panel Members: Charles Jayne, Robet Donath, Doug Pierce, Neil Michelsen (moderator), Buz Overbeck, Dr. Joseph Videmar, Dr. William Whisenant

Additional Panel Speakers

Lee Wayne Holt (USA): Professional astrologer and film maker

Ian McKinnon (Canada): Electronic engineer and advanced programmer

Malcolm Dean (Canada): Editor of PHENOMENA and lecturer

Ann Parker (USA): Research astrologer

Doug Pierce (USA): MA in statistics, research astrologer

James Eshelman (USA): Well known astrologer and siderealist.
TOPIC: ASTRONOMY Free-For-All (question & answer period)

Gary Duncan (USA): One of our top mathematicians and programmers.
TOPIC: Modern Astrological Research Methods

Gary Christen (USA): Well known Uranian astrologer

TOPIC: Transit Tracking Tools

There will no doubt be other last minute additions to the ACT speaker list. Check in at the MATRIX suite for last minute details. Address any questions concerning ACT to Michael Erlewine at (616) 796-2483.

ADZ

FROM MATRIX SOFTWARE

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MATRIX Software is an authorized dealer for a whole line of computer hardware and software. Computer systems in stock and ready to ship include the Commodore PET, APPLE II, ATARI, TEXAS INSTRUMENTS and HEWLETT PACKARD. CENTRONICS and SPINWRITER printers are also stocked. MATRIX offers many dozens of programs for the new home computers. All of this is illusrated and detailed in our new 1980 FULL CATALOG. The price of the catalog is deductable from your first computer software order. The price is $4.

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Charles Jayne has two 32K PETS and will sell one. PRICE is $1000 (retail $1295). Those interested may contact Charles by phone at (914) 783-1014. Jayne also has a small WANG computer for sale with built in tape transport and printer.

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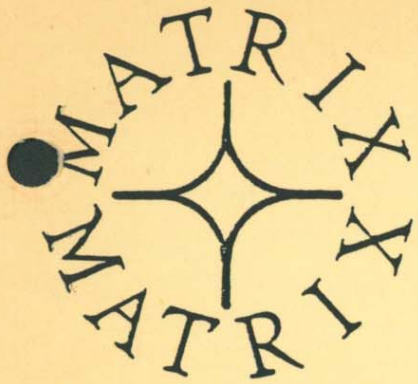
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Issue VIII MATRIX MAGAZINE

Front Cover		THE 1981 JOHNDRO AWARD
	1	NEWS & NOTES
Editor	5	EDITORIAL: NEW DIRECTIONS FOR MATRIX
Axel Harvey	6	DELTA-T CORRECTION FOR ALL TIME
Alexander Borg	7	BRIEF REPORT ON ANALYTICAL METHODS & EPHEMERIDES
Austin Levy	9	A HIGH SPEED ASPECT ALGORITHM
Editor	11	THE 1982 ACT CONFERENCE
Axel Harvey	15	FUDGE RECIPES
Doug Pierce	16	SYMBOLIC PERCEPTIONS OF ASTROLOGERS: A SURVEY
Michael Erlewine	22	ASTRO-DISK: VIDEO LASER DISK PROPOSAL
Editor	25	NEW GRAPHIC WHEEL TECHNIQUES
Doug Pierce	28	AISAR: ANALYTIC INTERPRETIVE SOFTWARE FOR ASTROLOGICAL RESEARCH
	8	ERRATA

315 Marion Avenue, Big Rapids, MI 49307

THE 1981 JOHNDRO AWARD

TO

JOHN M. ADDEY

It is with great pleasure that the award in memory of L. Edward Johndro is granted for 1981 to John M. Addey of England. This honor is not limited to those living in the United States but is given internationally for signal contributions to the technical side of Astrology. The choice each year is made by the Editors of a number of the leading non-commercial magazines in the United States.

Mr. Addey´s original studies of Harmonics have added to the store of knowledge available to all astrologers. He has applied the methodology of Science, which has been more honored in the breech than in the observance in modern astrology. It is generally recognised that, of the larger Organizations in our field, the British Commonwealth´s ASTROLOGICAL ASSOCICATION (headquartered in England) is qualitatively superior. While this has been due to many Astrologers, special credit must be given to Mr. Addey- who for so long served as its president.

The awarding Committee is composed of Zipporah Dobyns of THE MUTABLE DILEMMA, Michael Erlewine of MATRIX MAGAZINE, Robert Hand of NCGR publications, David Cochrane of SIRIUS, Charles Jayne of COSMECOLOGY BULLETIN and Henry Weingarten of NASO publications.

MATRIX MAGAZINE ISSUE VIII

MATRIX is a periodical with a single copy price (postpaid) of $6 ($7 First Class). Subscribers are notified as each issue is being prepared and their response determines the number of issues that will be printed. MATRIX is produced and edited by Michael & Margaret Erlewine. All inquires to:

MATRIX MAGAZINE
315 Marion Avenue
Big Rapids, MI 49307

(616) 796-2483 796-0381

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NEWS UPDATE

Life has been very busy here in Big rapids since the publication of MATRIX VII. This section will serve to bring you up to date on what has been happening. Please forgive the extended delay on getting this issue to you. We were waiting, among other things, for the SURVEY proposal to arrive from Doug Pierce. MATRIX, as you know, is a periodical in the true sense of the word. We get it out when and as we are able. Since I am still doing all of the work it has had to wait while the day to day business of living has been attended to.

MATRIX SOFTWARE

MATRIX Software has continued to change and grow. My brother Stephen Erlewine relocated to Big Rapids in the fall of 1980 and is working at MATRIX fulltime as a programmer and service technician. David and Gina Cochrane relocated here from Florida last May and David has also been working fulltime with us as a programmer. In addition, we have some part time help.

The most important result of the increased staff is that we have been able to extend full software support to the APPLE II and TRS-80 models I & III. Previously, the great majority of programs were available on the Commodore computer systems. New programs now appear simultaneously on Commodore, APPLE and Radio Shack machines. In addition we are supporting the ATARI and OSBORNE I computers. We are readying an entire line of CP/M compatible astro programs.

1981 CATALOG

Our 1981 MATRIX SOFTWARE CATALOG has been completely re-written. It is double the size of the previous catalog (152 pages), perfect bound and even has a glossy cover! No Xerox, but done by a real printer. Many photos and illustrations have been included. The $5 purchase price is refundable on any software order. This year´s catalog includes many new features including a glossary of computer terminology, a complete breakdown of various priced systems, and so forth. If you know of someone who wants to get a picture of what is happening with computers and astrology, the catalog will save them a lot of time. Of course we have descriptions and example print outs of all of the new programs including our hi-res designer wheels which represent a break-thru in computer graphics for inexpensive printers.

MATRIX NON-ASTROLOGICAL SOFTWARE

We have been expanding into some non-astrological software. At present we are marketing BOOKKEEPER (a complete accounting system), STAT (state-of-the-art statistical package), SORT (machine language multi-key sort) and CALC (MACHINE SPEED BASIC). Our mini-assembly like language CALC was developed by astrologer/programmer David B. Black. It operates on the 6502 chip and is entirely portable between the Commodore and APPLE machines. CALC is a small computer language that is used in assembly-level programming. It consists of easy to use BASIC-like words that produce object code that runs at near machine language speed. Its chief virtue is that number crunching code (like planetary calculation) can be coded very quickly with CALC. We have a complete planetary routine written in CALC that runs on the COMMODORE machines.

POLAKOFF FOUNDATION AWARDS RESEARCH GRANT

The POLAKOFF FOUNDATION is a corporation not-for-profit organized by astro-researcher Serge B. Polakoff of Florida. The purposes of the Foundation are to foster and publish research and to pursue educational programs related to geocosmic research.

Mr. Polakoff contacted MATRIX this summer with a request to visit our headquarters with the possiblity of awarding us some money to fund a research project.The visit was made and funding of approximately $2400 was awarded to MATRIX to supervise the research. Our choice was to fund the SYMBOLIC PERCEPTION survey proposed by Doug Pierce and detailed elsewhere in this issue. Altho this survey is modest in scope and perhaps unspectacular, it has the advantages that it is administered to astrologers and is about astrologers. The results, to be presented in the ACT convention at the AFA convention in Chicago in 1982, should provide a convenient introduction to the research process for the average astrologer. It is a study that should excite some interest in even the most un-statistical of astrologers. Other researchers interested in contacting Mr. Polakoff may write him care of: POLAKOFF FOUNDATION INC., 708 St. Matthew Circle, Altamonte Springs, Fla 32701

1982 ACT (Astrolgical Conference on Techniques)

The organization of the 1982 ACT Conference (The Second ACT!) is underway. This years effort is under the direction of Michael Erlewine and Charles Jayne. David B. Black, David Cochrane, Michael Munkasey and others are assisting in the planning of the conference. All readers of MATRIX are encouraged to read the section on this upcoming ACT conference elsewhere in this issue and to join in the organizational process. We need your help in selecting the catagories and subjects for the conference.

COSMECOLOGY BULLETIN NEEDS OUR SUPPORT

Charles Jayne, editor of COSMECOLOGY BULLETIN, notifies me that it is becoming more and more difficult to get enough support to keep issues of the bulletin coming. There are so few hi-quality journals in our field that it is a shame to see a publication like the COSMECOLOGY BULLETIN fail. I have offered to publish articles meant for the Bulletin in subsequent issues of MATRIX. There is a possibility that we may combine forces and publish one magazine containing both MATRIX and COSMECOLOGY BULLETIN articles. What do you think?

CORRELATION: New English Journal

The ASTROLOGICAL ASSOCIATION of Great Britain has resumed the publication of CORRELATION. Actually the new CORRELATION is a different animal from the early version. Originally CORRELATION was a small supplement to the ASTROLOGICAL JOURNAL that dealt with astrophysical items of interest. The new CORRELATION is a full blown journal devoted to empirical astrological studies. We have just received the first issue and can assure you that it is of the highest quality both in content and appearance. Those interested in subscribing (4.5 pounds surface, 6 pounds air per year) may write to Mrs. S. Griffiths, 98 Hayes rd., Bromley, Kent, England, BR2 9AB. Make checks payable to the ASTROLOGICAL ASSOCIATION.

1981 JOHNDRO AWARD TO JOHN ADDEY

As you can see from the inside cover of this issue, the 1981 JOHNDRO AWARD has been given to John Addey of Great Britain. John sends us the following note in response to receiving this year's award:

ACKNOWLEDGEMENT OF THE JOHNDRO AWARD

by John Addey

I need hardly say that I feel greatly honored to be the recipient of this prestigious award and am naturally pleased that so distinguished a panel of judges should consider my work deserving of it.

One good thing from my point of view is that it gives me a rare chance to say a word or two about my work.

Although this is an award for technical contributions to astrology- and it is true that some of the spin-offs from the harmonic concept do constitute technical innovation ("inovations", that is, bearing in mind that there is nothing new under the Sun)- yet, my approach to astrology was originally, has always been and remains to this day, from the standpoint of mystical philosophy. This was and is because I believe that in the end, this is the approach which gets closest to the essential truths of the subject and, indeed, includes all others.

Anyone who starts from this angle will sooner or later want to clarify, as far as he can, all the underlying truths of astrology and it was in the search fo a clearer understanding of the laws of practical horoscopy that I came upon the harmonics concept with all its implications.

Again, although I have made use freely of what is substantially the methodology of empirical science yet, I am not really a statistician and have to rely on others to advise me about such matters. (in this I comfort myself with the thought that most of the discoveries of history were made without the benefit of statistics as we now know them and that if a thing is really true then, as a rule, one has only to arrange the evidence in the right wy for everyone- who so wishes!- to see that it is true.)

I wished to make this brief statement partly to correct what may be a common mis-impression that the main spring of my work is a statistical urge, partly to encourage others not to be afraid of applying common sense (but rigorously) to what are essentially simple problems as I have tried to do,- but chiefly to emphasize that there is nothing incompatible between mystical philosohy and truly scientific methods.

All good truth-seeking should be a mixture of inductive & deductive methods, of science and philosophy, of observation and first principles. There is no surer path to discovery that this combination thoughtfully applied with scrupulous honesty and imagination.

THE MUNKASEY KEYWORD DATA BASE

Michael and Nancy Munkasey spent a day here in Big Rapids recently. The chief purpose for the visit was to share with the MATRIX staff the results of many years of research into astrological keywords. The amount of this KEYWORD research and documentation really has to be seen to be believed. Thank God it is all stored on disk via word processing!

Munkasey has very carefully and thoroughly compiled a massive collection of phrases and definitions for all major astrological categories. Planets, Signs, Houses, Sensitive Points and even Midpoint combinations are covered. This material exists in several different forms. Let me describe them:

For each subject, say a sensitive point like the Vertex, there are several pages of definitions that have to be the most complete attempts to describe astrological ideas that I have yet seem. You should have seen me digging thru the manuscript to find references to points and items for which I have never had my fill of understanding. Points like the Equatorial Ascendant (East Point) and others. This material alone should be published as a reference work.

These larger sections have been broken down into lists of keywords that acurately represent each subject. These lists, too, are fascinating. Munkasey has then taken any two sets of keywords (example: Venus and Leo) and combined these major keywords to form a series of phrases (in various combinations) that represent the idea at hand. These phrases have been carefully honed and worked until they interchange very well as parts of larger sentences.

In essence, what is finally available is a very massive collection of descriptions, phrases and single keywords that represent every major astrological idea by itself and in combination. This material is perhaps ideal (and maybe indispensable) for use in some of the new dynamic forms of computer interpretation that are in the works. The keyword task undertaken by

Original Date: 12/30/80 Update Date: 5/19/81 P. 1 of 1

SUN/MOON

Fluctuating (Rhythmic) Capablity
Sensitive about Self-Confidence
Fluctuating (Rhythmic) Determination
Authentic Fluctuation (Rhythm)
Willfully Reasoned Intuition
Willfully Reasoned Imagination
Concerned (R... Nurturing
Fluctuatimg
Exuberant (F
Fickle Exube
Exuberant (F
Sensitive (
Fluctuating

Effective C
Fickle Effe
Uncertain
Capable Co
Fickle Cap
Intuitive
Protectiv
Self-Conf
Fickle Se
Uncertain
Fluctuat

Determin
Uncertai
Imaginat
Authenti
Authent
Willful
Emotion
Intuiti
Protect
Motiva
Fickle
Intuit
Proted

Enthu
Fickl
Fluct
Sent
Unce
Imag
Emot
Encd
Lav
Lav
Arr
Pre

Effective Fluctuation (Rhythm)
Sensitive (Touchy) Determination
Authentic Sensitivity (Touchiness)
Willfully Reasoned Impressions
Willfully Reasoned Gloominess
Willfully Reasoned Sensitivity (Touchiness)
Concerned (Regardful) Mothering
...Fluctuating (Rhythmic) Motivation
...ew) Mothering
...ness)

Original Date: 10/20/80 Update Date: 1/29/81 Page 1 of 4

SUN/MOON

General Principles:
The quality or amount of personal care and concern, or the quality or amount of time and enthusiasm that one is willing to put into the care of their own family or home. The authority that one brings to the maternal aspects of their life. One's will to care about the quality of nurturing that one can show or produce. The capability that one has to be protective of their home or family. The enthusiasm that one brings to making adaptations or changes in their life dictated by others. The ups and downs that one encounters in their creative flows. Their enthusiasm about the popularity that is accorded to them. The sensitivity that they bring to the decision making process. The impressions that they have of the spiritual sense that we all came from. The weakness or awkwardness that one feels when placed in charge of others or when accorded honors. The vitality that they bring to their sense of rhythm. One's enthusiasm for romantic episodes.

Probable Manifestations:
+ The vitality and enthusiasm that one is capable of bringing to their home or family situations. One's capability to be protective of their ...ambitions to achieve popularty. One's sense of laughter ...be a sensitive person.

Original Date: 1/16/78 Update Date: 7/22/81 Page 1 of 1

KEYWORDS OF THE SENSITIVE POINTS

ASCENDANT
Impressions Received
Mental Focus
Sense of Self
Personal Style
Sense of Reality
Environment
Perceptions
Reactions
Mannerisms
Repressive Mechanisms
Relating to Others
Attitudes
Attention Seeking
Interpersonal Roles
Understanding Others

SOUTH NODE
New Influences
Taking In
Joining with Others
Past Memories
Absorbing
Learning
Attracting Others
New Acquaintences
Connections to Others
Karmic Memo...

MC
Maturation Processes
Personal Development
Self-Restraint
Coping
Learning & Growing
Stature (Standing)
Intellect
Intentions
Principles
Self-Concepts
Security Seeking
Origins
Integration
Protection
Sense of Belonging

EQUATORIAL ASC.
The Unconscious
A Personal Retreat
Your Shadow Nature
Experiencing Self
Self-Examination
Authentication
Where you...

NORTH NODE
Similarities
Ties to Others
Group Connections
Alliances
Meetings with Others
Attracting Others
Sexual Ties
Acquaintences
Presentations
Ridding
Separations
New Habits
Pathways
Life's Aim
Sense of Destiny

VERTEX
Entanglements
Involvements
Encounters
Situati...

Munkasey has obviously been a labor of love taking many years of work on his part. He is now considering how best to make this material available to all of us.

We include some examples of the Munkasey Keyword material to give you an idea as to the quality and richness of the work. Once this material is made available (in its different forms) on disk as part of a data base, there are a great many possible uses to which it can be put as regards dynamic forms of chart interpretations. For example, the KEYWORD data could be accessed and sentences built up from the material using pre-programmed grammatical rules. These sentences could be used to form paragraphs and so on. Munkasey has offered to make the KEYWORD material available as part of the proposed ASTRO video disk.

GEOFFREY DEAN TO VISIT

Australian author Geoffrey Dean will be visiting MATRIX for several days in October. The chief order of business is the forthcoming update of Dean's book RECENT ADVANCES- now in preparation. MATRIX will make available any of its programs, formulas and resources to Mr. Dean for possible inclusion in the book. We will provide you with a full report on the visit in the next MATRIX.

JOHN McCORMIC DEAD

We are very sorry to note that MATRIX contributor and friend John McCormick was fatally injured in a traffic accident this past summer. John was one of astrology's most educated and articulate voices -unafraid to speak his mind on any subject that concerned him. He had an abiding interest in both computers and the technical concerns of astrology. I am afraid that there is no replacement for the wit, understanding and candor that John brought to our field. We also regret to have to note the passing of Robert Jansky and Don 'Moby Dick' Jacobs.

MATRIX TO HELP IN AFA RESEARCH SECTION

The AMERICAN FEDERATION OF ASTROLOGERS (AFA) has recently formed a research division. MATRIX wib be glad to note that your editor (Michael Erlewine) has been selected by the AFA to organize the programming portion of this new organization. More details will be made available in the next issue of MATRIX. Bob and Sara Cooper will visit Big Rapids in September to discuss this new Research Division and to plan how best MATRIX might contribute.

I am sure that we will be needing programming and organizational help from any MATRIX readers that are willing. Here is an opportunity for those of us interested in the technical aspects of astrology to assist a major organization in establishing a research base. It is very appropriate that a group of astrologers as large as the AFA have a dedicated research facility. Let's help get this project on the road. Any readers interested in helping should contact Michael Erlewine at the MATRIX address.

BIBLIOGRAPHICAL INDEX TO ASTROLOGY (BIA)

The COLORADO ASTROLOGICAL SOCIETY (CAS) is producing an exhaustive BIBLIOGRAPHICAL INDEX TO ASTROLOGY for the world's astrological literature thru the year 1981. Contributions (tax-deductable) and inquiries can be sent to The Colorado Astrological Society Inc, C/O Colin James, 722 High St., Denver, CO 80218

PROPOSED ASTROLOGICAL MAGAZINE

Your editor has been very concerned about trying to facilitate the production of a quality astrological magazine. Since the ASTROLOGY NOW folded, there has been no general magazine for professional astrologers available. I have spoken with a number of people including Noel Tyl, former editor of ASTROLOGY NOW. Tyl states that he has obtained the rights to ASTROLOGY NOW and is considering starting up that magazine again- perhaps in 1982. That would be great.

Magazines like MATRIX, COSMECOLOGY BULLETIN and CORRELATION are far to specialized in nature to appeal to the wide majority of astrologers. Yet I miss the communication achieved thru such a popular publication. What can we do about it?

I have spoken to a number of other astrologers and all are in agreement that a popular astro magazine with a balanced format is much to be desired. All also agree that the days of the one editor magazine are past. What we now need is a publication fired perhaps by a single dedicated editor but under the direction of an editorial board that would guarantee to keep the magazine on course thru the passage of time. We need a magazine to serve all astrologers by offering many different sections or departments.

For example, one of the outstanding features of PHENOMENA under the direction of Malcolm Dean was that it presented abstracts of all other astrological journals and publications. Few of us have the money much less the time to read all of the astrological publications. What a joy it was to review the major publications by reading a brief abstract of each article. I could tell in a few minutes which journals I wanted to locate for more details.

Of course MATRIX readers would approve of a COMPUTER AND PROGRAMMING SECTION to keep the average astrologer up to date on current developments in this area. Also important would be a RESEARCH & STATISTICS section to report in abstract and sometimes in detail what is happening in this field. Other sections could include ASTRO-PSYCHOLOGY, COUNSELING, ASTRO-GOSSIP, TEACHING & EDUCATION, SYMPOSIUMS & SEMINARS and others. I very much approve of Noel Tyl's approach of giving to each issue of ASTROLOGY NOW a major theme or topic.

While the magazine would be under the general editorial control of an individual, auxiliary editors could be responsible for the organization of material for their particular section. The direction of the entire magazine could be subject to the approval of a board of qualified astrologers whose purpose would be to keep the format balanced and serving the majority of astrologers needs.

I have already contacted the following individuals and all would be willing to serve on such a board: John Townley, Charles Jayne, David Cochrane, David Black, Michael Munkasey and myself. We would need to balance the technical bias of this group with additions from groups I may not be in touch with. We need a backer or backers to raise the money necessary to support such a magazine. This could be a strictly business kind of thing provided that the format of the magazine remain under the control of whatever advisory board of astrologers were elected.

If I had my way I would like to see John Townley as the Editor-in-Chief of the publication. John has the skills and experience needed for the task. Noel Tyl too has supurb editing abilities but I am imagining that his new company TYL ASSOCIATES will be taking up a majority of his time.

There is a now a need for such a general astrological magazine. Certainly there is plenty happening within our field worthy of report and discussion. We need editors and backing. This should be a group effort worthy of the new spirit that is emerging in astrology- a magazine for both beginning and advanced astrologers, for the technical and the non-technical. How about some feedback.

EDITORIAL: MATRIX CHANGES DIRECTION

For the last several years, our little magazine has been directed towards the presentation of computer related events and astrological algorithms. This has been absolutely important since these areas of astrology had been very much neglected. However, we feel that MATRIX has done much to rectify this situation. In fact, we find ourselves re-viewing the original ideas that brought forth MATRIX in the fall of 1977. We are dedicated to helping to create an information cooperative along algorithmic lines <u>but also</u> to presenting **RADICAL ASTROLOGICAL THEORY.**

It is this RADICAL THEORY that now interests your editor and the format of coming issues will reflect this. MATRIX will continue to serve as a ground for publishing computer oriented material. But, in addition, we will begin to chart a new course as well. We hope most of you will care to pursue this new direction with us. Let me describe it.

I perceive a great need to begin to chart and document some of the more subjective areas of the astrological mind. As astrology begins to emerge and become more established, the general lines of its form gradually become clear or come into focus. Perhaps it is like seeing more than just the tip of the iceberg. It is as if astrology has taken more of a firm grip on the establishment.

At any rate, it appears that a considereable amount of awareness or energy has been made available, freed up or released to be put to work elsewhere. It seems to me that as the outward form of astrology emerges into view, it is quickly being attended to by astrologers around the world. I am not concerned about this external form and direction receiving proper attention and care. I am confident that it will be attended to. I would rather spend more of my attention on some of those areas of astrology that are still sub or beneath our general astrological awareness or consciousness- that are just coming into view. I am suffiently of the pioneer spirit to always wanting to be moving Westward towards new horizons. I am speaking here of that great body of subjectivity that has been both the main resourse and the whipping boy of astrology.

If we can reflect a moment on the history of psychology (Freud for example) we can see what I believe to be a parallel. Areas of our mind or ways of thinking about portions of our mind have gradually become known or into view. This is part of the history of psychology. Astrology is particularly rich in subjective content. It is our chief resource.

We need only think for a moment about all of the different kinds of astrologers that we have within our field. It is typical for there to be about as many opinions on an astrological subject as there are astrologers. Some examples: If you dont share my view or perspective, it may be that you do not 'feel' the way I do. My knowledge (or your own) may well depend upon my, and only my, personal experience. I may have only subjective proof. My knowledge (my knowing) may be subjective knowledge... and so on. I hope I am now pointing to a facet of our field known to us all- that of subjectivity. Do you understand what I am refering to?

Like the land that runs down to the shore of the ocean, many of our standards and common ground end at the great sea of subjectivity. Empirical science makes little attempt to carry its research into such a place. Only modern psychology has learned to swim a little in the subjective environment. Those of us with a real interest in astrology, who have been alive to astrological vision know that astrology is to psychology as formulae are to mathematics. That is: Astrology can be a formal notation system for the psychological realms.

My concern with mathematics and the computer implementation of astrology was to put these very powerful tools into the hands of many astrologers. Previous to the availability of home computers, only a very very few astrologers have possessed any real ability to manipulate the mathematics of astrology. This was so for centuries. Now we have taken possession of these most useful tools. We are ready to go on.

The day of this completely 'subjective' astrologer must end. Altho this task is excruciatingly difficult, we must begin to find and mark out standards and perceive what is common in our astrological subjectivity. Just as there are mountains and form beneath the sea, so too is there form within our subconscious. We can begin to work together and to find agreement as to what is and is not there. We can begin to make this subjective or subconscious area of our

self conscious. We can carry our consciousness into these realms. This we can now do thanks, i part, to the acceptance- however limited- of astrology (and the subjective) by established society.

My own intuition tells me that one of the difficulties with much of modern astrological research of an empirical nature is that we are working only with the most determined areas of our life, with the 'hardest' facts- so to speak. This domain of 'hard' facts has been the testing ground of modern science. We know this.

However, much of the body of knowledge of astrology is concerned with the intuitive and subconscious areas of our self. To study these areas (soft facts) may well require that we alter or adjust our concept of what constitutes a 'fact'- what are to be considered facts. One method of doing this is to make conscious more of what has been, to date, sub or beneath consciousness. We may be required to go there together, as a group, and come to some agreement as to what is there... what we find there. Such action on our part could result in areas of our self being considered or taken to be 'facts' (agreed upon) that were previously inadmissable as evidence, as facts.

It is towards this new concept of 'fact' that I wish to direct your attention and to devote some portion of MATRIX. Astrologers are in a perfect position to do this work. We are already comfortable with our intuition or subjective selves. What we each refer to individually or subjectively (by our self) may be seen to be a common experience, a group experience or simply recognised as a truth, a fact of our common lives. What I am proposing is that we begin to take down the barriers that separate your private or subconscious knowledge of astrology from my own. Perhaps the barrier of subjectivity that has separated astrologers can be used to bring us together.

I have no great instant solution or pill for us to take to clear all of this up. It is hoped that by articulating or making this question (quest-I-on) clearer that some response may be evoked. I am opening up the pages of MATRIX for articles, input and response that will further the above idea. I perceive the need for us to begin to explore, share and find a common experience (standards) in what now each appears to take alone or subjectively (that subjective part of our selves). If there are any of you out there who also feel this way, please let us get in contact and begin to work this great thing thru. O.K?

If I find some support out there, I will begin to look at some of this material in the next issue of MATRIX. In particular, the idea of the planets as realms of our experience (chakras) will be considered. If the planets represent whole levels of our consciousness, I would like to find some general agreement as to what parts of our lives these represent.

- Michael Erlewine
Editor

DELTA-T FOR ALL TIME

by Axel Harvey

Editor's Note: responding to his own challange for a Fudge Contest, this arrived from Axel Harvey

Here are nine formulas which together give an approximate delta-t for every year from 0 A.D. to the present. In each formula, the coefficients are in seconds of time; arguments of trig functions are in degrees.

If you convert to radian arguments, it is not necessary to reproduce the values of a given angle- say six degrees- to many significant digits. After all, it's possible that a rounded-off radian argument might produce <u>better</u> results! The idea of a fudge is that one always looks for a simpler way to cheat.

For the period 1820-1980 for which we have annual figures, the maximum absolute error is 1.75 seconds of time.

As for the other periods, the formulas fit closely whatever data we have but their overall shape is an artist's impression of what it should be. I'm sorry about formulas three and four; maybe someone can pull them into a single formula.

A word about polynomial fits and Fourier analysis. Sometimes they just can't beat a craftsman's eye. With formula eight (1841-1899) for instance, I started out trying Fourier analysis- an exhausting ordeal on the Hewlet-Packard HP41C. I obtained up to nine terms and there were still errors over 2 seconds. Finally I drew a picture of the data and said, "that looks like a flattened-down sine curve". The square root of the sine worked the first time I tried it. Maybe we should take a craftsman's look at our planetary perturbation series.

DELTA-T APPROXIMATIONS

Dates Inclusive:	y= year + 1/2; coefficients in seconds
1. to 1580	$9462 - 10.6578y + .002995\ y^2$
2. 1581-1639	$98.25 - 111.5\ e^{z}$ *where* $z = \frac{-(1639.5-y)^2}{26}$
3. 1640-1653	$\frac{1080}{y-1560}\cos 28°(y-1646)$
4. 1654-1689	$-9 + 5\cos 9.5°(y-1665.5)$
5. 1690-1727	$\frac{24z}{z^2+1}$ *where* $z = \frac{y - 1699.5}{10}$
6. 1728-1819	$4.25(\cos 5.54°[y-1718.5]+1)+.185(y-1790.5)\ (y>1790)$
7. 1820-1840	$556.76 - .303\ y$
8. 1841-1899	$-2.55 + 6\sqrt{\lvert\sin z\rvert}$ (SIGN sinz) *where* $z=6°(y-1840.5)$
9. 1900- ?	$0.7+.6533z+(10-.104z)\sin(4°675z)$ *where* $z= y-1903.5$

BRIEF REPORT on
ANALYTICAL METHODS AND EPHEMERIDES

Theory and Observations of the Motions of the Moon and Planets

Conference at Namur (Belgique), July 28-31, 1980

The scope of the conference was to present an up-to-date review of the analytical or semi-analytical theories for the motion of the planets and satellites (especially the Moon) of the solar system and assess to what extent these theories are or will be useful in the construction of ephemerides.

The presently used analytical theories for the Moon (Brown with corrections) and the planets except Pluto (newcomb/Hill) are all correct within a error bound of about 10 seconds of arc (some of them are considerably better) and therefore sufficient for the Astrologer's requirements. Moreover, other methods have been developed by James Neely to reduce the amount of memory needed in todays personal computers in order to achieve an accuracy of about 3 minutes of arc within a 100 year period. From this point of view, the conference could not bring very much for the astrologers, but what goes on is interesting anyway.

THE MOTION OF THE MOON

Dieter Schmidt from the University of Cincinnati let the computer do the same steps carried out by Brown 80 years ago, namely the main problem of lunar theory (no oblateness and no planetary perturbations). He presented the new perturbation coefficients and claims that the terms in longitude and latitude were found with an accuracy of .00001 seconds of arc. The results have been compared with the semi-numerical solution of M. Chapront from the Beaureau de Longitudes (Paris) and showed no term with a discrepancy of more than .00005 seconds of arc. At the same institution, J. Chapront presented the first results of the planitary perturbations of the Moon, which will be brought to an accuracy of .000002 seconds of arc, that is about 4 millimeters. This in turn will be compared with the work of D. Standaert from the University of Namur, who considers the contributions from Venus and Mars only. The remaining action on the Moon are the accelerations resulting from the oblateness of the Earth and Moon itself. This has been studied by Jacques Henrard from the University of Namur. He presented complete tables of this kind of perturbations. Finally, Claus Oesterwinter from the Naval Surface Weapons Center (Dahlgren) reported an enhancement of his numerical integration of the Solar System (including the Moon), namely the addition of acceleration terms arising from the physical libration of the Moon. I have observed that almost anyone in the world who is developing analytical theories of the Moon and planets is using this particular numerical integration for comparison purposes.

P. Bretagnon summarized the progress which has been made at the Bureau des Longitudes over the last two years. He and his collegues have developed highly accurate analytical theories for the inner planets (order by order method) as well as for the outer planets (iterative method) except Pluto. The precision of the solutions are as follows: Mercury ".0005, Venus ".0029, Earth-Moon Barycenter ".0028, Mars ".0047 (over several centuries). The expected precision for the outer planets will be ".01 over one century or ".1 over 1000 years. These values have been obtained by comparison with the numerical integrator of Oesterwinter and Cohen. Bretagnon reports that his theory of the Sun is about 100 times more accurate than that of Newcomb. He also presented many terms of second and third order which are not present in the theory of Mars of Clemence (which uses the Hansen method). It is impossible, however, to find a solution for Pluto the same way, because it crosses the orbit of Neptune and the parameter used for the expansions is the ratio of the solar distances of the two planets which must not be greater than one.

T.C. Van Flandern talked about the work which is in progress at the U.S. Naval Observatory, namely their new algebraic manipulator (called NOMAN), written in IBM FORTRAN IV, independent of bit and word structure of the computer) used to develop new planetary theories. What he told me after the session sounds fascinting: using the wellknown method of variation of elements, the celestial mechanics group at the Naval Observatory will produce analytical solutions which will be valid over several million years! How this goal can be achieved is still a mystery to me because there are no expansions known which are converging. Special problems were encountered in the case of Pluto but they can be solved. The coordinates derived from the new theory will first be printed in the 1984 Astronomical Almanac. This almanac will also have a complete new design, the changes being too numerous to list here.

The 1980 Almanac for Computers will contain series for all planets over extended periods of time, not only up to Jupiter. X.X. Newhall presented a completely new integrator of the Solar System and states in the abstract: "Within the past two years, the Jet Propulsion Laboratory has produced a numerically integrated planetary and lunar ephemeris spanning the interval 1411 B.C. to 3003 A.D. The force model includes the full general relativistic point-mass interaction of nine planets, the Sun and the Moon. It also includes the classical effects of the five largest asteroids on the solar system bodies; and the interaction of the Earth and Moon oblateness components with each other and with the Sun. The force equations for the physical lunar librations were included as part of the integration. The integration scheme was a variable-order Adams method...". This new integrator (called JPL DE102) uses a relatavistic Solar System barycentric frame of reference and represents the most rigorous approach ever. The asteroids mentioned are 1,2,4,7 and 324. Processed with automatic variable step sizes (there were 6.4 million of them) the job run 70,000 on a Univac 1100/81.

The JPL DE102 is an export ephemeris and can be ordered as magnetic tapes for the time span desired. Along with the package comes a FORTRAN program called MACSYMA, a very efficient and fast algorithm which produces Chebyshev series for position out of the... position, velocity and accelerations recorded on tape. It provides maximum flexibility for the user: he can choose from the planets, several time spans and error bounds. The series are them used to interpolate the ephemerides. M. Standish (also from JPL) pointed out that, according to the DE102, the 1950 Equinox commonly used is about ".1 in error.

There were other papers presented at the conference, of course, but I think that I have picked out the important ones, at least for the technically oriented astrologer.

Abstracts or full papers of the conference will be published in 'Celestial Mechanics' in about 14 months time (!), complete results of the researches of the Bureau de Longitudes will appear in **ASTRONOMY AND ASTROPHYSICS** in the near future.

EVIDENCE FOR THE 'EXPLODED PLANET'

Just after Olbers detected the second asteroid, he had the idea that there was once a planet between Mars and Jupiter which dissolved. It is also well known that Bode's law claims for such a planet. To prove the hypothesis, T.C. Van Flandern considered the particles which had almost the energy to escape the Solar System. Naturally, they are all of very long period (VLP comets), that means, they need millions of years to come back. We can observe only a few of them, and most of them come back for the first time (NEW comets). Van Flandern has picked 60 of them and studied their orbits, which are all nearly unperturbed (short period comets which have revolved the Sun for several times are very much perturbed and cannot be traced back). If the hypothesis of the exploded planet is correct, the new comets must all have emerged from the same point, thus their Keplerian ellipses must have a common point. In fact Van Flandern has observed such a clustering point. It is located in the direction of about 15 degrees in Scorpio. Interestingly enough, a cosmic explosion point which lies in the middle of the sign ruled by Mars and Pluto! Van Flandern will now integrate back the orbits of the new comets in order to find the exact location of the event, which happened about 16 million years ago. A still unanswered question is why the planet exploded...

Forch, Switzerland, 1980
Alexander Borg

BARGAIN ON USED MICROCOMPUTER SYSTEMS

We have some extra equipment here at MATRIX that we are willing to sell to interested individuals at a good price. In addition, we will include a generous amount of MATRIX software along with the deal. This equipment is not that old and in perfect running condition. Those interested should call us (616) 796-2483 or 796-0381 for more details. Equipment includes a Radio Shack Model I with 48K and dual disk drives,a 32K 4.0 Commodore system with a 4040 dual disk drive and Commodore printer and a good bargain on a Centronics printer. Here is a way to save a lot of money compared to the price of a new system.

Notes of the SYMBOLIC PERCEPTIONS SURVEY

A few words here about the SYMBOLIC PERCEPTIONS SURVEY. What is interesting about this survey is that it does not have for a goal the HARD statistical facts found in most astrological research proposals. Here we are interested in what we can call SOFT facts. We are attempting to begin to explore and map the intuitive and subjective areas of astrology. What we hope to get is a reflection of what we all know and feel about astrology. The only response that I have received so far about this type of thing goes something like this: "won't we be getting that same old stuff once more?". The answer is that we will be getting out of it exxactly what we, as a collective group, put into it. I am sure that a lot of what we find will be the traditional Sign, House, Aspect symbolism. In addition, we may get glimpses or even a picture of the general astrological landscape that includes facets of our collective vision not part of the typical stereotype image of astrology. We will have to wait and see.

Regardless, it is the intention of the SYMBOLIC PERCEPTIONS SURVEY to point towards what we feel is a new vista for astrological research, that of the SOFT SCIENCE study. We will be following in the footsteps of Psychology and Sociology in trying to survey our own subjective consciousness. I am not surprised that these first attempts may well be awkward and very imprecise. The areas we are working with are essentially uncharted waters and our first attempts at articulating them may well seem clumsy compared to any future vantage point. What I would like to see come out of this is some kind of standardization or agreement concerning our subjective astrological consciousness.

It is time that we, as astrologers, ceased to seek refuge in our own subjective realms. It is time that we began to compare and work towards a common vision of what is contained in these subjective areas. We must survey and map these regions and carve out for ourselves a new set of facts pertaining to them. We can call them SOFT facts since they have not yet reached the surface of consciousness to the point of taking on the qualities associated with the so-called HARD or scientific facts.

We can compare experiences and come to some agreement with one another as to just what the landscape of these subjective areas of our consciousness contain. We can carry on new kinds of research based on these SOFT facts. We do not have to wait until these SOFT facts crystalize to the point of being recognised as HARD facts We cannot afford to wait.

ERRATA

MATRIX VII

Page 19, line 5060, 'TAB(' should read '~'
Page 17, line 2570 should read R=SQR(X*X+Y*Y) :
A=ATN(Y/(X-1E-9*(X=0)))-PI*(X<0) :
A=A-2*PI*(A<0)

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A High Speed Aspect Algorithm

As the work of the many astro-programmers around the world develops, the need to find faster ways of executing programs becomes very evident. At present, there are three broad options for making such improvements a reality:

i) **Low Level Languages**
By abandoning high level languages like BASIC, FORTRAN etc for assembly codes, enormous improvements in execution time can be achieved. The major disadvantage of this approach is in the much greater time factors required for writing and debugging such machine language routines.

ii) **Hardware Improvements**
As computer technology develops further, there will be an inevitable improvement in hardware efficiency for micros. Examples of this include 16-bit processors, magnetic bubble memory, and of course, compilers. Most micros have available, or will have shortly, compilers for most existing high-level languages, and new ones such as PASCAL. Factors which might weigh against this are high cost, and delays in the availability of such improvements.

iii) **Optimal Program Design**
Improving existing high-level programs is by far the quickest and cheapest way of increasing execution speeds, and also the most fun! It offers the greatest scope for individual creativity, and is a challenge to the skill of the programmer. The major disadvantage is that not all tasks are amenable to overhaul, except perhaps in minor details. This article is intended to illustrate a case where such a design improvment IS feasible due to a different programming approach, and where this has in turn led to a dramatic improvement in machine performance of a familiar task.

The standard approach to aspect calculation by computer relies very heavily on the rigorous, repetitive abilities of the processor, and its concomitant speed. In doing so, it apes the human model, except that it is "ideal", because it is completely exhaustive in its testing of all possible aspect combinations between planets. But as we shall shortly see, this "ideal" approach is quasi-ideal at best, in that it does not optimise the full processing potential of the computer. We all know that computers are born drudges, but like us, even they operate most efficiently when given maximum inherent informational support. In other words the more useful feedback which can be supplied to a system during operation, the more efficiently it will perform a given job.

To see hov this idea could apply to aspect calculation routines, let's first just quickly review the standard approach to calculating apects (give or take a variant or two). It looks something like this:

```
      Programming Code          Remarks

      FOR  I=1 TO 12            First planet loop
      FOR  J=I+1 TO 13          2nd     "     "
      FOR  K=1 TO 9 (say)       Aspect test loop
      ...                       Search planet loops for
aspects

      NEXT K
      NEXT J
      NEXT I
```

This method sets up a pair of loops which generate all the planetary combinations, and then searches each of these 'cells' for a possible aspect via a third loop. The number of aspects actually checked in each cell depends on whether or not an aspect is found. So if none is found it will have checked all the aspects specified in the program. Such checks are called NON-TRIVIAL, since they are necessary (and sufficient) for finding all the aspects in a given chart.

Using simple probability theory, we can easily show that the number of aspects found in a 'typical' chart is around 40, which is about 8% of the total number of non-trivial checks required to extract them. (These in turn, add up to about 80% of all the possible planets-in-aspect combinations). This clearly demonstrates the inefficiency of the traditional method, as it has a 'hit' rate of only 1 aspect in every 12 loop passes. The weakness is in all the searching which the computer must do in order to find the aspects, and the answer lies in replacing the 'blind search' approach with an 'intelligent' (ie data encoded) one.

If we wished to categorise the traditional approach to aspect finding, one could describe it as a NUMERICAL technique, since we are repetitively comparing two sets of numbers to see if they agree within certain boundary conditions normally called orbs. The method for finding aspects which I will shortly describe, is one which would be classified as a LITERAL technique, since it exploits the computer's string handling capacities rather than its number-crunching power, formidable as that may be, and in doing so, eliminates the need for searching altogether.

Suppose we create a string consisting of 180 characters, in which each character symbolises the aspect pertaining to the corresponding number of degrees between any given pair of planets. Aspects are denoted by the following code in the string: Conjunction=1, Opposition=2, Square=3, Trine=4, Sextile=5, Semi-square=6, Sesqui-quadrate=7, Semi-sextile=8, Quincunx=9 & a Null aspect=0. Thus the 6th character in the string will be a '1', since a separation of 6 degrees is a conjunction, which is represented by the index 1. On the other hand the 19th character is '0' since a 19 degree separation is no recognisable aspect. We need only 180 characters in the string in order to cover all cases, since all angles can be reduced to a size somewhere in the range 0-180. For argument's sake, let's call this string A$; it would look something like this:

```
A$="111111111000000000000000000008888
    000000006666666000000005555551
    000000000000003333333333333330
    000000000000044444444444444400
    000000000000000007770000000000
    0000000000222222222"
```

In order to use this string for finding aspects, we simply get the angle between two planets, round it up or down to the nearest whole degree (ie an integer), and then use this number to extract the appropriate character from the string, which in turn tells us what the aspect is, if any. Voila, instant aspects! We have thus bypassed the whole search routine of the old method simply by giving the computer a bit more information to start with.

The thought may now be passing through the reader's mind, "what about that rounding, doesn't it make it all very inexact?". The answer is NO, because once we have ascertained that an aspect is present, we use the REAL angular separation to determine the exact orb of the aspect, so no accuracy is lost. The only possible defect is that an angle which was just outside the range of an aspect may, by rounding, become called 'in aspect'. This possibility is accounted for by a simple IF statement, which prevents such anomalies from arising.

On the positive side, the method has two very good things going for it:

i) It calculates aspects in 78 fixed passes, rather than 702 for 9 aspects with the old method, a speed improvement factor of almost 10.

ii) It also means that as many NEW aspect types may be added as desired without affecting execution speed whatsoever! This is due to the fact that a Null aspect is simply one which is not acted upon (ie printed). Theoretically, we could make each whole degree separation a different aspect, and, using the new method, use no more CPU time than for 9 aspect types! This inbuilt processing conservation feature makes the method ideally suited for research.

Now let's study the code necessary to implement the new method:

```
Program Code                Remarks

FOR I=1 TO 12
FOR J=I+1 TO 13
A=ABS(P(I)-P(J))            Angle between two planets
IF A>180 THEN A=A-180       Is angle greater than
                            180 degrees?
B=INT(A+.5)                 Round angle to nearest whole
                            degree
IF B=0 THEN B=1             In case of exact conjunction,
                            set angle = 1
B$=MID$(A$,B,1)             Get aspect character from A$
C=VAL(B$)                   Decode number of aspect
IF C=0 THEN GOTO 100        If no aspect then increment
                            planet loop
IF ABS(A(C)-A) > O(C) THEN GOTO 100
                            Is orb greater than orb
allowed?
PRINT .....                 Print Planet/Aspect/Planet/Orb
etc
100 NEXT J
    NEXT I
```

Arrays used:
P(x) - planet positions array
A(x) - aspect size array
O(x) - orb size array

Obviously A$ will have to be pre-defined elsewhere in the program, and its precise composition is entirely up to one's own judgement on matters of orbs and aspects used. This in turn raises another point - if we want to use more than 9 aspects, how to we do it, since there are only nine single number letters available, and each degree position in A$ must be represented by only a single character? The answer is to start using alphabetical letters for the additional ones, and put some extra code into the routine to handle this. Let's say you use A=Quintile, B=Septile, C=Novile etc, then the additional code is:

```
IF ASC(B$)>64 THEN C=ASC(B$)-55
  (to be inserted after C=VAL(B$))
```

This assumes that the additional aspects are indexed as 10, 11, 12 ..., since we are using truncated ASCII values of the letters as the basis for their subsequent identification.

On a screen-only system, this new aspect routine may not result in vast speed improvements, since it probably does aspects very quickly anyway, but if you have a printer, or you are using the aspect routine on larger tasks like midpoint structures, progressed-to-natal aspects etc then the improvements can be spectacular. In the case of midpoint structures there are more than 10 times the number of aspect possibilities, so the speed increase is very marked.

A final point worth making, although it is not within the scope of this article to discuss it in detail, is regarding the obvious unsuitability of PASCAL, and other high level languages, for the implemention of a routine such as this, given their relatively weak string handling abilities. Of course, a large array could be used to take the place of A$ instead, but it removes much of the practical appeal of the BASIC version, given the very expensive memory cost of defining a 180 element array.

* * * * * * * * * * * *

MACHINE LANGUAGE PLANETARY ROUTINES

MATRIX has been moving down the road towards machine language a little bit at a time. We now have complete machine language planetary routines for both the Z-80 (TRS-80 models I & III) and the 6502 (Commodore & APPLE) microprocessors. The Z-80 coding was done by Dwight Ennis of California and the 6502 coding was done (in our own language CALC) by Doug Pierce. These routines can calculate the planet positions in about 20-25 seconds- complete with various other information.

We also are working with compilers on the different machines to increase speed. We will be supporting CP/M with a complete disk package in the near future.

REFLECTIONS ON NEW ORLEANS

by David B. Black

The 1980 AFA/ACT convention in New Orleans provided a rare opportunity for valuable interaction with other astrologers. The time was full of interesting contrasts, from the sterile Marriott hotel sitting in the middle of the summer-hot, pulsating French Quarter of steamy New Orleans, to the incredible variety among those attracted to a convention of astrologers. Whatever you thought of it, you were a stone if you thought it dull.

There are of course many kinds of astrologers. The kind drawn to the ACT convention, as I was, tend to be somewhat less naturally social than the rest (whether by choice or by circumstance is hard to say), and more tending to be on the fringe of things. The radical fringe of a fringe group, as it were. But the chance to meet others who have been seriously working astrological things out over an extended period of time was important to me; even meeting the people who have been working things out not quite so seriously was interesting. It gave perspective: this is where I stand relative to the other folks who think they are working on the same sorts of things I am working on.

There are some things about the ACT convention that could have been better,; but it was good as it was, and a simple unimproved repetition in 1982 would draw me back. Incidently, I found my expenses to total about $500, including transportation from New York.

THE ACT CONFERECE AT AFA/NEW ORLEANS

New Orleans was your editor's first opportunity to experience an AFA Convention. In fact, I had been to only one other astrological convention where techniques were in high focus- the NCGR conference near Detroit in 1976. Those of you who have been to these large conventions will know that I was in for quite an experience.

The all night train ride from Michigan to Louisiana itself was an eye opener. My entire family came with me, and packed into an overnight compartment, we eyeballed all of the strange and different cities as we sped towards New Orleans. The kids had never been on a train ride.

The convention was, well, much bigger than my mind had allowed me to imagine it. I dont believe I had even been in a really first rate hotel before. The bathrooms, in particular, were wonderful. The whole place was like a tiny city. We met dozens and hundreds of people who we had only known by mail or phone. Disembodied voices, old friends over the phone, suddenly had bodies and faces too! Names and personalities known only to me from the pages of MERCURY HOUR were alive and walking thru the halls, at the restaurants, on the elevators. My mind had to work very hard to catch up with the happenings. I was still absorbing the events of New Orleans months later.

Aside from being half terrified of the whole thing, the convention was a very big experience. The whole week remembers like some transluscent vision. I got very high from it- to say the least.

The ACT conference (Astrological Conference on Techiques), for those of you who may not have been able to be there, was a kind of a mini conference within the larger AFA convention. ACT members included those scheduled to speak for the AFA as well as individuals whose sole purpose for being there was to participate in ACT functions. Everyone I spoke with was unanimous in proclaiming that the ACT conference was a success. Much more so than we might have hoped for.

The AFA in general, and Bob and Sara Cooper in particular, went out of their way to make the ACT staff feel at home. Our lectures and panels were scheduled right in with the larger AFA convention. Our activites were distinct yet very much a part of the larger convention. The consensus was that the ACT conference added very much to the tone of the entire convention. Keep in mind that there were over 30 speakers for ACT and almost 50 separate lectures and panel groups. And all of these of a technical nature. Not bad for a first try!

The ACT lectures and panels were, for the most part, very well attended. Of course, large attendance cannot, at this time, be of primary importance to us. Our goal is to provide a forum for the technical concerns of a modern astrology. While some of the lectures had between 50-100 people, others has as few as one or two. Those few were, in some cases, the only living experts in the world concerned with that particular technique.

THOUGHTS TOWARDS 1982 ACT CONFERENCE

Charles Jayne and myself are already organizing the next ACT convention to be held at the 1982 AFA convention in Chicago. David Cochrane and David B. Black have joined us in planning this next event. I agree with David Black's comment (Black's notes on the ACT convention) that a simple repetition of the ACT conference of similar quality would be acceptable. At the same time, we are taking steps in the designing of the next ACT program to improve the event.

One obvious thing we must do is provide for more time and places for getting to know one another. It was all too brief. Many of the speakers at the ACT conference do not travel very much. Also there is the fact that technically oriented astrologers are still very much a minority. What I am saying here is that more time could and should have been spent getting to know one another via group discussions, dinners, etc. This is something that we can do something about.

We had two types of presentation in the ACT conference at New Orleans. The first was the standard speaker/audience or lecture format. The second was in the form of a panel discussion with a moderator, a panel of speakers and an audience. The panel discussions were very well received, quite spontaneous and, for the most part, a lot of fun. The lecture type presentations were, in general, more formal than the panels. Much like you might imagine.

Obviously there is a need for the lecture-type format. In particular, when the subject matter is very complex. Also if the speaker is the only one with knowledge of the subject matter there is not a lot of room for discussion. But what we experienced in New Orleans, in many cases, was different from the above. Often others in the room besides the speaker were well versed (and opinionated!) on the subject matter. When a room contains several (polite) experts on a particular topic, some form of group discussion may be desirable. This is particularly true since it is still early in the game of technical astrology. There are many years ahead of us for these technical disiplines to come fully into their own- to get dry and dusty.

Here is how we are planning the next conference. Panel discussions will function as before with a moderator, a selected panel and an audience. The panel will make statments and converse with one another. Later in the presentation, the audience will be invited to join the discussion. This format worked out well.

The speakers selected to present the lecture topics, however, will have a choice of presentation formats. They may select to give a traditional speaker - audience kind of presentation or they may select to serve as moderator of the assembled group. The choice will be up to the speaker. When the subject matter lends itself to the traditional type of lecture presentation, that format will be selected. However, when a number of individuals are present in the room with the speaker who also have knowledge and interest in the subject matter, then the speaker may elect to act as moderator for the group.

Let´s face it. Many of our subjects are of interest only to a select group. It is good to lecture on a topic and to provide a tutorial. Yet, in many cases what happened in New Orleans is that many individuals would gather to hear a colleague speak who were themselves very knowledgable on the subject matter. In many cases, it was <u>not</u> possible to get these people together again at a later date. What happended was that these individuals heard a good lecture on a topic with which they were already familiar. What might have happened and perhaps should have happened is for this group to break thru protocol and have a healthy exchange of information and friendship.

We still possess numbers small enough to allow this sort of thing to take place. Most of the individuals knew who one another were and would have liked to have this sort of exchange. This is the kind of thing we want to encourage in 1982. Therefore we will offer the following :

(1) PANEL DISCUSSIONS : Moderator, selected panel of guests.

(2) SPEAKER MODERATED GROUP DISCUSSIONS

(3) LECTURE FORMAT

In addition, we will provide a number of other activities designed to facilitate get togethers. We will designate and set aside at least one small room where ACT interested folk can gather in the evenings to discuss and exchange ideas. We will try to find a way for this room to be available on into the ´wee hours of the morn´. We will select one good restaurant as the ACT designated restaurant for a given night. ACT speakers and participants will be encouraged to eat together and spend time with one another.

I, for one, was so busy running around trying to get a million things done that I regret very much not having taken more time to meet many of the individuals known to me only via the mails or phone. I am going to arrange it, if I can, so that I am free most of this coming convention for just such activities. I suggest that we might consider sponsoring one hotel room as a meeting place for late night discussions. We are talking about a couple of hundred dollars for such a room. I will try to raise that money. Some of your may want to contribute to this end. It would mean that at least one meeting place would always be available to act speakers and participants.

We are still in the beginning stages of organizing a worldwide group of technically oriented astrologers. The AFA has shown every intention of providing us with continued support via convention space. I have heard some comments to the effect that we should have our own conference independently of the AFA convention. This might be possible at some point. However, I am very grateful that the AFA is willing to take care of all of the expense and bother of setting up a meeting place. ACT has no money for such things. All of the mailings and other expenses involved in planning the ACT conference has come out of my own pocket (MATRIX) or from a few contributions.

Other comments have suggested that we need our own space to ´culture´ our own brand of vibrations- that the large AFA convention is too crude for our type of subject matter to flourish. At a meeting of ACT speakers held when the AFA convention was drawing to a close, it was decided that Rob Hand and some other ACT participants were going to hold such a smaller ACT meeting in the off years when the AFA convention does not meet. I suggested that I would put my efforts into the bi-annual ACT participation at the AFA convention and allow some of the others to concentrate on the off-year meeting.

I feel that ACT benefited as much from participating in the larger AFA group as it benefited that group. I am less open to ideas that we need to get away from all those non-technical astrologers. It seems to me that we have a happy marriage here and should pursure it.

NOW IS THE TIME TO PLAN!

We need your suggestions and support now for the convention to be held in August of 1982 at chicago. Chicago is centrally located so perhaps many of you can begin to make plans to attend. Keep in mind that while ACT members benefit from the lower hotel prices arranged for by the AFA, we do have to pay the AFA entrance fee as do all AFA speakers and participants. ACT participants may attend all AFA lectures and functions held during the entire conference. Now is the time for us to plan our activities for the 1982 ACT conference.

WHAT YOU CAN DO

Plan to attend. That is the most important first step for each of us. Plan to participate in subject areas in which you have interest or experience. As I have mentioned earlier, one of the goals of this coming ACT convention is to soften the hard line between speakers and audience- wherever possible. We need to have exchange and circulation between members. Be there to facilitate this.

Another thing that YOU can do is to help us plan the schedule of events and subjects. We need your suggestions and feedback. Too many readers of MATRIX feel that they are not qualified to comment or contribute. Nonsense. Please take a little time to jot down what technical areas of astrology you would like to see represented in this conference. Even if this is but a single topic on a piece of paper. Write it down and send it off. You can help to build the coming conference in this way.

We will take these suggestions and weave a schedule that reflects these requests. ACT consists of a small international group of individuals interested in the technical and theoretical aspects of a modern astrology. Together we can build a means of communication... a means to share and distribute information- to keep in touch with one another. ACT is here to serve a global need for astrologers to communciate on technical subjects. What follows is a tentative list of subjects that could be presented in the 1982 ACT convention. This list was the result of suggestions by myself, Charles Jayne, David Black, David Cochrane and others. Can you add to this list or comment on it? Are you interested in participating in any of these topics and, if so, which ones? Write to us and tell us. Are you qualified to speak on any of these subjects. PLEASE take the time to participate in this planning process. At least write a postcard indicating that you support our efforts to organize such a conference. **PLEASE ACT!**

TENTATIVE SCHEDULE OF 1982 ACT TOPICS

I. **FOUNDATIONS**

A. **PHILOSOPHY OF ASTROLOGY** A discussion of the different approaches or ways of conceiving astrology. The accent here is on Gestalts or theories of astrology.

B. **SCIENCE OF ASTROLOGY**

1. **THE QUESTION OF PROOF** What kinds of ´proof´ are important to astrologers. What do we consider ´facts´ and how does this concept of FACT differ from that of the so-called empirical siciences.

2. **ASTROLOGY AND THE SCIENCES** How and where does astrology fit into the empirical sciences? Is it a ´soft´ or a ´hard´ science? Where do we, as astrologers, stand today in the process of fitting into the scientific establishment.

C. **HISTORY OF ASTROLOGY**

1. **ANCIENT vs MODERN CONCEPTS** What do we know about ancient methods of using astrology? Can we perceive a continuum? or do modern ideas totally color what we und$rstand to be astrology? Did the ancients possess a living experience or vision that we have lost?

2. **MEDIEVAL TO MODERN** How and when did the astrological vision change from the ancient form to the present form. How did astrologers manage to ´fall from grace´ in terms of being an acceptable profession in the western world. What, if anything, have we forgotten?

3. **EASTERN ASTROLOGY** What basic concepts drive the Eastern forms of astrology? How do they differ from western ideas. How developed is Eastern astrology in terms of techniques? concepts? role of the astrologer in those societies? Why are western methods seemingly so unspecific in comparison to those used in the East?

II. **THE PROCESS**

A. **ACQUIRING ASTROLOGICAL KNOWLEDGE** What is astrological knowledge? How does it differ from the psychological sciences? What do you know when you know something astrological? How do astrologers accumulate knowledge? Are there different ways, different schools of thought, different ideas of what are astrological ´facts´?

B. **TEACHING ASTROLOGICAL KNOWLEDGE**

1. **TEACHING PROBLEMS** What are the problems of the teacher of astrology? Aside from the methods or techniques, how to we ´teach´ or communicate an attitude or way of seeing something? What are some of the difficulties in teaching a ´soft´ science such as astrology?

2. **AN ORGANIZED CURRICULUM** What efforts have been made to create an organized method of learning astrology. The efforts of the NCGR in this area. What is happeing now and what can we do to standardize these efforts.

3. **DEMONSTRATING TO THE ESTABLISHMENT THE RESULTS** Since astrology is, to a great degree, still a ´soft´ science, how to we communicate astrological knowledge to the establishment and general public. Here we should address the problems of providing empirical evidence as well as educating the public to ´see´ astrologically. If much of what an astrologer ´sees´ as true is not yet considered a part of the establishment´s conscious knowledge, how to we introduce this establishment to a different way of seeing- a new perspective?

III. **STATE OF THE ART or WHERE ARE WE TODAY?** Here we would have a series of discussions on major astrological techniques meant to raise the questions of: Where are we at today? Is there a consensus? What new developments? Who is active in this subjects. How can we communicate or cooperate? etc. The following list is by now means complete:

A. HARMONICS	B. URANIAN
C. HELIOCENTRIC	D. COSMIC STRUCTURE
E. PRE-NATAL EPOCHS	F. RELOCATION
G. HOUSE SYSTEMS	H. WESTERN SIDEREAL
I. EASTERN SIDEREAL	J. MEDICAL ASTROLOGY
K. SYNASTRY	L. COUNSELING
M. CYCLES	N. RECTIFICATION
O. GAUQUELIN	P. FORECASTING
Q. TRANSIT WORK	R. DIRECTIONS
S. PROGRESSIONS	T. SOLUNAR RETURNS

The list could be much longer. The idea is to present lectures or group discussions of the major astrological techniques.

IV COMPUTER ASSISTED TECHNIQUES

A. **COMPUTER CO-OP** A growing need for individuals with computer systems to cooperate in organizing and storing information of interest to the astrological community. We need to establish a clearing house to delegate specific tasks to individuals interested in participating. For example, a data bank for birth data of well known individuals that could be made available to astrologers. A data bank for keywords, for different sets of birth data to be made available for study and the like.

B. **ASTRO-TALK 1982:DYNAMIC COMPUTER INTERPRETATION** A fast growing subject. Techniques to enable the computer to create an interpretation. Where are we? What is happening? Who is doing it? How can we cooperate?

C. **MICROCOMPUTERS: STATE OF THE ART** What low and medium priced computer systems are adequate for asrological work? What is the state of astrological software? What is being done? Who is doing it?

D. **ASTROLOGICAL PROGRAMMING** This would be a 'how to do it' mini-course in programming small computers for astrological purposes. How to get started doing your own programming.

E. **COMPUTER GRAPHIC TECHNIQUES** A meeting on the state-of-the-art in computer graphic techniques. What is possible via hi-res techniques on video monitors, dot-matrix printers and printer/plotters. This field is beginning to open up very fast. What is ahead? How long? How expensive? etc.

F. **DIAL-UP MODEM COMMUNICATION NETWORK** A seminar towards establishing an information network via a link-up of small micro systems using modem communications. This would include on-line data banks and the problems involved in providing access to this data for anyone interested.

G. **STATISTICS 1982** What is happening in the various astro statistical studies being performed at this time. A review of the Gauquelin research and other research currently underway. This section would probably consist of several seminars.

H. **RESULTS OF THE SYMBOLIC PERCEPTIONS SURVEY** The results of the Pierce survey of asrologers (described elsewhere in MATRIX VIII) will be presented and discussed.

I. **ADVANCED PROGRAMMING PROBLEMS** Questions on the creation of disk ephemerides, numerical integration, new ephemerides, pluto and other celestial mechanics related items would be discussed. This would be an advanced seminar on some of the problems that astro-programmers have to be concerned with.

J. **THE GAUQUELIN KEYWORD RESEARCH** A report from the staff at ASTRO-COMPUTING as to the status of the recent keyword research by the Gauquelins.

V. INTERFACES

A. **PSYCHOLOGY, INTERPERSONAL & HUMANISTIC** The state of the marriage between modern psychology and astrology. Are more and more psychologists using astrology, and if so, how and why?

B. **STATISTICAL PSYCHOLOGICAL RESEARCH** What is new in the world of research astrological projects using the psychological approach.

C. **ASTROLOGY AND THE SYSTEM OCCULT SCIENCES** How is the modern astrological approach relating to the other 'occult' systems? Growing closer? Growing apart?

ACT! ACT! ACT!

Now is the time for you to ACT. The above are only some of the possible topics we should be considering. Can you provide more? Once we get two or several speaker/participants on a given subject, we will put them in touch with one another. Sooner than later. They will be responsible to inform one another what it is they are going to present. This will help each of the speakers to have an idea as to what the other speaker's approach will be. This should help make the discussion lively. We can make this conference what we want and need it to be. Let's ACT!

BOB & SARA COOPER VISIT MATRIX

Bob and Sara Cooper of the American Federation of Astrologers (AFA) spent a day with us here at MATRIX headquarters. The visit was a good one and several items worth mentioning here came out of it. First of all, MATRIX presented AFA with a written proposal for the ASTRO-DISK (Video Laser Disk). Your editor gave a demonstration of the capabilities of the Video Laser Disk and the Coopers were very much enthused. They saw at once the value of such a disk to the astrological community. In particular, the use of the disk for astrological course material appealed to them. They intend to make a presentation of the concept of the ASTRO-DISK to the AFA board of directors. Great!

More details were forthcoming concerning the new AFA Reasearch section. Your editor has been given the fancy title of 'Program Analyst' for this new operation. What this means is that MATRIX will serve to reach out into the community of astrological programmers for assistance in the programming needs of the new organization. And that means many of our readers may be asked to contribute their expertise. I would be glad to hear from any of you who are interested in participating in this new project. At this early date it is difficult to determine exactly what kind of help may be required. I told the Coopers' that MATRIX would be glad to help in any way possible to assist in the establishment of a worldwide research organization.

FUDGE RECIPES

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Every kibitzer in astro-mathematics has notebooks full of fudges, more or less precise substitutes for the official way of doing something. Here are a couple.

PERIODIC OBLIQUITY Newcomb's polynomial for the mean obliquity is not meant to be valid for all time. In fact obliquity is periodic, whereas Newcomb's formula implies that obliquity was very steep in the remote past and will become negative in the remote future.

Now it is possible, with some tedious recursive solving, to fit Newcomb's expression for the mean obliquity to a periodic function. Such fits naturally have long hairy coefficients. The following result is not one of these. On the contrary, its coefficients contain fewer decimal digits than Newcomb's expression (in degrees- a fact which might make it useful. Here it is (in degrees):

23.29 + 1.323 sin (7.0466 - 0.56835T)

where T is in Julian centuries of 36525 ephemeris days from JED 2415020.0. In spite of its brevity, this formula differs from Newcomb's by less that 0".9 for the period 1 to 2400 A.D., and by less that "0.06 for the period from 1600 to 2000. The implied period is 63,341 years.

The authorities I have read disagree about the true period of obliquity, about its mean value, and about its extremes, so I can't guarantee anything. I hope this will help all of you who wish to rectify the horoscope of the last Ice Age.

FICTITIOUS ABERRATION Many years ago I set myself the task of composing a fudge for light-time aberration affecting a planet's longitude. The formula had to work well enough (within say, one tenth of an arc minute after rounding, without taking into account the planet's latitude, its actual geocentric motion, or any other fact excepts its own longitude and the Sun's longitude.

In the case of the Sun, an adequate formula is

20".496 + 0".345 cos (281 - longitude).

Let this value be S. I was able to build reasonable formulas for Jupiter, Saturn, Uranus and Neptune in terms of S and of the planets's elongation (longitude of planet minus longitude of Sun). These are:

Jupiter: 9".4 + S cos (elongation)
Saturn : 6".66 + S cos (elongation)
Uranus : 4".68 + S cos (elongation)
Neptune: 3".9 + S cos (elongation)

I had to give up on the other planets. Has anyone else succeeded? Warning: the above formulas are checked against the only official ephemerides I own, one from 1920 and the other for 1975.

CASTING OUT CIRCLES FOR HIGH PRECISION Now, a piece of real food for people who don't like fudge.

Formulas involving a very rapid daily motion, such that for the Moon's mean longitude, have to be handled carefully on machines with limited precision. Multiplying the Moon's daily motion (13.17639...degreees) by a few thousand days will result in a large number and the consequent loss of "least significant" bits- i.e., of those seconds of arc you want to preserve down to the last step. Here is one approach to the problem.

Given the polynomial P + ad + bd + cd

with d in days and coefficients in degrees, let

A - d modulo 360/a

The polynomial can now be written

P +Aa +bd + cd

For formulas in radian measure use A = d modulo 6.283185/a

The term Aa is equivalent to ad but will never exceed the circle because, instead of casting out circles after multiplication, you have to cast out periods of revolution before multiplication.

If Michael will allow me, I am ready to offer the **Joseph G. Dalton Memorial Fudge Prize** for 1981. All candidats should sent their favorite fudge recipe directly to MATRIX. Prize will be a batch of home-cooked you-know-what in a handsome tin box.

To qualify as a genuine fudge, a formula must satisfy the following requirements:

1. It must be opaque- that is to say, while the solver may have been inspired by basic knowledge of geometry and astronomy, his or her solution must defy all rational attempts to deduce it from the correct formula.

2. It must be easier to write down or execute that the correct method.

3. It must match the results of the correct method within a reasonable orb of precision and for a reasonably long period of time.

4. Fourier analysis is strictly forbidden.

[Editor's note] Thanks Axel! Let's have that contest. To date the greatest 'Fudger' that I have seen has to be Ian McKinnon of Toronto. There is more fudge than not in his equations for the inner planets in MATRIX III. But I am sure there are some powerful cooks out there who are even now starting up their ranges. James Neely, for one, who normally doesn't use a lot of the stuff has his fudge diploma. So let the contest begin. Send us your fudge!

SYMBOLIC PERCEPTIONS OF ASTROLOGERS:
A SURVEY PROPOSAL

Douglas K. Pierce, MSPH, Biostatistics
August 20, 1981

PURPOSE AND OBJECTIVES

The proposed survey is concerned with the measurement of astrological perceptions. These perceptions constitute the subjective element that enters into the application of astrological principles. While this subjective element is clearly essential to the interpretive process, research efforts in astrology have largely focused on measuring patterns of astronomical phenomena. This survey seeks to demonstrate that the measurement and objectification of symbolic or intuitive perceptions can provide significant insights into several areas of astrology.

This survey is a natural extension of an approach presented in the author's article in Issue VIII of Matrix magazine: AISAR: Analytic Interpretive Software for Astrological Research. This approach focuses on analysis of the interpretive process as an essential starting point for development of computer-assisted interpretive tools. The relativity of subjective perceptions of the astrological language was emphasized in this context. The article presented a theoretical framework for examining symbolic perceptions on a subjective basis. Also presented was a set of techniques for computer implementation of user-defined models of symbolic relationships. The proposed survey would take this approach one step further by providing a broader empirical base for inquiries into the nature of astrological perception and interpretation.

This survey would provide statistically sound findings concerning those symbolic perceptions generally assumed to be widely shared by astrologers. This empirical confirmation in itself would contribute to the quality of communication within this discipline. Beyond this, analysis of survey data would provide clues to some of the more complex questions that arise from inquiries into the nature of astrological perception. Such analyses may demonstrate that these intuitive processes are more accessible to meaningful measurement than is generally recognized. Further, this type of measurement may perform a vital function in aiding the researcher and theorist in the identification and formulation of meaningful questions. This heuristic function is particularly vital to a discipline such as astrology, where the question of what constitutes valid research remains largely undefined.

The 20th-century revolution in astrological theory and practice has been closely associated with developments in humanistic and transpersonal schools of psychology; this is well recognized. Also well recognized, particularly among psychologists, is the enormous gap between the humanistic/transpersonal schools and the more measurement-oriented schools of psychology. A similar gap is also apparent in astrology. A major objective of this

THEORETICAL ISSUES

This type of study raises a number of theoretical issues, and these issues tend to cluster around two questions: What is really being measured by this survey, and what are the implications of the approach being taken here?

In regard to the first question, it seems apparent that respondents' perceptions of astrological symbols will partially reflect the particular schools of thought to which they ascribe. At the same time, it is a quite basic assumption that there is an element of astrological perception that goes deeper than theoretical differences, that may be described as universal, archetypal, or collective. There is no clear-cut way of separating these aspects of symbolic perception for research purposes. The type of questionnaire presented in Attachment A may get around this problem to some extent. The novel format of the questions asked here may tend to nudge respondents out of their customary frames of reference, so that their responses would be more likely to rely on free-associating rather than on intellectualizing. Hopefully, this approach will tap the desired level of intuitive perceptions. This is an important issue to be addressed by contributors to questionnaire design.

In regard to the second question, only some rather global observations can be made at this time. This approach emphasizes the importance of the subjective element of astrological practice, as a proper focus of astrological measurement. This does not imply that there is "nothing to" astrology other than subjective perceptions. It does stand in contrast to those approaches that exhibit a preoccupation with making astrology a "hard" science of exact measurement. This was a preoccupation of psychology (and still is, to a large extent) which led to a patterning of psychological theory on the model of 19th-century physics. This was a deterministic model of a "billiard-ball" universe that has long since fallen by the wayside. The universe has proven to be far more complex than that.

One implied assertion of this approach is that it is okay for astrology to be a "soft" science, but that softness is not the same thing as fuzziness. Softness equates with complexity of subject matter, combined with the fact that relativity is a much greater problem when studying persons than when studying rocks, plants, or fish. Fuzziness is the inability to develop well-formed questions and theoretical problems. By any accepted criteria of modern thought, astrology is significantly more fuzzy than the established soft-sciences. The key to the "de-fuzzing" of these disciplines has been the development of sophisticated measurement techniques that have also served as powerful heuristic tools. The approach presented here is an attempt to apply these techniques meaningfully to a central aspect of the subject matter of astrology.

METHODOLOGY OF DATA COLLECTION

The methodology of data collection for this survey includes: 1) questionnaire design, 2) identification of respondent population, and 3) mail-out and processing of questionnaires. The third item is discussed in the section of this proposal concerning resource requirements.

Attachment A is a first draft of the questionnaire being proposed for use in this study. There are basically three types of information requested from respondents. The first is information about the respondents, and includes identifying data and additional data, such as astrological characteristics, that may be useful in analyses of subgroups of respondents. This information is requested in the first section of the questionnaire. The other two sections consist of lists of items for which data will be collected on the respondents' perceptions of astrological symbolism.

One type of data that will be collected on symbolic perceptions could be termed "perceived distance" data. Given a list of all possible (45) pairs of planets, respondents will be asked to assign distance scores for each pair, on a scale ranging from 1 to 9. These distances would represent the perceived similarity or dissimilarity between each pair of planets. For example, one might assign a score of 2 (quite similar) to the pair Sun/Jupiter, and a score of 8 (quite different) to Venus/Pluto.

Analyses of these data would yield an empirically validated picture of overall patterns of planetary relationships. This problem has been "resolved" theoretically in a variety of ways. This is an interesting problem largely because of this wide variation in theories and perceptions of planetary relationships. Empirical validation in this context would equate to the identification of patterns of responses that exhibit consistency in spite of this wide variation that is so apparent in the literature. Although there is room for modification, it is proposed here that this type of data be collected only for planets. Distance measures among signs or houses would probably yield far less interesting information, because the framework of elements and qualities (and their parallels in house structure) is so universally established.

The other type of data that will be collected on perceptions of symbolism involves the assigning of scores to individual symbols on several scales provided in the questionnaire. This technique has been employed extensively in psychological studies of attitudes and perceptions, and has been termed the "semantic differential" technique. These scales consist of pairs of bipolar adjectives such as hot-cold, hard-soft, or strong-weak. Respondents are asked to assign a position along each of these scales to the concept (or in this case, symbol) in question. Positions along these scales correspond to perceptions of a given symbol, in terms of the adjectives or other bipolar terms that define each scale. A score of from 1 to 7 is then assigned to each response, corresponding to the position marked on each scale.

It is proposed that this type of data be collected for all elements of the astrological language, including planets, signs, houses, elements, qualities, and aspects. Asteroids, Uranian planets, and other less widely used symbols should probably be included as well, although one would expect more missing data (non-responses) for these items. Contributors to questionnaire design should give suggestions about inclusion of other items they feel would be of interest. Perhaps number symbolism would be of interest in this context, particularly given its importance for harmonic theory.

In regard to the identification of the respondent population, this seems to be a straightforward matter. Mailing lists will be provided by Matrix magazine and perhaps by the AFA. Issues of randomness of sampling do not arise in this context, since this study will not involve the kind of statistical inferences for which randomness is important. It is hoped that the respondents to this survey will represent a fairly broad cross-section of the astrological community. Information about the respondents will be requested that should allow some judgements to be made about this.

METHODOLOGY OF DATA ANALYSIS

It is beyond the scope of this proposal to provide more than a general strategy of data analysis. The primary statistical tool that will be employed is known as factor analysis. This term actually refers to a variety of statistical techniques. Their common objective is to represent a large number of observed variables (such as questionnaire items) in terms of a small number of hypothetical variables known as factors. This has the effect of reducing a very large amount of information to a more manageable and interpretable form. In the major psychological fields of human ability and personality, and to a growing extent in other sciences, factor analysis has become an inescapable and powerful technique for coping with the overwhelming numbers of variables being measured.

The practicing astrologer, whether in counseling or in research, continually deals with overwhelming numbers of variables. The strategy in this study is to examine these variables, our symbols, and to construct a clearer picture of their interconnectedness than has been possible to date. This is the power of factor analysis, to extract from a set of data the information that defines the most significant dimensions of relationship between variables. In this way, this study would address questions that are central to the theory and practice of astrology. Since analysis of relationships is so central to the practice of astrology, it is clearly important to learn as much as we can about how these relationships are perceived by astrologers.

RESOURCE REQUIREMENTS

The resource requirements of this survey study may be grouped according to its three phases: 1) printing and distribution of questionnaires, 2) keying of completed questionnaires onto computer tape, and 3) statistical analyses of computerized data.

The number of questionnaires needed depends on the desired number of respondents and the estimated response rate. The typical response rate for mail-out surveys is low, in the range of 10%-20%. Given the plans to publicize this survey through Matrix magazine and the AFA, and assuming a high level of interest among astrologers, we can probably assume a much higher response rate. A 50% response rate would mean that out of 2000 mailed questionnaires, about 1000 would be completed and returned. This number is definitely adequate for statistical purposes, although analyses of subsamples of responses might be limited to some extent. If 1500-2000 completed questionnaires are desired, this would require a mail-out of 3000-4000. Since the questionnaire will be about 3-4 pages, and respondents will be asked to provide return postage, printing and mailing costs should be limited to less than $0.30 each, not including labor. This would amount to $900 for 3000 questionnaires.

Keying costs would be substantially higher, if keying is done commercially. If the records to be keyed are limited to about 300 characters each, keying and verifying onto IBM tape would likely amount to about $1.50 per record. This must be considered when deciding how many completed questionnaires are desired.

Computer costs for performing statistical analyses may be less problematic, since there will likely be facilities available, at no cost to the author, for performing all analyses. In addition, these facilities will in the near future allow transfer of survey data from standard IBM tape to floppy diskettes. It will probably be necessary to make this transfer through Apple machines, due to facility limitations. It is important, in any case, to have these data accessible from floppy diskettes for future analyses.

TIMETABLE FOR IMPLEMENTATION

The following is a rough timetable for implementation of the survey design proposed here; modifications will no doubt be made.

9/81-10/81: Questionnaire design with feedback and suggestions from selected contributors.

11/81-12/81: Printing and mail-out of questionnaires.

1/82- 2/82: Processing and keying of returned questionnaires.

3/82- 6/82: Statistical analyses and reporting (initial phase); compilation of findings for presentation.

6/82- 7/82: Coordination of survey presentation with other aspects of the Astrological Conference on Techniques.

8/82 : Astrological Conference on Techniques at AFA Convention, Chicago: presentation of findings.

The sucess of this survey will clearly depend on rather tight coordination and scheduling. All feedback from contributors to questionnaire design must be in my hands by October 10, 1981. This will allow the questionnaire to be in the hands of the printers on November 1, 1981. Hopefully, this will permit mailings to be accomplished completely before December 7, 1981.

ATTACHMENT A

SURVEY QUESTIONNAIRE -- INITIAL DRAFT OF PROPOSED FORMAT

A. Information about this survey, its purpose and objectives, who is sponsoring, what presentations and publications are expected, and additional information as suggested by contributors to survey design.

B. Respondent Information Section

Questions will be included about length of study and/or practice, birth data, geocentric planetary positions, areas of interest or specialization, and additional information as suggested by contributors to questionnaire design.

C. Perceived Distance Items

Items will be included for each of 45 planet pairs, in the following format:

Sun/Venus ___ (enter a number between 1 and 9)

Instructions will be provided to assign values corresponding to perceived distances (similarity/dissimilarity).

D. Semantic Scale Items

Items will be included for individual symbols, and at the top of each page of this section, the semantic scales will be listed in a format similar to the following:

(Instructions: Enter a number between 1 and 7 in each space provided beside the name of each symbol below. There is a space to score each symbol on each of the 8 (or whatever) scales. These scores will represent where you feel each symbol belongs along these scales)

	static						dynamic
assertive	1	2	3	4	5	6	7 receptive
	1	2	3	4	5	6	7

These examples are simply illustrative; the selection of scales to use in this section is one of the most important areas in which contributors to questionnaire design can be of help.

ASTRO-DISK: ARCHIVAL LASER RESEARCH DISK

by MATRIX Software (Michael Erlewine)

MATRIX Magazine under the editorship of Michael & Margaret Erlewine proposes that the American Federation of Astrologers (or some other major group) fund the organization and production of a Video Laser Disk pertaining to astrology specially designed for educational purposes. The following pages will provide the necessary technical and conceptual details. The project would involve a worldwide effort to assemble information to be encoded on a Video Laser disk. The disk would then be manufactured and made available to astrological organizations, teaching centers and interested individuals at cost. This would be a non-profit enterprise.

WHAT IS A VIDEO LASER DISK?

Television is familiar to all. We can agree that it is not only here to stay but also that it is perhaps the single most important communications medium presently in use. We should also be aware that home video cameras and video tape recorders have been available now for several years. These devices allow the user to, among other things, record network broadcasts on their own recorders and view these programs whenever they desire. The video tape recorder is similar in appearance to the much used audio tape recorder.

New, however, is the video disk machine. The Video Disk resembles the phonograph in that it has a turntable and accepts standard sized records. The Video Disk, when connected to an ordinary TV, produces full screen video and sound. Disks are available containing full length movies and sports as well as educational material.

So far, the description of the Video Disk we have given does not differ, in function, from the video tape recorder. There <u>are</u> some very real differences. The quality of Video Disk recordings are very much higher than those obtained from home video tape recordings. These disks ($10-$25) may be produced and retailed at about half the cost of video tape cassettes ($50). There are several types of Video Disks available. The only type of interest to us is the **Video Laser Disk.**

The laser driven video disk has several unique qualities. The video images are accessed by a laser beam. The video record is never physically touched and will last virtually forever. Even fingerprints have no effect on the quality of the image since the beam of the laser focuses beneath the surface of the smooth record.

The one quality of the laser disk of absolute importance to education is the fact that every image stored on the disk can be accessed individually. The laser disk contains up to 54,000 frames or video images on each side (104,000 two sides). Each frame is equivalent to a full color 35mm slide. These frames may be sequenced in the manner of cinema films to achieve the typical 'movie' effect or they may be viewed one at a time. In addition, any sequence of frames may be viewed in fast or slow motion .. in forward or reverse action.

EDUCATION & THE LASER DISK

It is the ability to randomly access any of the 54,000 video frames that makes the laser Video Disk (Pioneer, Magnavox, Sony) different from other styles of video disk (RCA, ZENITH) on the market. From the point of view of the educator, the laser Video Disk appears to hold immense possibilities. For example, MATRIX Software is considerin a project involving the Michigan Department of Natural Resources to create a video laser disk for the state. The disk will contain about 80,000 video pictures of virtually every aspect of the state's geography- all in color. The Michigan Disk will allow residents of Michigan to examine all of the hiking trails, vacation spots, flora & fauna in extreme detail. The disks will sell for between $10-$20 and be advertised thru the states natural resource magazine.

The IDEA

The prime concept is this: until now, information on any given subject has been collected, catalogued and cared for by either dedicated organizations or individuals. We have bird lovers, boat lovers and the like. Each of these groups has made books available to the general public containing prose and pictures introducing their particular subject. If a book contains several hundred color photos on a given subject, that is considered lavish illustration. Most books can afford no where near that many black & whites- much less color- photos. In essence, the only people who have access to anything like a large catalog of info/photos are the people who run the associations or the few who have the time, training and wherewithall to get access to this information.

The Video Laser Disk changes all of this. There is absolutely no reason why you and I wont be able to go out and purchase a record for $10 that contains literally ALL the birds in the world on it... or all the cars ever made ... or the trees & shrubs, etc. These disks can also contain instructional material and text. Yet, in addition, we can have all of the more detailed levels of information available to us as well.

It should be a recognizable fact to those reading this that when we get 'fired up' about a new subject, we are particularly open to absorbing information. Often that information is just not available. By the time we manage to locate the books, magazines, articles and what not we need, we are in a different mental space.

Basic collections of data on Video Disks... Birds, Bugs, Cars, Boats ...could provide an in depth wealth of information at a low price. At the very least, public libraries and schools will have both the video disk players and a collection of disks. These disks can be played on the equipment at the schools or borrowed to be viewed at home. In particularly, this could be of immense value to the underprivileged child who perhaps has never had this kind of information available to fuel the fire of the imagination. In this regard, we are all to be numbered among the underprivileged!

THE NEXT STEP

The video laser disk players are available now from an appliance dealer near you. The techology is fully developed and operative. MATRIX has an interface between the video disk and small computers such that the computers can provide very sophisticated sequencing of the material recorded on the disk. Each teacher or lecturer wishing to use a disk for educational purposes can mold their own material from the disk. They can make their particular selection and sequence of frames. They can design their own program.

THE ASTRO-DISK

We should begin now to design a disk that would encompass all of the many facets of astrology as we know it today. No single person or group could possibly be responsible for all that needs to be done to design such a disk. We would need global cooperation from every branch of astrology. The information to be stored on the disk could be of all kinds.

The disk could be made available very inexpensively to be used by any individual, bookstore or association able to afford a laser disk (about $700). The ASTRO-DISK could hold say 100,000 full color frames of information. If more space than this is needed, a second disk could be prepared.

Each of the 100,000 frames can be accessed individually or in any sequence selected by the user. This single-frame access can be had from the console or from a remote keypad. In addition, sequencing via home computer is also available. A time delay of 15 seconds represents a 'worst case' search from the first frame on a disk to the last. Most searches take but a second or so. A written catalog of the contents of the disk would allow a teacher or lecturer to select from the many thousands of slides, the set of slides to be used for a particular purpose. The selected series of slides could be accessed manually one at a time during a lecture or automatically via a computer interface. The computer would also be able to time each slide if that is desired.

Let us imagine for a moment a few of the many uses to which such a disk could be put. A single disk could serve thousands of teachers for thousands of different purposes. Questions of astronomy, for instance, could be answered by a touch of a button bringing up the relevent diagram or photograph. If a student did not understand retrograde motion, we could show them a diagram- at once. If a student wanted to visualize the Campanus House system, we could bring up an illustration showing how space is divided using that house system.

The same disk can serve as a library of definitions and keywords. Want to understand Solar Arc Directions? Bring up a written definition, a formula, a diagram or a worked example in seconds. Move from slide to slide as you desire. Keep in mind that there is no friction with a laser disk and each slide or frame will last virtually forever.

And how about beginning students? Could we not have a section of our disk devoted to educating beginning and advanced students? Frame by frame a student could study a given course answering questions.. one by one. A question answered corectly would lead to the next sequence. An incorrect answer would automatically lead to a review of the most recent material leading up to the question. Not one or two but dozens of complete courses could be available in this way. And still the disk is not full!

How about a section using all of the NASA space photos which are in the public domain. Full color slides of galaxies, planets, weather and the like. How about hundreds of pictures of people with different sun or rising signs? Sidereal and tropical. Or a visual ephemeris section that showed planetary movement every 10 days? A hundred year visual ephemeris of this kind would only use up some 3600 frames! And we could sequence thru it frame by frame or in slow motion watching the aspects form and disolve.

These are only a few of the possible ideas that could be implemented on such a disk. The expense is not too great. About $3000 will master a disk and give you about five copies. Extra copies can be had for about $15 each and once the master has been created, subsequent batches of copies are not expensive. What then is keeping us from having such an ASTRO-DISK?

WHAT WE NEED TO DO

First of all, a project of this scope must involve the entire astrological community. Since we will have to ask each group and major center to contribute information, diagrams and photos, the final laser disk must be made available to all as a non-profit item. In other words, the disk must be a group, even a global project. Assembling this amount of information is a monumental task that will require at least two years of preparation.

Only a national or international organization could facilitate such a massive project. I am submitting this proposal to the AFA Board of Directors for their consideration. If, for some reason, the AFA is not interested in overseeing the project, I will approach other organizations.

The material once gathered and photgraphed can be saved and used to create masters on any future device that might be developed. The material can be maintained and updated by a designated group of volunteers.

There you have the basic idea for the creation of an astrological video laser disk.

COLLECTING THE INFORMATION

The first step would be to collect the information to be recorded on the laser disk. Every major astrological group and association would have to be contacted. Every expert in every branch of astrology. This would have to be a worldwide project involving the entire astrological community.

The material to be placed on the disk would not attempt to duplicate or replace text material that is available now. In other words, existing books and authors need not feel threatened by the advent of an ASTRO-DISK. The disk would concentrate on illustrations, photographs, diagrams, maps, outlines, etc. Here is a list of what might be on our disk. I am sure that you will think of many other items.

A VISUAL ASTRONOMY section containing every kind of diagram and illustration of use in

teaching astrologers astronomy. Star maps, star fields, constellation maps, etc. Planetary diagrams, tables, charts, etc.

ASTRONOMY PHOTO section with hundreds of pictures of the galaxies, nebulae, star clusters, fixed stars, planets, moon, sun etc. For example, we could have actual photos of the phases of the moon to include as we teach students about the lunar cycle. There is a great amount of astronomy material in the public domain.

MAJOR ASTROLOGICAL TECHNIQUES. Every major (and minor) technique could be fully represented, complete with diagrams, outlines, key concepts and the like. The teaching aids for each subject would be organised and contributed by an expert in that field. These teaching aids would be available for use with existing texts on the subject. Want to get a better idea of Harmonics? We could have dozens of diagrams and graphs illustrating the harmonic approach and so forth.

ASTROLOGICAL STUDIES. A complete series of courses taking the student from beginning to advanced studies. Students could procede at their own pace moving forward and backward thru the disk, as prompted by instructions on the disk itself.

VISUAL EPHEMERIDES. Many kinds of visual and graphic ephemerides. Charts and tables of all kinds and types. Planetary motion sequences that could be run forward, backward, in slow or fast motion or by single frames. Cycles of all kinds could be animated such as: moon cycle, saturn cycle, progressed planets thru the houses, diurnal motion, etc.

ASTROLOGICAL DEFINITION SECTION. A library of astrological definitions, keywords, phrases could be available at a button's touch. Michael Munkasey has already volunteered his massive KEYWORD collection for this project. Want to look at what has been written about the Vertex? Several pages of vertex definition are available in seconds.

FORMULAE & COMPUTING A complete collection of all of the necessary algorithms and formulae used in astrological calculations. Planetary, lunar, house systems... you name it. Complete with computer program listings and worked examples. Always there when you need it.

HISTORY OF ASTROLOGY. We could have a complete history of astrology and astrologers available to us. Want to read about Marc Edmund Jones and look at his chart. There it is! We could have thousands of birth data recorded on just a few disk frames. Want to look at some ancient astrological texts or horoscope forms? We could have them on the disk if we wish.

BIBLIOGRAPHY OF ASTROLOGICAL MATERIALS. A complete bibliography of astrological books and articles could be provided using a minimum of disk space. Perhaps some of the material in RECENT ADVANCES could be placed on disk. A history of research experiements along with their results, etc.

PICTORIAL HISTORY OF ASTROLOGY Imagine color slides of all the chart forms, wheels, paintings, drawings, glyphs and what not used thruout the history of astrology. Almost all of them are in the public domain. Every teacher of astrology could be rich in material compared to anything that exists today.

That should give you some idea as to what is possible if we are willing to work together. This would be a collective project involving astrologers around the world. No individual or group would 'own' the disk. It would be the property of the entire astrological community. Some major organization such as the AFA could be in charge of organizing the disk and distributing it to the rest of us on a non-profit basis.

The material for the disk needs first to be collected. Second, the collected material must be transferred to 35mm slides or to video tape. The finished tape/film would then be used to create the actual master disk. Each frame or photo would be given a number and so forth. I have studied the techniques necessary to organize and create a master disk. I would be glad to oversee the technical process involved.

I woud appreciate feedback, support and additional ideas concerning what materials should be included on the disk. How about a group and worldwide project that can only benefit all of us? Please send your comments to MATRIX care of me. Thanks.

TECHNICAL NOTES ON VIDEO DISK SYSTEMS

There are, at present, three different types or styles of video disks being manufactured. Unfortunately, these three types are totally incompatible with one another. Each type is incapable of playing video disks designed for the two other types. There has been no attempt at standardization. More unfortunate yet is the fact that all three types of players are backed by huge companies determined to have a significant share of the market. In other words, we can expect to live with several types of video disks for some time to come. There are dramatic differences, as well, in the capabilities of the three different style playes. We shall now examine each type.

THREE MAJOR STYLES

The three major styles of video disk players in production are (1) Laser Illuminated/Optically scanned, (2)Needle in a Groove and (3) Grooveless with Needle. Although, for astrologers, only the first (Laser Disks) appear to be suitable for our needs, it is important that we understand the differences between video disk players.

VIDEO LASER DISKS

This style player uses a gas laser beam to read and scan the recorded disk. The disk is rotated at 1800 rpm and the scanning laser bean is capable of forward/reverse, fast/slow motion as well as accessing any single frame for as long as desired. Unlike celluloid films, no damage results from prolonged viewing of a single frame on a laser disk. At present, the disks contain one half hour (per side) of video material. If the user forgoes the freeze-frame and other fancy motion options, programs of up to one hour per side are possible. However, for archival type information storage, the half hour format which includes single frame viewing is necessary. Currently the price for this style machine is around $700 altho this will drop in time.

The laser disk was developed by the Phillips Co. in the Netherlands. This style player is being produced by Pioneer Electronics of Japan/U.S., Magnavox, and Sony Electronics. The video disks are produced by MCA DISCOVISION which is half owned by IBM.

NEEDLE IN A GROOVE

This style player employs the needle in a groove concept used in the record industry. The needle has a capacitor plate that senses variations in the magneticsides of the groove. The diamond stylus has a life of about 3000 hours and the recorded disk has a limited life span. Single frame playing is not possible.

This style player is greatly inferior to the laser type. Unfortunately RCA, CBS and Zenith have chosen to market and support it. The machines will sell for $200-300 less than the laser player. Most of the features that make the video disk distinct from the video recorder are lost with this system.

GROOVLESS WITH NEEDLE

The last style player uses a needle that is servo controlled on a flat groovless disk. The saphire needle has a life of about 2000 hours and there is disk wear. This style is being introduced by JVC (Matsushita) of Japan. The price will be somewhere between the Laser and the Needle in a Groove types.

COMPARISON TABLE

Here is a table comparing the three styles of player. The asterisk (*) indicates that the quality is present or that the style player has an advantage in this catagory.

FEATURES	LASER	GROOVE	GROOVELESS
MULT SPEEDS, FOR/REV	***		***
RETAIL PRICE		***	***
RANDOM FRAME ACCESS	***		*** (#)
SINGLE FRAME PLAYING	***		
NO DISK OR STYLUS WEAR	***		
ADVANCED STEREO SOUND	***		***
2-HOUR PLAYBACK	***		***
AUTOMATIC FRAME STOP	***		*** (#)
SOFTWARE VARIETY	***		***

Even a quick look will tell you that the laser disk has all of the desirable features except that of low price. The laser type represents the way of the future, the needle type, the way of the past. It is unfortunate that the public need be confused with the needle type at all since without the single frame capabilities, these needle type disks are no better than video tape machines.

I want to thank E. Q. Carr of the Herkimer County Board of Cooperative Education of the state of New York for some of the information used in this article. Mr. Carr is in charge of the Educational Services planetarium and is engaged in creating an astronomical laser disk that should be of great interest to astrologers as well. A limited number of copies of this astronomical disk will be made available for $50 per disk. If you are interested in obtaining a copy, contact me. The disk will be filled with color slides and video film on the stars, planets and so forth.

I am using the Pioneer Laser Disk here at MATRIX. Among other disks, I have an experimental disk prepared by the Jet Propulsion Laboratory in California. This disk contains thousands of slides including closeup footage of rotating jupiter in color, mars shots and the like. The future for video laser disks is very bright.

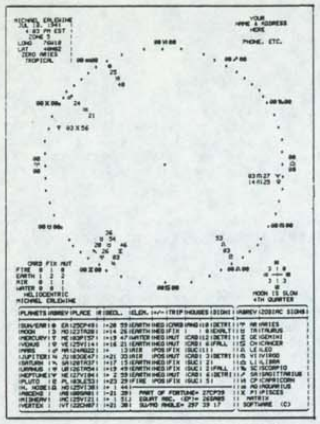
ADVANCES IN CHART WHEEL GRAPHICS

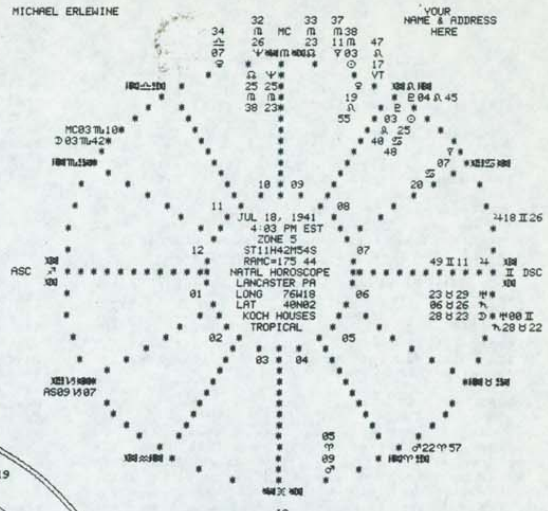
The representation of natal chart wheels via computer graphic techniques continue to be developed here at MATRIX. We thought you would enjoy a peek at our latest endeavors. We have a number of new chart representation techniques including astrological glyphs on the Commodore, Epson and IDS printers, double wheels and our new hi-res Picture Wheels. The new Picture or Designer Wheels represent some kind of breakthru in astrological graphics on inexpensive machines. Take a look at the accompanying examples. Keep in mind that the Versatec plotter used by Neil Michelson to get his nifty chart wheels costs between eight and ten thousand dollars. The Epson MX-70 used to print these examples retails for $445! That's a considerable price break for what we see as similar quality.

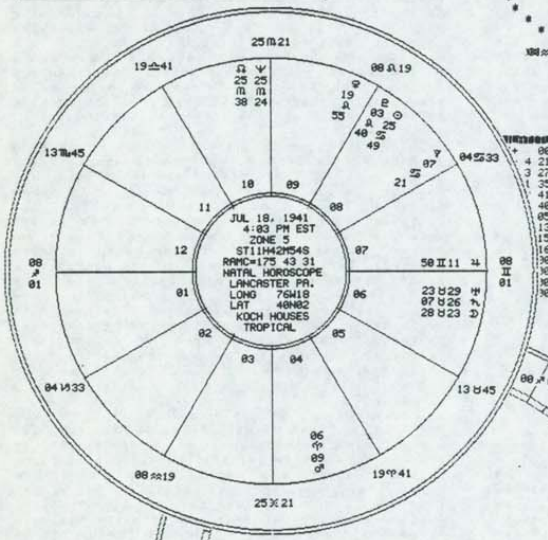
The techniques necessary to implement these Picture Wheels took a lot of work and research on our part. The majority of the interfacing and machine language work was done by Stephen Erlewine. Among other things we found that the companies that make these printers dont always know how to use their own machines. This seems to be particularly true for the Japanese printers. Japan sends them over here and assures their reps that all features operate. Yet they do not seem to be very willing to provide them with more detailed information. We had the technical staffs of two major printing companies confering with Stephen to learn how to get their printers to produce the bit-imaging graphics that were needed to get the Picture wheels to work.

These new wheels represent only the beginning of what we will be able to accomplish using these new techniques. Of course we will be able to have a wide variety of chart wheel forms including ornate and complex types. Also in the works are hi-res graphic plotting techniques that will do Astro-Geography & Local Space. Imagine printing out your own locality analysis on maps of different sections of the world! We will have a series of graphic ephemerides that you will be able to custom fit to your needs. Star maps complete with all 360 degrees of the natal horizon also will be made available. At this point we have control of 480 dots by 'n' on several of the standard 80 column printers including the IDS 445 (PAPER TIGER), IDS 460 and Epson MX-70 and MX-80 FT with graphics.

Also interesting are our Bi-Wheel printing packages. These allow the use to place one chart in the wheel center and a second around the circumference. Another new feature of most of our printing wheels is the ability to select the european open wheel style of chartwheel. These are especially good for drawing in aspects. More details on these and other new techniques can be found in our 1981 MATRIX SOFTWARE catalog.

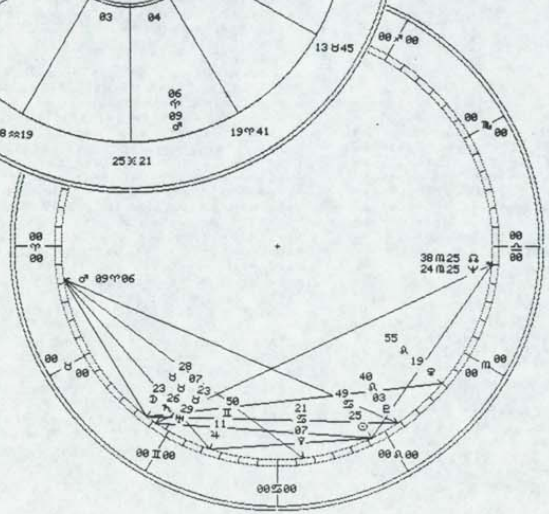




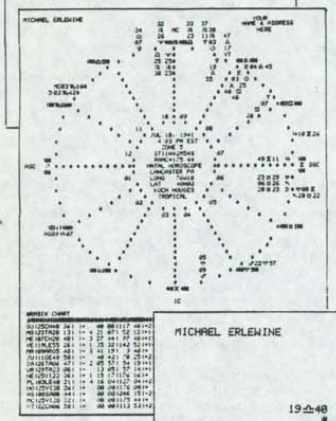


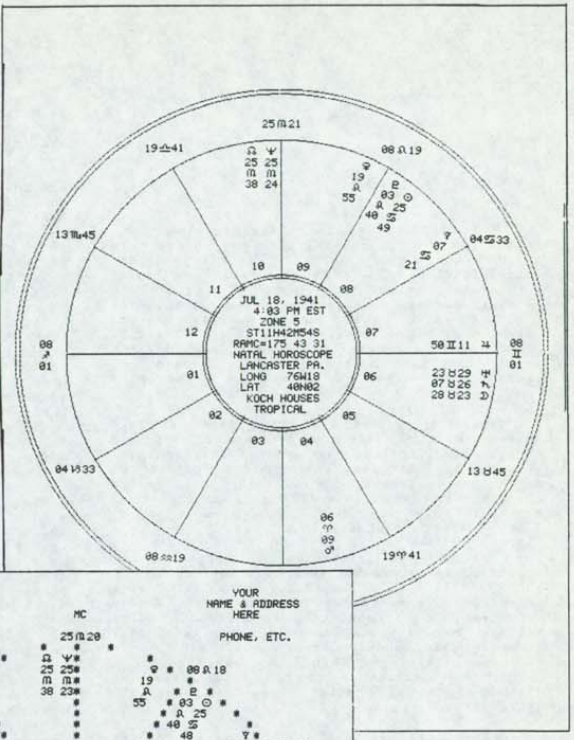
SECONDARY CHART 1981

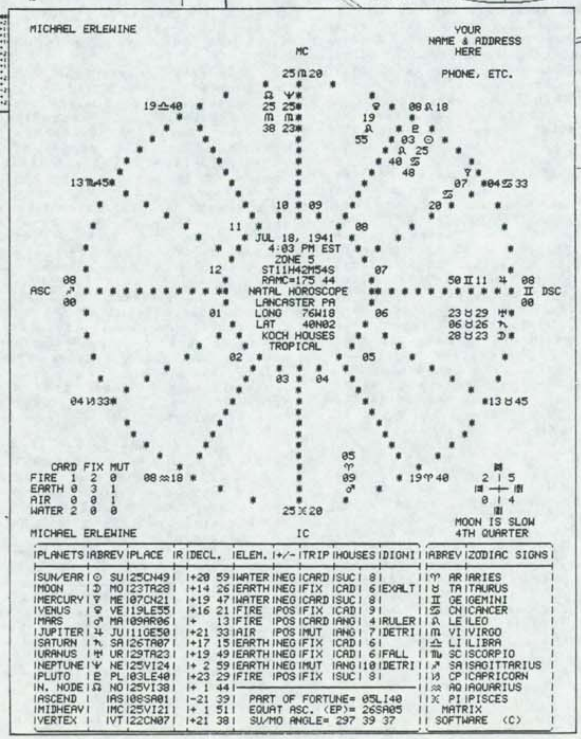
+	00	00	117	48	+20	59	SU	03V	38	56	+	00	00	155	34	+10	10
4	21	07	52	12	+14	26	MO	03S	42	31	+	3	26	49	212	39	-	9	31
3	27	44	97	48	+19	47	ME	11V	37	15	+	1	25	33	163	36	+	8	32
1	35	32	142	52	+16	21	VE	07L	34	26	+		34	19	187	11	-	2	29
	41	19		9	48	+	13	MA	22R	57	57	-	4	27	47	22	54	+	4	47
	48	42	70	25	+21	33	JU	18	0E	26	14	-		48	56	77	38	+	22	16
	05	57	54	19	+17	15	SA	28	TA	22	11	-	2	12	49	56	38	+	17	39
	13	05	57	14	+19	49	UR	00	0E	10	55	-		13	10	58	12	+	20	01
	15	17	176	16	+	2	59	NE	26	V	32	31	-	1	14	32	177	19	+	2	31
	16	04	127	04	+23	29	PL	04	LE	45	55	-	4	19	33	128	14	+	23	16
30	00	176	00	+	1	44	NO	23	V	33	04	+		00	00	174	05	+	2	34
30	00	246	15	-	21	39	AS	09	CP	07	21	+		00	00	279	56	-	23	00
30	00	175	44	+	1	51	MC	03	SC	10	53	+		00	00	210	58	-	12	35
30	00	113	53	+21	38	VT	17	LE	47	48	+		00	00	140	14	+	15	30











MICHAEL ERLEWINE — IC

PLANETS	ABREV	PLACE	R	DECL.	ELEM.	+/-	TRIP	HOUSES	DIGNI	ABREV	ZODIAC SIGNS
SUN/EAR	☉ SU	25CN49		+20 59	WATER	NEG	CARD	SUC 8		♈ AR	ARIES
MOON	☽ MO	23TA28		+14 26	EARTH	NEG	FIX	CAD 6	EXALT	♉ TA	TAURUS
MERCURY	☿ ME	07CN21		+19 47	WATER	NEG	CARD	SUC 8		♊ GE	GEMINI
VENUS	♀ VE	11LE35		+16 21	FIRE	POS	FIX	CAD 9		♋ CN	CANCER
MARS	♂ MA	09AR06		+ 13	FIRE	POS	CARD	ANG 4	RULER	♌ LE	LEO
JUPITER	♃ JU	11GE50		+21 33	AIR	POS	MUT	ANG 7	DETRI	♍ VI	VIRGO
SATURN	♄ SA	26TA07		+17 15	EARTH	NEG	FIX	CAD 6		♎ LI	LIBRA
URANUS	♅ UR	29TA23		+19 49	EARTH	NEG	FIX	CAD 6	FALL	♏ SC	SCORPIO
NEPTUNE	♆ NE	25VI24		+ 2 59	EARTH	NEG	MUT	ANG 10	DETRI	♐ SA	SAGITTARIUS
PLUTO	♇ PL	03LE40		+23 29	FIRE	POS	FIX	SUC 8		♑ CP	CAPRICORN
N. NODE	☊ NO	25VI38		+ 1 44						♒ AQ	AQUARIUS
ASCEND	AS	08SA01		-21 39	PART OF FORTUNE= 05LI40					♓ PI	PISCES
MIDHEAV	MC	25VI21		+ 1 51	EQUAT ASC. (EP)= 26SA05					MATRIX	
VERTEX	VT	22CN07		+21 38	SU/MO ANGLE= 297 39 37					SOFTWARE (C)	

Some Notes on the AISAR Project

by Michael Erlewine

The article by Doug Pierce that follows represents, in my opinion, a step towards a new approach to computer assisted chart interpretations. And computer chart interpretations are only just now beginning to be taken seriously. Astrologers, as a group, may tend to assume that cookbook style written horoscope reports represent the best that can be hoped for from computers. In fact, the cookbook style computer report is an afterthought compared to what we can expect in the years to come.

The computer is too often seen as man's menial servant endlessly performing what are essentially life-less tasks. It is the same kind of mentality that sees in the night sky and the space surrounding earth a cold, dark and foreign environment rather than a matrix or womb for holding life as we know it. The computer is not just another 'machine' to take its place alongside the toaster and the refrigerator. It is a machine that resembles or represents the truth or way things are much more so than we can yet appreciate. The computer is much more like an art form, a means for us to express and know ourselves. It is capable of reflection. I dont believe very many people realize how absolutely dependent and interdependent we already are on computer technology. We have in the computer a symbiotic relationship in the exact sense of that word. At this point, computer technology has a life of its own!

Traditional cookbook style computer reports have been available for years thru companies like Para Research and others. Most our our readers have probably seen one. In the last year, smaller versions of these cookbook style astro-reports have appeared for microcomputers. Astrographics, under the direction of Rob Hand, has brought out Astro-Scope and Sex-O-Scope and MATRIX has brought out both a natal and yearly transit report writers. One of the more interesting features of the MATRIX reports is that any of the text paragraphs can be replaced or modified to suit the astrologer using the package. Thus the report can gradually be modified until it exactly represents the flavor of the user. If you feel you have some especial understanding of the planet Venus, you would be able to replace the Venus paragraphs with your own words, and so forth.

Another computer interpretation effort worthy of note is that of Claude Weiss of Switzerland. Weiss operates ASTRODATA which is the major chart calculation service on the continent. Weiss offers written reports that have several features that distinguish them from the standard cookbook fare. For one, he determines dominant planets in the chart and retrieves paragraphs that represent this particular mix of planets rather than stringing shorter statements together to form a paragraph. Weiss is also making use of the Gauquelin sector research in his reports instead of the traditional house cusps. He has separate interpetations for male and female.

Our own Astro-Talk concept is also worth reporting on. Our approach is to provide the computer with grammar and syntax enough to generate text rather than to refer to pre-written paragraphs. We will be using the AISAR model to determine planetary dominance. We examine several coordinate dimensions to do this including the Geocenteric, Heliocentric and Local Space realms. At this point, we are working towards an interactive program rather than a report writer. Our goal is to create a program capable of both natal and transit/progression analysis. The user will be able to move from level to level within the program examing astrological concepts and events. The program will speak and spell out the astrological events. The goal is to provide a program that will engage the user much like the popular Adventure and Dungeons & Dragons programs do. The only difference will be that, if we succeed, our program will in fact be about the very life and events of the user.

Pierce's AISAR system has some definite affinities with the ASTRODYNE and other rulership systems. Yet it differs from them in that it may be able to provide us with a really dynamic and multi-dimensional method for chart analysis as opposed to the somewhat arbitrary collection of rules that make up most rulership systems. Please keep in mind that I see AISAR as only the beginning, a first step in what is an essential dimension of the astrology of the future. Even since this article was written, AISAR has gone thru several metamorphoses.

Several generations of AISAR has been implemented on the Commodore machines to date- each more refined than the last. These programs are available to astrologers via MATRIX Software. From a practical point of view, the goal of the AISAR project is to produce a balanced multi-dimensional model of the energies in effect in a particular astrological moment. Altho this article is concerned with a three dimensional model, current versions of AISAR employ four and more dimensions. AISAR takes advantage of sophisticated statistical techniques to provide a multi-dimensional picture of the cosmos that, while not losing sight of any of the minor astrological factors, is sble to present the major factors is a balanced context. AISAR not only indicates what in the horoscope should receive special emphasis but also the relation of these factors (the context) to other factors also active in the chart. The result is a graph and/or set of numbers ready to hook into either the static cookbook or the dynamic Astro-Talk interpretation schemes.

We are in the process of combining the AISAR dynamics with the ASTRO-TALK comcept set forth in MATRIX V by your editor. ASTRO-TALK is based on the idea of assisting the Cosmos to speak and articulate its principles to us much like astrological counselors do. The computer is used to organize and present the information. In fact we are teaching the computer to speak rather than to draw upon paragraphs of pre-written text. At this point in its development, the computer is like a very bright student who is in the first grade. During the next few years we can expect to see some dramatic changes in the quality of computer produced interpretations as the education of the astrological computer continues. Pierce's AISAR is one of the signs of these coming changes.

AISAR: Analytic Interpretive Software for Astrological Research

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This is a preliminary report on an experimental approach to machine-assisted interpretation. AISAR is experimental at this point in that the theory and methodology of this approach are relatively undeveloped. Phase I of the AISAR project has culminated in the development of a 16K program written on the Commodore PET. The task of this report is to describe the concepts and techniques on which this software is based.

Any piece of software that does more than generate positions of planets and other points, scan for aspects, and display or print this information, might be labeled "interpretive software". There are two examples that come to mind: text-assembling programs such as those authored by Michael Erlewine and Roger Elliot, and an Astrodynes program authored by William Keatley. AISAR seems to have more in common with the Astrodynes program, since it does a lot of number-crunching and does not (yet) generate text. My ignorance of Astrodynes limits this comparison; my impression is that the resemblance is superficial.

I. A Frame of Reference for Interpretive Software Development

The AISAR project began two years ago with these questions:

1. What are the most essential and universal features of the interpretive process?
2. How can these features be made explicit in a way that permits

their representation within a computer?

I can speak with authority only about my own interpretive process, and thus resort to speaking in the first person. I believe this can lead to far more meaningful communication than could any gross generalizations and assumptions about the interpretive process of "the astrologer".

To begin with, I have a general concept about the astrological system as a universal language of qualities. The symbolic elements of this language--the Sun, Moon, and planets, the twelvefold cycle--point beyond themselves. As symbols, this is their nature. What they point to is the set of concepts I have developed about personality--about the nature and behavior of persons, in the most inclusive sense of "personality". My perceptions of personalities tend to group together around these symbolic pointers. The concepts that form in this way are interdependent; they have no meaning apart from each other. More to the point, they have meaning only in terms of the distinctions I have learned to make between them. It is useful to think of these distinctions as emerging from groupings of "primitive" polarities--fundamental units of meaning that, when superimposed on each other, give rise to complex meanings.

What I have just described is prior to, and underlies, my interpretive process. In referring to the set of concepts I have developed around these symbolic pointers--planets, etc.--I will use the term "implicit model". This implicit model is the tool-box of concepts I apply to flesh in a bare framework of chart symbols with meaning. It is implicit because, in

practice, the structural relationships among these concepts are only implied. Yet in the absence of this structure, there is no model, only a fairly useless bag of concepts.

When I examine a particular chart configuration, a chain of associations begins to form automatically. I do not have to go back to square one in my knowledge and laboriously build this chain. The structure of my implicit model automatically frames my perceptions of the chart in a way I have defined as meaningful. My interpretive process is totally oriented within this model. Its structure is so implicit that it is generally unconscious, and yet there is no interpretive process without it. The symbolic pointers I have drawn on the chart somehow trigger the linkage of specific concepts within this structure.

This implicit model is dynamic, in that it grows in complexity as I learn, yet is continually restructuring itself along cleaner, simpler lines. This model is composed of several levels of organization. On the highest level are the complex concepts that consciously come to mind. They may seem rather simple, but are truly complex in comparison to the lower levels. At rock bottom, it is useful to think in terms of the fundamental units of meaning I referred to earlier. These are the primitive, one-dimensional polarities that are the building blocks of all my distinctions about qualities of personality.

This description of an implicit model could go on indefinitely, but the first question posed earlier has at least been tentatively addressed by drawing in the essential features of this model.

The aim of the AISAR project is toward the development and computer implementation of an explicit model that is patterned on the features of implicit models such as I have described. It is explicit in that the structural relationships among symbolic elements are fully specified, not just implied. These symbolic elements, as I have stated, point to concepts about personality. Similarly, the explicit model points to the implicit model that is the totality of these concepts. As I will show, there are a variety of possible explicit models that one may construct. These alternatives are variations on the structure of relationships between symbolic elements.

The explicit model has distinct boundaries. It is limited to one order of concepts (about qualities of personality). When I make distinctions among various charting techniques, coordinate systems, and so on, I am outside this order of concepts. These considerations lead to particular sets of "raw" positional data, and define a particular context for interpretation. My implicit model begins at the point I define this context, and so the explicit model begins here as well. It does not point to my concepts about cosmic structure. It does not even point to my concepts about how cosmic structure can be related to personality. This is the order of concepts I just referred to, that defines a context for interpretation. When I draw boundaries around the explicit model, I am also limiting this other order of concepts, in a way that proves to be important to the choice of a starting point for building this model.

When I am dealing with concepts about how cosmic structure relates to personality, I am thinking about ways of defining a larger context for applying my implicit (or explicit) model. When I think about planetary cycles, I am defining a developmental context within time. When I think about the ecliptic in relation to the prime vertical, I am distinguishing between a global context and a more specific context. When I identify aspects on a chart, I am defining a particular syntax of relationships. The meaning or semantics of these relationships is defined within the explicit model, apart from their astronomical structure.

These different orders of concepts are grounded in different units of meaning. The imaginary space of a conceptual model is framed by a set of basic distinctions. Thus the explicit model cannot be directly mapped onto cosmic structure. In other words, the semantics of our symbolic elements, as expressed in this model, cannot be derived from that structure. This presents a problem: If this model is to be formulated in terms of the astrological language, then it must be based on elements of this language that are not derived from that structure.

The symbolic structure of signs--really, of the twelvefold cycle in general--fulfills this requirement. I am referring to the organization of the four elements and the three qualities. This structure has no existence except within an imaginary space. The fact that the cardinal points are defined by the intersection of equator and ecliptic does not conflict with this. Within

this symbolic twelvefold cycle, we must focus not on the developmental sequence, but on the fundamental units of meaning, the primitive polarities, on which this imaginary structure is built up.

II. Constructing an Explicit Model

In beginning to construct an explicit model, the first step is to identify the primitive polarities that will represent our fundamental units of meaning. What are the most primitive polarities of the astrological language? An answer that is remarkably simple, yet not immediately obvious, points to the elements of Fire, Air, Water, and Earth, where we find three polarities of element pairs: Fire/Water vs. Earth/Air; Fire/Earth vs. Air/Water; and Fire/Air vs. Water/Earth. There is no particular significance in placing Fire first, except for the sake of convention. Each of these polarities represents a contrast within a qualitative dimension. A crucial point is that one cannot describe a polarity very well until it is given a context. This context is defined by the qualitative dimension within which the polarity becomes meaningful. As an analogy, one can speak of introversion vs. extroversion, but until one has clarified that this is a distinction between two ways of adapting to the world, the contrast is rather shallow. These three polarities of element pairs have received attention from several authors, and yet little or no attention has been paid to defining them within specific dimensions of meaning.

The next step, then, is to provide contexts for these three polarities, and to do so in terms of the astrological language we have to work with. I have found it inescapable that the qualities--Cardinal, Fixed, and Mutable--must serve to define these contexts. The natural association of the qualities with the four elements--within the twelvefold cycle--takes on a new dimension. It is, in a sense, like transforming the structure of this relationship from polar to rectangular form. Making this association becomes self-evident when we come to the next level of the explicit model, where signs are represented by these units of meaning.

At the next step, we arrive at the first branching point in this sequence. Which polarities belong with which qualities? It is time to take stock of the larger situation. There are exactly six branches one could take at this point, and a lot more of them farther down the road. Each branch leads to a distinct set of alternative models.

Constructing an explicit model is, among other things, an exercise in symbolic logic. Whatever skills I have in this have not come out of formal study. I suspect this is true of most of us, but that we all have an innate sense of what fits and what doesn't. If we can define the explicit models we are coming from, we may be able to better appreciate the differences in each other's logics. In a sense, such models permit us to define a symbolic place where we can know that we are together on solid ground, and share a common starting point.

There is indeed one model I have arrived at, after going all the way through the sequence I began to describe. I can say that, from my current perspective, this model looks like a more meaningful alternative than any other. Within my own logic, this model stands as self-evident. I cannot expect it to be self-evident to others, nor can I demonstrate with any rigor that this is the "best" model. Even so, I think that if one explores various alternatives, one will find that some models are definitely better candidates than others, and that this will not be just a matter of opinion. I do not know at what point the reader will find it necessary to part ways with my logic, and take a path to an alternative model. The important thing is that the explicit nature of this sequence at least permits us to clearly define our differences, in terms of alternative paths.

It is important to note that the first two steps taken so far are crucial; there are no options available. They are crucial in the sense that any model developed from a different starting point is, by definition, based on different units of meaning. There could be no explicit structure of relationship between such a model and any one of the "family" of models being developed here. The grounding of alternative models in common units of meaning is essential for any meaningful communication among these models. This communication, I believe, will be crucial to the future evolution of these models. This depends on the explicit structure of relationship that is defined by the alternative paths leading to these models.

In continuing through this sequence, and beyond this to a discussion of computer implementation of the explicit model, a reference model must be chosen. Keeping this discussion on the level of this general family of models would leave the whole structure hanging in the air. Only a specific model can actually be applied to anything. I will use the model I have arrived at, without further belaboring the point that this is not the only valid model. The steps in this sequence are common to all models in this family.

I have used the term "explicit" a lot, and have attempted to develop a discussion that is in itself clear and, well, explicit. Yet there is no way to adequately get across any of this unless I draw you a picture. Before I do, there is a point to be made about drawing pictures; or diagrams, in this case. What is a diagram, except a way of fully specifying a set of structural relationships? Words evoke a variety of images, but a diagram allows you to put these images into place. It gives you a pattern to follow, and you create for yourself an imaginary space. Within this space, you can begin to piece together these images.

An explicit model performs a function similar to that of any diagram, but in this case we are creating a special kind of imaginary space. In constructing a model, we specify a structure that is then represented graphically. This structure consists of linkages between symbolic elements. These linkages are dependent on the relative positions of the symbols within this graphic space. As we shall see, this is not just a static

frame of reference. We can graphically construct our model within a rectangular coordinate system, and assign coordinate values to the positions of the symbolic elements. This provides the key to implementing this model on a computer, since the whole model can be translated into sets of coordinate values. We now have sets of variables that are directly interpretable within the context of our graphic model. And at this point, we can develop statistical techniques for analyses of complex symbolic relationships.

After taking this leap to preview a sequence we have not even gotten to yet, it is time to return to the sequence that is still sitting there at the third step. Figure 1 represents the explicit model as it stands now:

Figure 1: The Primitive Polarities of the Explicit Model

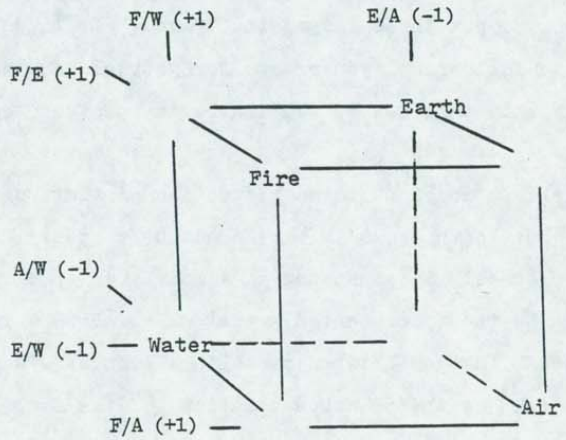


Figure 1 shows that the three polar dimensions intersect to form a cube. Each of the four elements is assigned a corner, by reference to its position within each of the three polar dimensions. There are exactly twelve edges on a cube. For each of the six possible matches of these polar dimensions with the three qualities, the signs will fall into place on these edges in a distinct pattern. The three signs of each element will always converge at the same corner, regardless of how the elements are matched up with the qualities.

Note the 1's and -1's assigned to each polar dimension; these are XYZ coordinates. By convention, Fire is assigned the set of coordinates (1, 1, 1). The four elements are defined within all three dimensions; they are represented by points in 3-dimensional space. Signs are defined within only two dimensions, and therefore are represented by edges, or continuums, within this space.

Figure 2 on the next page represents the reference model as it looks after the polarities have been matched with the three qualities. Table 1 above it shows the associations between polarities and qualities on which the reference model is based. Note in Figure 2 that, for example, Aries is assigned to one of the horizontal edges; the other Cardinal signs are assigned to the other horizontal edges. Fixed signes occupy the vertical edges, while Mutable signs occupy the lateral, front-to-back edges. Using the coordinate values that correspond to its position, Aries is assigned the set (0, 1, 1). These values

Table 1: Associations between Polarities and Qualities

CARDINAL: Immediate context of encounter

Fire/Water (+1)	Polarity	Earth/Air (-1)
Dynamic/ Fulfilling the Moment	Keywords	Structuring/ Placing in Context

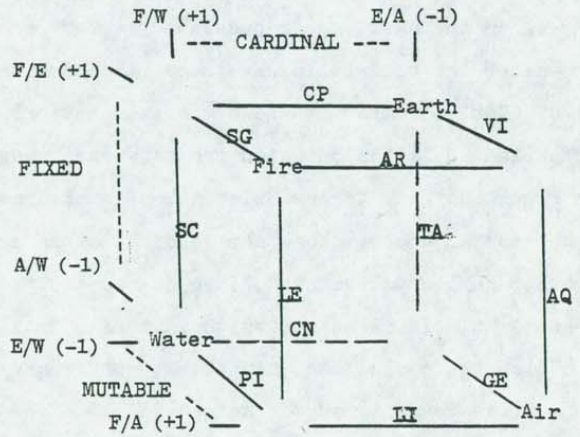
FIXED: Developmental context of identity

Fire/Earth (+1)	Polarity	Air/Water (-1)
Individuation/ Shaping Selfhood	Keywords	Socialization/ Acquiring Membership

MUTABLE: Ecological context of adaptation

Fire/Air (+1)	Polarity	Earth/Water (-1)
Externalizing/ Braadening Participation	Keywords	Internalizing/ Intensifying Awareness

Figure 2: The Polarities matched with the Qualities



correspond to the position of Aries within, respectively, the Cardinal, Fixed, and Mutable dimensions. The zero value for Aries' natural quality (Cardinal) corresponds to this sign's representation as a continuum that is parallel to the Cardinal axis. Aries is not defined by a particular pole of this qualitative dimension. The zero value places Aries at the origin of the Cardinal axis. Within a static model, there is no way of representing the fact that Aries can take on any value along this axis. This is not true of a computer simulation based on this model, which will be described in later sections.

It should be evident that this representation of signs as continuums does not imply anything about the discrete nature of signs within the ecliptic. This model is a method of representing, within an imaginary and graphic space, a way of thinking about signs. This method is to define signs in terms of qualitative polarities.

The relationship between planets and signs is described by the structure of this model. Signs are represented by two dimensions, planets by three. Planets therefore are defined more specifically, in terms of the same qualitative polarities. Each sign has two poles, and there are two planets that define the poles of each sign. In this way, these symbols are defined in terms of each other, and yet are not related in any manner resembling a rulership system. Again, this is a way of making explicit a conceptual process, not a "system".

Table 1 labels each qualitative dimension and its polarities with key phrases. This is about as far as I should go toward turning this discussion into an interpretive exercise. These labels embody my implicit model, and are therefore limited to that frame of reference. In this sense, the reference model I have developed transcends my implicit model, since its symbolic elements transcend my particular set of concepts about personality. The reason I am providing any labels at all is that the development of labels for these basic units of meaning is harder than it looks. We are dealing with a fundamental level of organization here, and finding labels that are sufficiently inclusive is not easy. The reference model does not stand or fall on these particular labels, but we cannot begin to evaluate any model until we have provided some labels for our units of meaning. These qualitative polarities clearly transcend any particular set of labels.

Once one has made a specific match between polarities and qualities, as in Figure 2, the resulting (incomplete) model can be examined and labelled in the following way:

--Translating one's concepts of the qualities into concepts of qualitative dimensions that define the contexts of the three elemental polarities;

--Looking at each polarity in terms of its context, and seeing how it is focalized and made meaningful in this context;

--Examining the ways these units of meaning--polarities within specific contexts--come together in pairs to describe each sign;

--Examining the distinctions that can be made between signs of

the same element, and between signs of the same quality, based on their positions within this model.

We began with primitive, one-dimensional polarities at the first level of the explicit model. At the second level, I made associations that led to the representation of signs by pairs of qualitative dimensions. While it was necessary to define the four elements in three dimensions in order to get to the second level, they really belong to the first level. They entered the model at the first step in this sequence. The symbolic elements that belong to the third level are the planets.

We all know that the Sun and Moon are only referred to as planets for the sake of convenience. These symbols are more primal than those of the planets, which represent more specific and differentiated qualities of activity. This model should represent this distinction in some way. In a sense, the Sun-Moon polarity defines the larger context of all the primitive polarities and qualitative dimensions. This context encompasses all levels of this model. Within my frame of reference, this polarity that is inherent in all others is simply this: a polarity that describes the relationship between self and world, between part and whole. This simply reflects the fact that the explicit model points to my implicit model in a meaningful way. My implicit model consists of concepts of personality: not personality in isolation, but in the world.

This global description helps to clarify the nature of all of the polarities encompassed by this model. This model frames its structure of relationships within the context of this most basic of polarities. Sun and Moon are implicit in Figures 1 - 4. Yet if Sun and Moon are to be defined at all within this model, a more specific association must be made. Since this model represents my concepts of these symbols, I define the Sun-Moon polarity in terms of the Fixed dimension. Using the labels from Table 1, the Sun is the primal symbol of shaping selfhood; the Moon, of acquiring membership. The Sun represents creative wholeness; the Moon, the need for "partness" within a larger whole.

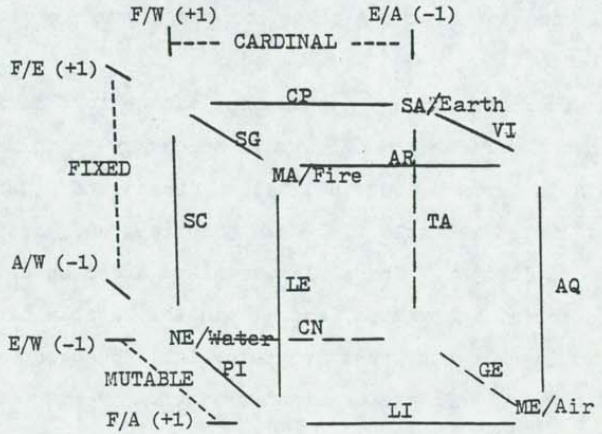
The discussion of the limits of the explicit model, at the end of Section I, anticipates some of the issues surrounding the representation of planets within this model. The points that need to be made have, I hope, been made in that discussion. Planets are represented here only to the extent that they can be defined in terms of our units of meaning.

At the third level of the explicit model, and the final step in this sequence, we find a large number of branches. Planets are defined within all three qualitative dimensions, and thus are represented as points within the graphic space of this model. The eight corners of the cube can be matched up with the eight planets in 40,320 (8!=8*7*6*5*4*3*2*1) different ways. Taking into account the six possible branches in the previous step, there are 241,920 alternative models to

choose from. Experimenting with a few of these alternatives can show one something about how one makes qualitative distinctions between symbolic elements.

I did not arrive at a model by laboriously trying out thousands of alternatives, or even dozens. I relied on my previous associations of planets with the units of meaning I have adopted here. This initially came down to making the associations shown in Figure 3, between four planets and four elements. Mars is one planet everyone might agree on; Mars belongs with Fire. In this sophisticated manner, I linked Saturn with Earth, Mercury with Air, and Neptune with Water. Thus I solved half of the problem, at least for myself. These are the associations that come most naturally, and since what

Figure 3: Constructing the third level of the model



I want is a model that represents how I think about these symbols, that is good enough for me. However, in evaluating the total model, it turns out that these simple associations have quite complex implications when one looks at them all at once. In fact, it is very difficult to look at them all at once, but the graphic form of the model provides a certain constancy for attempts to piece things together. It is clear that the four elements have come to the rescue once again, and have provided a starting point at this level, just as they did at the first two levels.

At this point, there are only 24 (4!=4*3*2*1) alternative models, instead of many thousands. The problem has been reduced to a manageable size. The four planets that have entered the model first have not been dignified in any special way; they simply cluster most closely with my concepts of the four elements when I remove everything else from the picture except planets and elements.

In order to define the positions of the four remaining planets within the reference model, it is necessary to think of these planets in terms of our qualitative dimensions. Using the labels listed in Table 1, I draw parallels and contrasts between Venus and Jupiter. These planets share a common orientation toward social adaptation, and within the Mutable dimension, they would share the positive pole, labeled "broadening participation". Within the Cardinal dimension, Venus points to a relatively structured approach in comparison to Jupiter's

dynamic openness to experience. Within the Fixed dimension, Venus's emphasis on developing an individual style contrasts with Jupiter's orientation toward embracing a larger sense of identity. These considerations lead me to place these planets in the positions shown in Figure 4, on the following page.

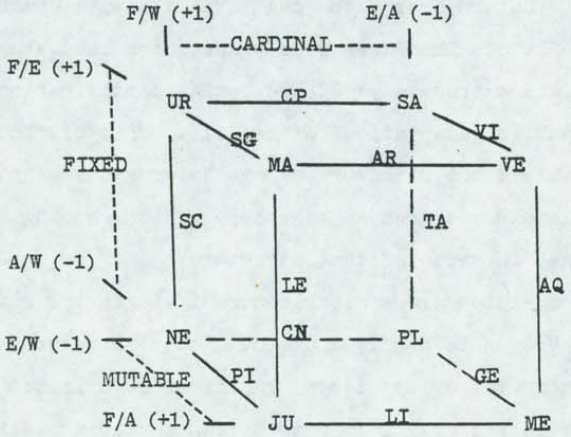
This leaves Uranus and Pluto, and now there are only two alternatives. Their positions within the Mutable dimension are already determined; they share the negative pole, associated with intensification of awareness within a private "adaptation" (or version) of reality. This model distinguishes between "private" (Mutable dimension) and "individualistic" (Fixed dimension). An act can be privately oriented and yet represent a movement away from individuality. Conversely, an act can be publicly oriented and yet represent a movement away from identification with one's "membership", whatever this may be. Saturn shares the negative pole with Uranus, Neptune and Pluto. The other four planets contrast sharply with these, and express ways of broadening participation within the public "adaptation" of reality. This distinction clearly parallels the structure of the solar system, in that the outer planets are grouped together. This grouping, however, is not defined in terms of that structure.

Uranus and Pluto form a clear contrast within the Fixed dimension. Uranus is highly individualistic in nature, while Pluto points to the expression of racial or generic motivations. All of these labels are limited to my own implicit model, but I

suspect this distinction would be a point of consensus. What this leads to, as shown in Figure 4, is a completed model. There is still the Cardinal dimension to take note of. Uranus is clearly the more dynamic and impulsive of the two, while Pluto is associated with restructuring and establishment of new forms. Thus the structure of relationship between these planets has been at least outlined. In a similar way, any planetary relationship may be defined in terms of qualitative dimensions.

Rather than explaining this model further in the abstract, I encourage the reader to explore it more thoroughly, along the lines I have indicated, and to experiment with alternative models. The rest of this paper deals with the mathematical application of this model to interpretive software.

Figure 4: The Completed Reference Model



III. Computer Implementation of the Explicit Model

In the preceding section, I have shown how the explicit model represents signs and planets as complex units of meaning, built on simple polarities. Contrasts and parallels between these symbols can be drawn within the imaginary space of this model. This is a static model that defines an explicit structure of relationships.

This structure allows us to define these symbols in terms of 3-D rectangular coordinates. Figure 4 specifies these coordinates; each position in this graph corresponds to a set of three coordinate values. If we take a particular planet as a reference point, all other planets can be assigned scores representing their positions on an axis. This axis is different from the axes of the static model, which represented simple qualitative dimensions. This axis represents a complex qualitative dimension, composed of three simple ones. The positive pole of this axis corresponds to the nature of the reference planet, as defined in terms of all three qualitative dimensions. The negative pole corresponds to a nature that is polar to, or very different from, that of the reference planet.

Scores on any axis of this sort are computed by the formula:

SCORE = SUM(R_j * W_j), j=1 to 3; where:

R = the set of coordinate values (from Figure 4) for the reference planet

W = the set of coordinate values for the planet to be scored

Taking Venus (-1, 1, 1) as the reference planet, and scoring Pluto (-1, -1, -1) on the axis defined by Venus,

Pluto = (-1*-1) + (1*-1) + (1*-1) = -1.

Scoring Mars (1, 1, 1) on Venus,

Mars = (-1*1) + (1*1) + (1*1) = 1.

Scoring Neptune (1, -1, -1) on Venus,

Neptune = (-1*1) + (1*-1) + (1*-1) = -3.

This axis defined by Venus would have a range of -3 to 3, with Venus at the positive pole and Neptune at the negative pole. This corresponds to the reference model, where Venus and Neptune are at opposite corners of the cube. Mars is closer to Venus, while Pluto is farther away than Mars but closer than Neptune. This is apparent from Figure 4, and so these scores are not providing any new information, just a different way of looking at the static model.

This becomes a dynamic model only when we specify a set of planetary positions. We start out by simply taking into account their sign positions. We now have a set of six coordinate values: three for planets and three for signs. The same formula applies; this addition of sign coordinates just includes more information in defining an axis. The axis now represents a more complex qualitative dimension. If we wish to include house positions in this kind of analysis, we can assign coordinate values to houses that correspond to those for the signs, and end up with a total of nine coordinate values. For the sake of simplicity, I will stick to planet and sign coordinates in

this paper. Because of the way these values are used, I will use the term "weights" to refer to these coordinates. This is also to avoid confusing these values with scores such as those computed above, with Venus as the reference planet. I will refer to these latter values as "scores". A set of planet and sign weights defines an axis, and scores computed from these weights specify positions on this axis.

The formula given above for computing scores on an axis is really the last (and simplest) step in AISAR's computational procedure. This step produces graphic plots based on planet scores on given sets of weights. Later on, I will introduce ways of combining these weights to represent the dynamics of planet and sign interactions. When these weights are combined, we still end up with a single set of weights defining each axis. The difference is these weights are based on still more information, when these interactions are taken into account.

AISAR's Computational Procedures

AISAR's DATA statements contain values corresponding to the model in Figure 4. Rather than the 1's, 0's, and -1's used in Figure 4, these are proportional values (between 0 and 1), that are used to initialize an array of planet and sign weights. The correspondence with the values in Figure 4 is: the 1's correspond to a proportional value of .8.; 0's, to .5; -1's, to .2. These are simply starting values that are modified during execution; this will be illustrated shortly. Note that

the values for Sun and Moon are not taken from Figure 4, but correspond to their definition within the explicit model as discussed in the previous section.

The reason for using proportional values is that they do a good job of representing relative emphases within each polarity. There is an axiom that no quality is ever totally excluded, that any qualitative emphasis always implies its opposite. The use of proportions reflects this; the emphasis on one pole over the opposite pole is only relative.

To clarify the use of proportions, let us take, for example, the set (.8,.8,.8) that is assigned to Mars. This set corresponds to (1,1,1) in Figure 4. This is really a set of pairs, where each pair always adds up to 1. Thus (.8) always implies the pair (.8,.2), and only the (.8) need be specified. The unspecified member of each pair corresponds to the "negative" pole, in terms of the values assigned to each pole in Figures 1-4. AISAR's DATA statements give only the values for positive poles, since including both values would be redundant and take up unnecessary space.

The most straightforward and useful way to present AISAR's computational procedures is with some of the actual BASIC routines from the program. Appendix A includes a thoroughly remarked listing of the following:

--DATA statements with proportional values that are translated directly from the reference model shown in Figure 4. There are values for planets and signs included.

--Defined functions used by the included routines, two of which will be unfamiliar to most astrologers:

--DEF FNL (X) = LOG (X / (1 - X)); this function transforms proportions into "logit" weights.

--DEF FNE (X) = 1 - 1 / (EXP (X) + 1); this function is the inverse of FNL, and converts logit weights back into proportions.

These two forms for planetary (planet & sign) weights are equivalent, but are used for different purposes. The proportional form is necessary for computing combinations of weights. The logit form is necessary for computing scores, for scaling sets of weights to a common scale, and for more sophisticated statistical analyses that will be discussed.

--A routine to read, transform (with FNL) and scale the values in DATA statements into an array of planetary weights.

--A harmonics-based aspect scanning routine that is linked to:

--A routine to combine weights of aspecting planets, and to adjust their weights by the resultant of each combination.

What these routines accomplish is to yield sets of weights for the planets that reflect all of the interactions they have participated in during the aspect scan. The order in which a planet "encounters" aspects makes a great deal of difference in the final set of weights for that planet. The aspect scan has been adapted for this purpose; it looks for all possible conjunctions, then all possible oppositions, and so on. This assumes that prominence of aspects is related to the harmonic

numbers associated with these aspects. The last routine, which combines weights, also takes this as well as exactness of aspect into account by scaling the vector of combined weights to emphasize tight, major (low harmonic #) aspects.

A scoring routine can be added very easily, and this routine will yield a score for each planet on an axis defined by a selected reference planet. A very interesting type of aspect analysis is made possible in this way. Given an aspect between, say, Mars and Uranus, we can assign a horizontal axis to Mars, a vertical to Uranus, and use scores on these axes to create a graphic plot. Each planet will have a set of two scores that define its position on this plot. We can then see which planets "team up" with Mars, which with Uranus, and which ones form strong polarities or clusters in the context of this particular aspect. A plotting routine can be added quite easily to the basic computational routines in Appendix A.

A Brief Example

Since this is not an interpretive exercise, I am not going to go to great lengths to demonstrate the interpretive power of AISAR. At this point, AISAR can communicate only in the form of graphic plots, but one can get a good feel for the relationships portrayed in this way, after some experience with the technique. I will use my own geocentric planetary positions, which are as follows:

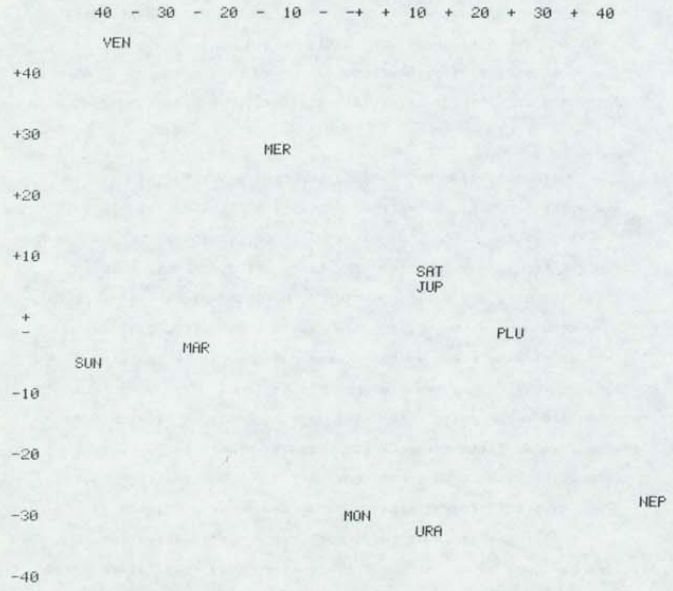
SUN 05 TA 17	JUP 29 AR 13
MON 20 TA 34	SAT 09 LI 51
MER 10 AR 24	URA 10 CA 33
VEN 19 AR 09	NEP 19 LI 56
MAR 12 SC 36	PLU 19 LE 06

The array of weights that is created upon initialization is listed below. The last three weights for each planet are the weights for its sign position. The Cardinal, Fixed, and Mutable weights for planet and sign are abbreviated in the heading as CD, FX, and MT. Note that, since the planet weights for Sun and Moon contain only one non-zero element, this emphasizes the Fixed dimension of the planet weights and also emphasizes all the sign weights more strongly than in the case of the planets. This is because each set of weights is scaled so the total of absolute values is 6.

Planet	Planet Weights			Sign Weights		
	CD	FX	MT	CD	FX	MT
SUN	0	2	0	-2	0	-2
MON	0	-2	0	-2	0	-2
MER	-1.2	-1.2	1.2	0	1.2	1.2
VEN	-1.2	1.2	1.2	0	1.2	1.2
MAR	1.2	1.2	1.2	1.2	0	-1.2
JUP	1.2	-1.2	1.2	0	1.2	1.2
SAT	-1.2	1.2	-1.2	0	-1.2	1.2
URA	1.2	1.2	-1.2	0	-1.2	-1.2
NEP	1.2	-1.2	-1.2	0	-1.2	1.2
PLU	-1.2	-1.2	-1.2	1.2	0	1.2

Figure 5 on the next page is a plot based on these initial values, which examines the opposition between Venus in Aries and Neptune in Libra. The two planets are strongly polarized in this plot. Note that Venus is at the positive pole of the vertical axis, and Neptune is at the positive pole of the horizontal axis (see numbered scales). The scores for each planet on each axis can be determined by these scales. The planets furthest from the center are most strongly emphasized, whether strongly positive or strongly negative (by scores).

Figure 5: Initial Configuration for Venus-Neptune plot



During aspect scanning, the routine for combining weights for aspecting planets adjusts planet weights as described earlier and in the remarked listing (Appendix A). The array listed below is the result of scanning and processing weights for all aspects from conjunction through septile (harmonics 1-7).

Planet	Planet Weights			Sign Weights		
	CD	FX	MT	CD	FX	MT
SUN	-0.8	2.5	0	-2.1	0	-0.6
MON	-0.3	-1.7	-0.2	-2.0	-0.3	-1.4
MER	-2.5	0.6	0	0.2	-0.3	2.4
VEN	-0.9	0.2	0.2	0.8	0.6	3.3
MAR	1.2	1.1	1.1	1.4	0	-1.1
JUP	1.4	0.3	1.2	-0.7	0.9	1.5
SAT	-1.7	1.2	-0.6	-0.4	-0.6	1.5
URA	-0.3	2.0	-0.7	-0.6	-1.5	1.0
NEP	0.4	-0.9	-0.7	0.2	-0.5	3.4
PLU	-1.8	-0.4	-0.8	0.2	0.1	2.6

Figure 6 on the next page is a plot based on this set of planetary weights, again examining Venus and Neptune. Note that Venus and Neptune this time are much closer together than in Figure 5. This is largely due to the opposition-trine-sextile relationship that also includes Pluto. However, the total set of aspects all of these planets have made together results in this plot and these weights.

The essential thing to keep in mind in interpreting such plots is that they take into account all the complexities of planet and sign interactions, at least to the extent that the natures of these symbols can be represented within our model.

Figure 6: Final Configuration for Venus-Neptune plot

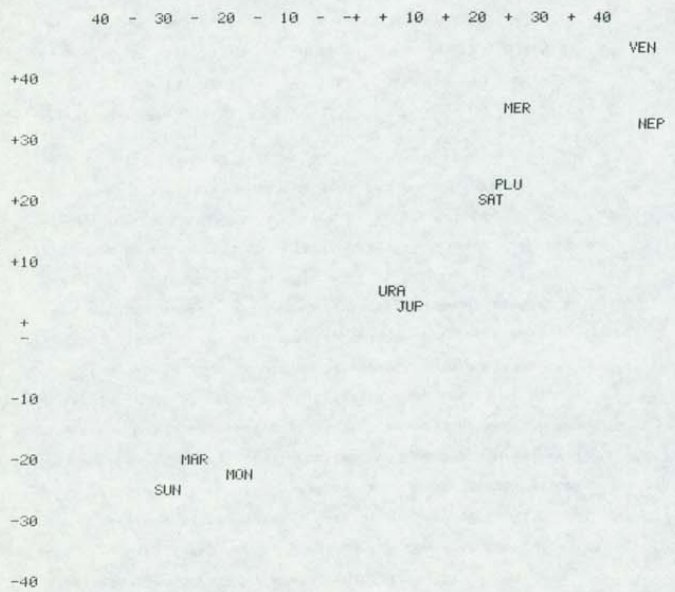


Figure 6 encompasses all of the encounters each planet has had with the rest of the planets. The dynamics of these encounters involve aspect prominence (exactness and "priority" in terms of harmonic number) and the quality of the planet and sign relationships. These qualitative relationships are of course defined in terms of the explicit model. In other words, the process of synthesis has to some extent been carried out for us. AISAR takes us a step or two beyond the "raw data" of planetary positions.

In Figure 6, the Venus-Neptune relationship frames the entire plot in a unique way. Any other planet pair would produce its own unique plot. On the geocentric chart, Mars opposes both Sun and Moon. In Figure 6, these three planets form a cluster. This cluster forms a strong polarity with a Venus-Neptune cluster. Whatever the Venus-Neptune opposition on the chart represents, it tends to unite Sun and Moon with Mars in an intense reaction that goes in the opposite direction. Uranus and Jupiter are placed in a position of having to resolve this polarization; they are "caught in the middle". Saturn, Pluto and Mercury are leaning strongly toward the Venus-Neptune cluster.

How might these observations be translated into more personal terms? Sun, Moon, and Mars (particularly with their Taurus-Scorpio placements) react strongly with an urgent effort to mobilize resources, in the face of a dissolution of self-image and personal values (Venus-Neptune). The whole structure of perspective and role-definition (Saturn, Pluto and Mercury) is

caught up in this dissolution. The resolution of this situation relies on a Jupiter-Uranus quintile. This involves a continual reaffirmation of personal autonomy, of the potential for a creative breakthrough. This is one way of looking at this picture. There are not always such definite correspondences between aspect configurations and plot pictures. This may seem confusing at first, but this means that we have here a viable frame of reference for making associations that are not tied down to the structure of aspects. We can examine relationships, as in the example, between several configurations that are isolated or only tenuously related to each other in terms of aspect structure. The example illustrates a basic approach to interpreting plots in a way that takes advantage of the explicit model's structure of relationships. This leads to a highly flexible technique that yet remains grounded in a well-defined frame of reference.

IV. A Look Ahead

While this introduction to AISAR is nearing its end, AISAR as presented here is in its infancy. There are two areas of current work that deserve discussion: the application of multivariate statistical procedures to the variables developed here, and the development of a capacity for AISAR to communicate with the user in natural language.

This introduction has omitted a substantial body of techniques of a more advanced statistical nature, that have actually been implemented in AISAR but that are yet to be fully refined and tested. There are two reasons for this omission: my desire to keep this initial presentation to a manageable length and level of complexity, and the need for further work with these techniques before any presentation of them would be useful. Even so, it is useful to briefly introduce some concepts that can lead to a larger picture of what AISAR is all about.

These statistical techniques can grouped under the heading of factor analysis. This has become the generic term for a variety of procedures developed for the purpose of analyzing the correlations within a set of variables. These techniques provide a means of reducing the complexity of a set of variables by taking advantage of these correlations. The input to a factor analysis routine is in the form of a correlation matrix. This matrix is somewhat analogous to the array of planetary weights that is continually adjusted during aspect scanning, which I have described. The correlation matrix is a more sophisticated way of capturing the same information that this array of weights is based on. During factor analysis, information is extracted from this matrix, resulting, not in a set of weights for each planet, but in a few sets (or factors) that are independent of any particular planet. These factors capture the maximum variance within the correlation matrix.

What results is two or three factors that represent, in this context, the most significant symbolic dimensions of a chart. A single 2- or 3-dimensional plot based on these factors provides a frame of reference for the whole chart. This means that, rather than having many possible starting points (plots based on planet pairs) for interpretive application of AISAR, there is one all-encompassing frame of reference that other plots can be related to. The set of factors that leads to this kind of plot describes the total behavior of planet and sign weights during aspect scanning. They frame this chart information in a way that is remarkably close to my concept of a chart Gestalt, as a representation of the chart-as-a-whole.

The possibility of using factor analysis (and other multivariate statistical techniques) on astrological data is a relatively novel concept. For astrological researchers who work with large samples of charts, there have been no real variables, in the sense of numerically scaled units of measurement, and thus no way to mathematically define or test theoretical models. This has been a substantial barrier to researchers, who have generally been limited to counting frequencies of aspects and positions. There has indeed been significant work done within this limitation, such as John Addey's work with harmonics. However, there has been a lack of effective models for representing larger configurations and whole chart patterns. Further, there has been a lack of any methodology for translating such models into a form accessible to statistical analysis.

The AISAR methodology, as this presentation has hopefully made clear, has been oriented toward interpretive relevance right from the start. What comes out of this is a methodology that has something to offer to the practicing consultant as well as to the researcher. Grounding AISAR thoroughly within meaningful interpretive applications makes it possible for practitioners and researchers to communicate more clearly with each other. Again, this points out the importance of developing common units of meaning.

The other area of current work within the AISAR project is that of developing more intelligent communication capacities. Plots can provide much meaningful information, but leave something to be desired when it comes to translating this information into natural language. There is a massive and impressive body of knowledge that has grown out of research into computer processing of natural language. The potential is definitely there for integrating some of this knowledge with the AISAR methodology as it stands now.

What would result from this integration would be a conversational system that could interact with the user in a highly flexible way. The user could opt to introduce his or her own terminology to AISAR, or to select from a variety of preprogrammed vocabularies. In terms of their level of grammatical organization, these vocabularies would be (at least in the beginning) on the level of phrases. The explicit model would provide a "semantic data base" of greater complexity than the current implementation of this model. This would allow AISAR

to use its vocabulary of phrases in a meaningful way, and to integrate new information and new terms within its existing vocabulary. AISAR would interact with the user to make it easy to develop and test an explicit model that reflects the user's own distinctions among the symbolic elements of the astrological language. In short, AISAR would provide a laboratory for research into one's own interpretive process, and the way this process leads to a particular structure of concepts about a chart. This would be a first step toward a useful body of knowledge about the interpretive process in general. AISAR and the user would be able to learn from each other, and to communicate meaningfully about what they learned. This is very far from a "canned" interpretation that is printed out in final form with no opportunity for interaction or learning by the user or the computer.

This aspect of the AISAR project will involve a long-term development, and will require machine language speed and flexibility not provided by BASIC. A remarkable programming language, CALC, authored by Matrix's "own" David Black, provides the key to developing sophisticated machine-level routines to accomplish what is needed. In addition, the factor analysis routines that are so time-consuming in BASIC will be speeded up by whole orders of magnitude using CALC, which makes it feasible to even consider doing such things on the machine level. Future articles about AISAR will detail developments in both of these areas.

```
10 REM  AISAR ROUTINES FOR IMPLEMENTING THE EXPLICIT MODEL
20 REM  ************************************************
30 REM
40 REM  DATA STATEMENTS FOR PLANETS ARE LINES 50-60
42 REM
45 REM  LINE 50--SUN - MARS (3 VALUES EACH)
50 DATA .5,.8,.5,.5,.2,.5,.2,.2,.8,.2,.8,.8,.8,.8,.8
55 REM  LINE 60--JUPITER - PLUTO (3 VALUES EACH)
60 DATA .8,.2,.8,.2,.8,.2,.8,.8,.2,.8,.2,.2,.2,.2,.2
70 REM
80 REM  DATA STATEMENTS FOR SIGNS ARE LINES 90-100
82 REM
85 REM  LINE 90--ARIES - VIRGO (3 VALUES EACH)
90 DATA .5,.8,.8,.2,.5,.2,.2,.2,.5,.5,.2,.2,.8,.5,.8,.2,.8,.5
95 REM  LINE 100--LIBRA - PISCES (3 VALUES EACH)
100 DATA .5,.2,.8,.8,.5,.2,.8,.8,.5,.5,.8,.2,.2,.5,.8,.8,.2,.5
101 REM
104 REM  LINE 105--PLANET NAMES
105 DATA SUN,MON,MER,VEN,MAR,JUP,SAT,URA,NEP,PLU
109 REM
110 REM  ARRAYS DIMENSIONED IN LINE 130
115 REM  WV(10,6) IS ARRAY OF "WEIGHT VECTORS" FOR EACH PLANET.
120 REM  X(10) IS ASSUMED TO CONTAIN PLANETARY POSITIONS
122 REM  IN 360.DEC FORMAT (FULL CIRCLE WITH DECIMAL FRACTIONS).
125 REM  A(3), W(10), Y(10) AND Z(10) ARE USED DURING COMPUTATIONS;
127 REM PD$(20) IS USED TO STORE ASPECT STRINGS DURING SCANNING
130 DIM WV(10,6), A(3), W(10), X(10), Y(10), Z(10), PD$(20)
135 REM
140 REM  DEFINED FUNCTIONS ARE GIVEN IN LINES 150-190
142 REM
145 REM  FNU IS THE MODULUS FUNCTION
150 DEF FNU (X) = X - (INT (X / 360) * 360)
152 REM
155 REM  FNC COMPUTES SIGN NUMBER FROM 360.DEC POSITION
160 DEF FNC (X) = INT (X / 30) + 1
162 REM
165 REM  FNL TRANSFORMS PROPORTIONS INTO "LOGIT" WEIGHTS
170 DEF FNL (X) = LOG (X / (1 - X))
172 REM
175 REM  FNE IS THE INVERSE OF FNL (CONVERTS BACK TO PROPORTIONS)
180 DEF FNE (X) = 1 - 1 / (EXP (X) + 1)
185 REM
190 REM  A ROUTINE FOR COMPUTING OR ENTERING PLANET POSITIONS
195 REM  SHOULD BE RUN BEFORE CALLING THE FOLLOWING ROUTINES.
200 REM
205 REM  A MAIN ROUTINE AT LINE 1000 IS ASSUMED HERE.
210 GO TO 1000
215 REM
220 REM  A SUBROUTINE IN LINES 230-265 READS DATA INTO WV AND PD$.
222 REM
225 REM  THIS LOOP READS IN PLANET WEIGHTS AND TRANSFORMS THEM.
230 FOR I=1 TO 10: FOR J=1 TO 3: READ WV(I,J)
235 WV(I,J)=FNL(WV(I,J)): NEXT J,I
240 REM
245 REM  THIS LOOP READS IN SIGN WEIGHTS AND TRANSFORMS THEM;
250 REM  IT SKIPS OVER VALUES TO GET TO THE RIGHT SIGNS.
252 REM  THIS AVOIDS USING ARRAY SPACE.
255 FOR R=1 TO 10: FOR I=1 TO 12: FOR J=1 TO 3: READ A(J): NEXT J
260 IF I=FNC(X(R)) THEN FOR J=1 TO 3: WV(R,J+3)=FNL(A(J)): NEXT J: I=12
265 NEXT I: RESTORE: FOR K=1 TO 30: READ SKIP: NEXT K,R
266 REM
270 REM  READ PLANET NAMES
275 FOR I=1 TO 36: READ SKIP: NEXT: FORI=1TO10: READ P$(I): NEXT
276 RESTORE: RETURN
278 REM  END OF DATA READING SUBROUTINE
279 REM
280 REM  NEXT IS A SUBROUTINE THAT SCALES WEIGHT VECTORS
285 REM  TO A COMMON SCALE.  THIS IS USED AFTER COMBINING WEIGHTS.
290 REM
300 LL=0: FOR R=1 TO 6: LL=LL + ABS(WV(G,R)): NEXT: IF LL=0 THEN 320
310 FOR R=1 TO 6: WV(G,R)=WV(G,R) / LL * 6: NEXT
320 RETURN
325 REM
330 REM  A HARMONICS-BASED ASPECT SCAN  FOLLOWS (UP TO LINE 465)
335 REM  IT TRANSFORMS THE ARC-DIFFERENCE BETWEEN TWO POSITIONS
340 REM  INTO THE HARMONIC SCALE CORRESPONDING TO EACH ASPECT.
345 REM  ORB FOR EACH ASPECT EQUALS THE SPECIFIED ORB FOR
350 REM  THE CONJUNCTION TIMES THE SQUARE ROOT OF ITS HARMONIC.
355 REM  ASPECTS ARE SCANNED IN ORDER OF THEIR HARMONICS,
360 REM  WHERE 1=CONJUNCTION, 2=OPPOSITION, 3=TRINE, ETC.
365 REM
370 REM  INPUT STARTING AND ENDING HARMONIC, AND CONJUNCTION ORB
375 INPUT "FROM"; X1: INPUT "TO"; XX: INPUT "ORB"; YY
380 REM  Y1 IS THE ORB LIMIT TO TEST AGAINST
385 F=0: FOR K=X1 TO XX: Y1=YY * K ↑ .5
390 REM  MAKE ORB LIMIT EQUAL FOR CNJ, OPP, TRI & SQR (OPTIONAL)
395 IF K < 5 THEN Y1=YY * K
400 REM  SCAN ALL COMBINATIONS FOR EACH TYPE OF ASPECT--
402 REM  "ZZ" HOLDS THE ARC-DIFFERENCE FOR EACH PLANET PAIR
405 REM  THIS IS DONE BECAUSE THE ORDER IN WHICH WEIGHTS ARE
410 REM  COMBINED MAKES A DIFFERENCE, AND SOME TYPE OF PRIORITY
415 REM  MUST BE ESTABLISHED FOR THIS PURPOSE.
420 FOR I=1 TO 9: FOR J=I+1 TO 10: ZZ=ABS (X(I) - X(J))
425 REM  IF SCANNING HELIOCENTRIC POSITIONS, SKIP MOON
430 REM  (LABELS FOR TYPE OF POSITION ASSUMED TO BE IN Z$)
435 IF LEFT$ (Z$,1)="H" AND (I=2 OR J=2) THEN455
440 REM  "A" HOLDS THE VALUE TO BE TESTED AGAINST ORB LIMIT
445 A=FNU (ZZ * K): IF A > 180 THEN A=360 - A
449 REM  IF "A" IS WITHIN ORB LIMIT, BRANCH TO COMBINE WEIGHTS.
450 IF A < Y1 THEN 485
455 NEXT J,I,K: F=F - 1
460 REM  IF COMPLETED, GO TO ROUTINE TO COMPUTE SCORES
465 GO TO 600
470 REM
475 REM  THE ROUTINE TO COMBINE WEIGHTS FOLLOWS (THROUGH LINE 580)
480 REM  ASSEMBLE STRING WITH PLANET NAMES
485 PD$(F)=P$(I) + "*" + P$(J)
490 REM  CHECK PREVIOUS STRINGS FOR DUPLICATION OF ASPECT
495 FOR E=1 TO F-1: FL=0
500 IF E <> F AND PD$(E)=PD$(F) THEN FL=1: E=F-1
505 NEXT: IF FL=1 THEN 455
510 PRINT PD$(F): F=F+1
520 REM  TRANSFORM WEIGHTS TO PROPORTIONS AND COMPUTE RESULTANTS
525 FOR E=1 TO 6: G1=FNE (WV(I,E)): L1= FNE (WV(J,E))
530 W(E)=G1 * L1: Y(E)=(1 - G1) * (1 - L1)
532 REM  WV(0,E) CONTAINS RESULTANT OF COMBINED WEIGHTS
535 W(E)=W(E) / (W(E) + Y(E)): WV(0,E)= FNL (W(E)): NEXT: G=0
540 GOSUB 300
545 REM  SCALE WEIGHT VECTOR BY STRENGTH OF ASPECT
550 FOR E=1 TO 6: W(E)=FNE (WV(0,E) / SQR (A)): NEXT
555 REM  ADJUST WEIGHTS FOR PLANETS "I" AND "J" BY RESULTANT
560 G=1: GOSUB 570: G=J: GOSUB570: GOTO 455
565 REM  SUBROUTINE TO ADJUST PLANET WEIGHTS
570 FOR E=1 TO 6: Z(E)=W(E) * FNE (WV(G,E))
575 Y(E)=(1 - W(E)) * (1 - FNE (WV(G,E)))
580 WV(G,E)=FNL (Z(E) / (Z(E) + Y(E))): NEXT: GOSUB 300: RETURN
585 REM  END OF ROUTINE TO COMBINE AND TRANSFORM WEIGHTS
590 REM
600 REM  THIS LOCATION IS BRANCHED TO AFTER ASPECT SCANNING.
610 REM  A ROUTINE FOR COMPUTING SCORES CAN BE INSERTED HERE
620 REM  IN BASIC, THIS FORMULA COULD BE WRITTEN AS:
625 REM
630 SCORE=0: FOR I=1 TO 6: SCORE=SCORE + WV(X,I) * WV(Y,I): NEXT
635 REM
640 REM WHERE X IS THE REFERENCE PLANET AND Y IS SCORED ON X.
READY.
```

4 new products from Matrix

stat

STATISTICS APPLICATIONS FOR TECHNICIANS

Here is a package that is so state-of-the-art that many of the statistical techniques implemented here are not even in the textbooks yet. STAT is a set of programs for performing a large portion of the most frequently used statistical inference methods. Data can be entered and stored on four different types of data files. These data files can be modified also. The statistical procedures available in the package include the following parametric inference procedures:

SUMMARY STATISTICS for each data file and date set, including the mean and standard deviation.

CONFIDENCE INTERVALS for the following: (1) the mean of a normal population (both with and without the variance known). (2) the variance of a normal distribution (both with and without the mean known). (3) the parameter (mean time to failure) of an exponential distribution. (4) the parameter (proportion) of a binomial distribution. (5) the difference of two normal means (for various combinations of assumptions about the variances of the populations) and (6) for the ratio of two normal variances.

TESTS OF HYPOTHESES about (1) a normal mean, with various cases corresponding to possible assumptions about the variance, (2) the difference in two normal means (various cases) and (3) the ratio of two normal variances.

TESTS OF THE EXPONENTIAL MEAN (mean time to failure) and **RATIO OF MEANS.**

TESTS OF THE BINOMIAL PARAMETER (proportion) and **DIFFERENCE OF PARAMETERS**

MULTIPLE REGRESSION, including estimation of coefficients, estimation of the error variance, and test of significance of the regression.

ANALYSIS OF VARIANCE for one-way and balanced two-way designs, including interaction.

The software is user-friendly, allowing easy recovery from errors and selection of alternate analyses, as desired. The user's interaction is entirely menu driven, with error recovery features. An extensive user's manual introduces the statistical inference procedures used, and gives worked examples for each situation considered, illustrating typical applications. These worked examples serve as a pattern and allow the reader to check his use of the programs. The user's manual gives complete documentation of the programs and procedures used in them. All formulae, algorithms and procedures are listed and referenced to commonly available statistical literature.

A notable feature of the package is inclusion of very efficient routines for the computation of probabilities and quantiles for the most common statistical distributions, including normal, binomial, chi-square, t and F. Thus the user is not required to furnish "tabular values" from outside sources when performing statistical analyses with this package. STAT complete with all documentation is $200.

APPLE II APPLESOFT and at least one drive
APPLE II PASCAL SYSTEM
COMMODORE 32K with 4040/8050 drive

Radio Shack Mod III and CP/M compatibility by fall.

calc

MACHINE SPEED "BASIC"

CALC was designed to provide programmers of microcomputers with a portable language that combines the programming ease of the higher languages with the speed and flexibility of assembler programming. CALC is totally portable on the Commodore and APPLE II computers. This means that CALC source code written on an APPLE II will run **as is** on a Commodore machine and vice versa.

When possible, CALC makes direct use of the BASIC ROM machine language routines in the Commodore and APPLE II. In essence, CALC provides access to the power in the BASIC ROMs without the overhead of the BASIC interpreter. This includes floating point arithmetic and all library functions. In addition, we have added features that BASIC does not have. These include true integer arithmetic and machine speed string handling with search and replacement features.

CALC can fetch and replace BASIC variables and arrays by name. The programmer indicates what is to be done using simple keyword commands (ADD, MULT, SINE, etc.) and leaves all register set-up, bit-format and the like to CALC. The object code resulting from CALC programs is very compact and consists of direct calls to the BASIC ROMs or to the CALC runtime package.

CALC comes in 4K of PROM containing a relocatable runtime package and a very complete Trace Window feature for debugging CALC programs. CALC produces romable 6502 code that does **not** require the CALC development PROM to function. Programs written in CALC will run on any stock PET or APPLE. CALC comes with a 60-page manual.

CALC PROM on Commodore is $115.; indicate 3.0 or 4.0 BASIC, 40/80 column screen and rom sockets $9000, $A000 or $B000.

CALC on APPLE II via quality slot independent board is $160.

CALC manual by itself is $10.

CALC requires Moser/Mae Macro Assembler (Tape or Disk version)

sort

MULTI-KEY MACHINE LANGUAGE

A 6502 machine language in-memory sorting algorithm of commercial quality is available as part of a new utility eprom for PET and APPLE owners. Most sorts are accomplished in less than a second and very large sorts take only a few seconds. The algorithm is a diminishing increment insertion sort, with optionally chosen increments. This algorithm has the advantage of being significantly faster (but not much longer) than simpler ones, and significantly smaller (but not much slower) than more complicated ones. Moreover, unlike some of the more complicated algorithms, there are no conditions under which the performance of this sort degenerates or fails.

SORT is intelligent to the degree that almost no user set-up operations are required. SORT handles integer, floating-point and string arrays, as well as multiple dimensioned arrays with equal ease. In addition, multi-key sorting of string arrays has been enabled. The user may specify the character within a string to begin sorting on and how many characters are to be evaluated. SORT is capable of performing up to twenty of these multi-key sub-sorts (on matches found) at the same time. This multi-level 20-KEY capacity for string arrays greatly increases the uses to which SORT can be put.

SORT comes as part of a utility EPROM that also includes a hi-speed machine language text screen dump. Complete instructions for installation and use are included.

SORT is available for large-keyboard PETS Only. One ROM will work for BASIC 3.0 & 4.0, 40 or 80 column screens. When ordering you need only to indicate which ROM socket address in PET you prefer EPROM ($9000, $A000 or $B000). PET SORT EPROM at hex $9000 location if you do not specify. PET EPROM price is $55.00 (postpaid).

SORT is available on the APPLE II via a top quality, fully socketed, EPROM board that is slot independent. The MATRIX APPLE board includes a function driver that supports up to 16 EPROM based functions in case you would like to use your own EPROM in place of ours. EPROM board with SORT, text screen dump and function driver are all slot independent and may be used in any slot except 0. Price APPLE CARD $110.00 (postpaid).

bookkeeper

TOTAL BUSINESS SYSTEM

BOOKKEEPER was designed by a team of accountants and businessmen, and then programmed especially for microcomputers. This is not hand-me-down software from mainframe computers. BOOKKEEPER is a totally integrated management and accounting system that is available now on the more popular micro systems.

This series of interlocking programs is menu-driven and self-prompting with relative file structure implemented throughout. In some versions, machine language routines have been used to provide more efficient operation. The system employs state-of-the-art techniques and has been designed to be user-friendly. No knowledge of accounting or computers is required.

We believe the system can be operated using little more than the screen prompts. But for completeness, our MATRIX User Guide (two-inch ring binder) contains almost 200 pages of details on the BOOKKEEPER system plus a helpful introduction to business accounting principles. We suggest that you send for a more complete description of BOOKKEEPER or invest in a copy of the User Guide. There is room here only for a general description.

BOOKKEEPER is available for both SERVICE and RETAIL/WHOLESALE firms. This total business system contains the following: 375 General Ledger accounts (ten departments with accompanying revenue and expense accounts). Accounts Receivable file with maintenance and report capabilities (1000 accounts). Payroll with all federal withholding computed, state and local income tax capabilities for all fifty states (100 employees). Cash Receipts and Cash Disbursements programs that keep track of inventory sales by department. Sales Tax computations. Receipts and Invoices. Accounts Payable file with maintenance and report capabilities (100 accounts). The system also generates and prints valuable management reports such as Departmental Budgeting, Profit and Loss Statements by Department, the traditional Chart of Accounts Summation (Trial Balance), and Financial Reports.

The Retail/Wholesale version of BOOKKEEPER includes a perpetual inventory control system and permits point-of-sale invoices.

BOOKKEEPER is available now on the COMMODORE 8032/8050, 48K APPLE II+ and RADIO SHACK Model III computers. CP/M compatible version available by September.

The BOOKKEEPER system retails at $1000.00.

Bookkeeper manual by itself is $20.00.

Matrix software

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Matrix is the software source for computer astrology.

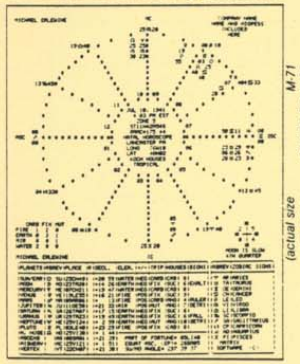
Home Computers for Astrologers

Home computer systems like the Commodore PET and APPLE II mark the advent of a new era for astrological study and research. These are plug-in appliances that require no technical or programming experience on the part of the user. A library of astrology programs prerecorded on standard audio tape cassettes is available from MATRIX. All an astrologer need do is play the tape and enter the standard birth or event data. The computer will do the rest.

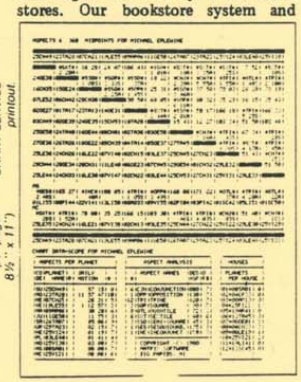
Home computers provide much more for astrologers than increased accuracy and time savings. They are a "window" into the great wealth of astrological tradition and techniques. Difficult techniques such as Primary Directions, Harmonic Analysis, Cosmobiology and Astro-Geography become instantly available to you via the computer. The home computer is fast becoming the preferred way to learn astrology. It opens the door to the world of astrological tradition without requiring weeks or months of study with each technique. Best of all, you can learn these techniques using sample charts on your own choosing and determine in a short time if the particular technique is a meaningful one for you.

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For the professional, the MATRIX system offers a comprehensive and integrated home chart service. Choose from a variety of system packages tailored to fit your needs. Complete details on all of our programs can be found in our Full Catalog. Pictured is an example of what a single MATRIX program can do: A computer and a printer is all that is required to run our M-71 Chart Service package. This package can process up to ten charts at a time (with separate options for each chart) and provide you with this two-page printout for each horoscope.



M-71 CHART SERVICE printout (actual size per page 8½" x 11")



MATRIX Full System

Our full computer system for the professional astrologer or small book store includes a computer, printer and floppy disk storage system. This system is equally prepared to operate as a chart service or research facility. We offer a wide selection of astrological and business software. The astrology package includes the ability to file and store an unlimited number of client or research natal charts. You may select to printout any of these chart records in a full wheel with a choice of nine house systems. Process one or 100 charts at a time with all options operative for each of the charts and come back later to find them all printed out and ready for your customers or research notebook.

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Computer systems are expensive. We suggest you read about them in detail and determine which system will suit your needs. Our Full Catalog is available to you for this purpose. The catalog is a bound 150-page book filled with articles, specifications and information about computers and astrology. Beginners will appreciate the introduction to computer systems and astrology—how they go together. For the advanced enthusiast, a detailed explanation of each component of a computer system is provided along with specifications and illustrations of the more popular models.

More than 100 MATRIX astrology programs are described in detail and most include a picture of what the program looks like when it is operating. The major features common to MATRIX programs are discussed in detail in a special section. A complete list of the contents of the technical journal Matrix Magazine is included. In addition, the catalog includes books, periodicals and calculator programs available thru MATRIX plus new program announcements and general news items of interest.

The Matrix full catalog of computer hardware and software for astrologers can be ordered for $5.00 postpaid. This amount is refundable on any software or hardware order.

MATRIX USER GUIDE

Our User Guide is a valuable reference guide that provides the maximum amount of detail on the MATRIX system. This two-inch ringbinder contains complete documentation on all facets of our system. Sections include: (a) Hardware Set-Up illustrating computer setup, electrical considerations, handling tapes and disks, etc.— all in detail. (b) Software Use, how to operate and get the most out of your astrology programs, (c) Analysis & Applications with articles and information on how to use and interpret the many astrological techniques open to you thru MATRIX software and (d) Program Documentation including the full user instructions for every program MATRIX offers.

Matrix software

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Issue IX MATRIX MAGAZINE

Front Cover		**THE 1982 JOHNDRO AWARD**
	1	**NEWS & NOTES**
Laurence Ely	2	**TRUE SECONDARY & TERTIARY PROGRESSIONS**
Doug Pierce	43	**THOUGHTS ON INTERPRETIVE SOFTWARE DEVELOPMENT**
Mark Pottenger	50	**NUMERICAL INTEGRATION: Volume XXII A.P.N.A.**
Mark Pottenger	58	**THE ISAR DATA BASE PROJECT**
David B. Black	59	**Excerpts from SPIRITUAL SCIENTIFIC ASTROLOGY**

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THE 1982 JOHNDRO AWARD

TO

THOMAS SHANKS

It is with great pleasure that the award in memory of L. Edward Johndro is granted for 1982 to Thomas Shanks. Commencing in 1978, this annual Johndro Award for excellence is being given for those who have distinguished themselves through some major contribution to the technique and theory of Astrology.

Tom Shanks has been an applications programmer at Astro-Computing Services since October of 1976. As Director of Research at that organization, he has been in charge of running a wide variety of full scale research projects including work for John Addey and the Gauquelins. In addition, he has exhaustively tested and re-tested any number of traditional astrological theories on large sets of data. To my knowlege, Shanks is the only astrologer working full time in a purely research capacity on a large computer.

Shanks has served as the prototype and symbol for what it is to be doing serious statistical research in astrology for a whole generation of research oriented astrologers.

- Michael Erlewine

The awarding committee is composed of Zipporah Dobyns of THE MUTABLE DILEMMA, Michael Erlewine of MATRIX MAGAZINE, Robert Hand of NCGR publications, David Cochrane of SIRIUS, Charles Jayne of COSMECOLOGY BULLETIN and Henry Weingarten of NASO publications.

MATRIX MAGAZINE ISSUE IX July 1982

MATRIX MAGAZINE is a periodical in the truest sense of the word with a single copy price (4th class postpaid) of $6 ($7 First class). Subscribers are notified as each issue is being prepared and their response determines the number of issues that will be printed. MATRIX is produced and edited by Michael & Margaret Erlewine.

MATRIX MAGAZINE
315 Marion Avenue
Big Rapids, MI 49307

(616) 796-2483 796-3081

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JOHN ADDEY DIES

We are very sorry to report that astrological pioneer John Addey passed away on March 27, 1982 at 5:17 p.m. at the Royal Homeopathic Hospital in England. He had been seriously ill for about two months.

It is too early to assess John's unique contribution to modern astrological theory and technique. The ramifications of the harmonic approach he pioneered are only now beginning to be understood and applied on any large scale. It is obvious that this approach will continue to be integral to any future astrology.

It is important to point out to those who may not have had an opportunity to know John in person that his work is the result of a rigorous spiritual discipline. John was a great poet in the world of spiritual ideas. The astrological ideas that he has left us are a direct result of his great personal dedication to spiritual ideals and the discipline that can come from such dedication.

John is an example of one who, above all, attempted the great work of integrating his convictions into the details of everyday life. The following is part of a response sent by John Addey to MATRIX upon receiving the 1981 Johndro Award. It says what I have been trying to convey.

"... Although this is an award for technical contributions to astrology- and it is true that some of the spin-offs from the harmonic concept do constitute technical innovation ('innovations', that is, bearing in mind that there is nothing new under the Sun)- yet, my approach to astrology was originally, has always been and remains to this day, from the standpoint of mystical philosophy. This was and is because I believe that in the end, this is the approach which gets closest to the essential truths of the subject and, indeed, includes all others."

MATRIX VIII, page 2, 1981

NEW FULL-TIME MATRIX STAFF MEMBER

MATRIX is happy to announce the addition of Doug Pierce as a full-time staff member here at MATRIX. Aside from being a research astrologer, Pierce is a professional statistician and computer programmer. One of Pierce's initial projects here at MATRIX will be to design and program a statistical module for use with the M-65 RESEARCH SYSTEM. Pierce is one of the foremost researchers in dynamic astrological interpretations systems involving computers. With his help, MATRIX will be offering a variety of new approaches to computer assisted interpretation. Pierce and his wife will re-locate to Big Rapids Michigan in September of this year.

THE SECOND A.C.T. CONFERENCE

The 1982 ACT CONFERENCE will be held as part of the bi-annual AFA CONVENTION at the CHICAGO MARRIOT hotel from August 28 thru September 1 of 1982. ACT (Astrological Conference on Techhniques) is under the direction of Michael Erlewine and Charles Jayne. We will have one room devoted to ACT running during the entire AFA Convention. Registration for the AFA convention automatically includes all ACT workshops and activities. The goal for the 1982 ACT conference will be an attempt to establish standards among astrologers in research areas.

With the exception of two research project reports, all ACT functions this year will be in the form of workshops involving a panel of experts who will interact with each other and with the attending audience on the subject matter. ACT workshops include: Creating a Standard List of Astrological Subjects and their representatitives (who is doing what), Research techniques & the Stock Market, Proposed Standards for an Astrological Data Base, Computer Hardware & Software roundtable, Design for an Astrological Research Language, Statistics in Astrological Research, World Personality Data Exchange Project, Dynamic Computer Interpretation Schemes, and many more.

ACT panels include some of the foremost technical and research oriented astrologers in the world today. We have a top notch staff and a carefully laid out program. We hope many of our MATRIX readers will be there to share in the workshops and to meet one another. Don't miss the 2nd ACT!

M-65 RESEARCH SYSTEM LAUNCHED

MATRIX headquarters has been more that a little busy during the last year as we put the finishing touches on our new M-65 system. A computerized system capable of actual research projects has been a dream of my brother Stephen and myself since the late 60's. It would be hard to find an astrologer who has not had similar dreams.

We have worked on M-65 for several years but only recently have we had the manpower to bring it all together and implement it on several machines at the same time. David Cochrane, Stephen Erlewine and your editor have worked on this system (it seems like day and night!) for the past year. It is finally finished and available on the Commodore 32K, Radio Shack Model I and III and the APPLE II computer systems with dual disk drives and a printer. The Commodore and Radio Shack systems have been shipped and the APPLE II system is in the final testing stages.

The initial release of the M-65 consists of two main parts: (1) CHART CREATION & STORAGE and (2) RESEARCH QUERY SYSTEM.

(1) The CHART SERVICE is a self-contained system capable of generating and storing most of the commonly known astrological charts and techniques. This system includes quite elaborate analysis and printout capabilities including single and dual wheels plus many different types of graphic printout (Planetary Pictures, Trees disgrams, etc.). The user may control the arrangement of the final printout, custom program their own set of aspects and orbs, etc.

(2) RESEARCH QUERY SYSTEM The second part of the M-65 system allows the user to access any of the material stored in the astrological files plus create their own set of user defined questions and answers to be accessed. The user may design SEARCH PHRASES to analyze any of the stored data. Data may be sorted thru, counted and formatted for printed output. A multiple pass option allows the user almost unlimited flexibility in designing research projects.

(Continued on page 60)

TRUE SECONDARY AND TERTIARY PROGRESSIONS

By

Laurence Ely
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Belchertown, Massachusetts 01007

In this paper I present new theories of secondary and tertiary progressions which are much more accurate and precise[1] in their predictive ability than the customary theories. Besides their superiority in careful rectification and prediction over the customary theories, these new theories, unlike the customary ones, dovetail completely with the theory of transits thus creating a unity of conception in the astronomy or physics of astrology. While a lot of the theory is now tight, a lot of theoretical questions issue from it and so a lot more work still needs to be done as will be seen towards the end of the paper. Before proceeding with the development of this new theory, I want to put secondary and tertiary progressions into perspective with respect to the structure of the body of dynamic or predictive techniques. I must intermix a little history of astrological thought to help put our current knowledge of dynamic techniques into focus.

The presiding astrological wisdom conceives of the structure of the body of predictive techniques as follows. First there is the technique of primary directions based traditionally on the conception of the daily rotation of the heavens about the earth at the rate of one degree in four minutes of sidereal time. The idea here is to equate each degree of rotation (each change of one degree of right ascension of the MC) with one year of life. This theory is credited to the second century A.D. astronomer, Ptolemy, about whom more later.

The word direction arose out of the idea that in primary directions all planets, fixed stars, etc. move at the same rate and in the same direction thus preserving the relative positions as found in the natal chart. By way of contrast, in progressions planets move at different rates from each other and all but the sun and moon go retrograde at times just as in the domain of the technique of transits. It was Placidus, the father of Placidean houses, who introduced the term arcs of direction in his Primum Mobile.[2] This work represented a thorough discussion of the technique together with the introduction of spherical trigonometry to handle the calculations. It must have had a considerable impact on astrological thought to follow, judging from the fact that at least as late as 1935 primary directions or arcs were also called Placidean arcs.[3] That Placidus was influential in the world of astrology is further testified to by the fact that his theory of house division continues to be far and away the most widely accepted theory and it is now more than three hundred years since his death.

Over the past several decades various alternative theories have been proffered as substitutes for the one degree per year of Ptolemy and Placidus. I will explain the reasons for this proffering of alternative theories a little later. For now, it is well to realize that only a handful

of astrologers employ primary directions of one variant or another. By their attachment to the authority of Ptolemy and Placidus, two of the most famous names in astrology, primary directions have taken on an aura of respect and elitism on the one hand yet obliqueness and distance on the other. They have remained the province of certain technical and research astrologers. The spherical trigonometry has kept away most non-mathematically inclined astrologers.

Turning now to the next dynamic technique, we have the widely employed secondary progressions or day-for-a-year progressions. This theory is based on the analogy between two cycles, the cycle of the day and cycle of the year. Accordingly, a sunrise on the daily level corresponds to the vernal equinox on the yearly level, etc. In this technique we go one day forward in the ephemeris for each year of life from the birth moment. As to its origins, we do not have the case of a personalizing as with Ptolemy handing us down the primary directions. Somewhere in the Bible I believe someone says, "Ye shall count ye days as years." Henry Owen indicates the theory as coming from the Arabs, because he refers to it as "the secondary or Arabian system."[4] Zipporah Dobyns told me the theory goes way back.[5] In the technique of solar arc directions, commonly understood to be loosely associated with secondary progressions, the difference between the position of the secondary progressed sun and the natal sun is taken as defining the solar arc or arc of the sun. Johannes Kepler, whose dates are 1571-1630, employed solar arc directions, and so I surmise, secondary progressions as well. Here is what Richard Svehla says on the matter:

> These directions are not a new feature either, having been extensively used by the great Astronomer-Astrologer, Johannes Kepler, and he probably was following in the footsteps of others before him.[6]

Although the technique of secondary progressions would appear to go as far back as primary directions in its origin, the technique was not in great use vis a vis primary directions it seems until nearer our times. Robert DeLuce had some comments which go to the question of why that was. He refers to secondary progressions as the progressed horoscope and to primary directions as equatorial arcs:

> In the last decade of the 19th century there was a growing interest in Astrology and the method of the progressed horoscope was largely brought into popular use because it was easy of application, requiring only the simplest mathematical calculations and furthermore could be used independently of a knowledge of the exact birth time. The method of equatorial arcs requires that the birth time should be known to the very minute, while in the method of the progressed horoscope if a birth time is known to within ten minutes the results are usually satisfactory.[7]

Two who were largely behind the movement towards more widespread employment of the theory of secondary progressions appear to have been Sepharial (1864-1929) and Alan Leo (1860-1917) according to Henry Owen:

> "Sepharial" (Walter Gornold) wrote on the primary system, but he is generally held to have introduced the "progressed horoscope" which Alan Leo popularized.[8]

I have thus far discussed three predictive techniques, which are regarded as three independent theories, namely, primary directions, secondary progressions, and solar arc directions. A fourth theory is that currently called minor progressions, but called embolismic lunations a long time ago. Here, our friend Placidus pops up again. The theory was explained by DeLuce as follows:

> . . . embolismic lunations treated of by Placidus. By this system each lunation following birth relates to a corresponding year of life. Thus the first time after birth when the Moon holds the same phase or relative position to the Sun that it held at birth denotes the indications for the first anniversary after birth, and the second lunation the second anniversary, and so on.[9]

This means that for every year old you are, you go 29.530589 days forward in the ephemeris from the time in the ephemeris corresponding to your birth time. On page 108 DeLuce gives the following example. I abbreviate embolismic lunation progressed by ELP:

Natal Date	August 24, 1877
Event Date	August 24, 1934
ELP Date	April 3, 1882

Minor progressions are also employed by correlating a year of life with the 27.321582-day period of the moon recontacting its natal place. In either case, these minor progressions are minor, indeed, in terms of use by astrologers.

A fifth technique is that of tertiary progressions. Here the cycle of a month is equated with the cycle of the day. While in secondaries we go a day forward in the ephemeris for a year of life, in tertiaries we go a day forward in the empheris for a month of life. As in minor progressions, the month can be either the synodical month of 29.530589 days or the tropical month of 27.321582 days. In as much as these tertiaries bear such a close resemblance to secondaries, it is surprising that there is no mention of them in the astrological literature until recently. Charles Jayne says that Edward Troinski of Germany concocted them,[10] and I surmise the date to have been in the 1960's.

A sixth technique is that of symbolic directions in longitude motivated no doubt, by Ptolemy's one degree per year key in the primary system. Henry Owen informs us of this development:

> . . . in the years 1928-1929 by various symbolic measures first introduced by W. Franklan and by Charles Carter, by which a fixed number of degrees of longitude or fractions thereof were added to all natal positions for each year of life.[11]

These include Carter's 1/4 degree per year and Franklan's 4 2/7 degrees a year, his so-called "Point of Life" (one zodiacal sign every seven years). Also he employed 4/7 of a degree for a year (Sepharial argued for 3/5 of a degree for a year instead).[12] Also given by Carter was 2 1/2 degrees per year.[13] Rudhyar offered his "Point of Self" of 12 6/7 degrees a year, apparently styling this after Franklan's 4 2/7 degrees a year by multiplying

his value by three.[14] And last but not least, there is the one degree per year direction, exactly paralleling the traditionally employed primary system.

Carter has been one of the more influential astrologers of the 20th century and so I would guess that his symbolic directions and the symbolic directions of Franklan and Rudhyar have gained a certain coinage, although I personally do not know anybody who uses them. But I would hazard to guess that they are employed more than primary directions are.

A seventh technique includes two directions related to solar arc directions in longitude. Here we have the Naibod arc of 59'08" movement per year, based on the average daily speed of the sun and the Simmonite or birthday arc based on taking the speed of the sun on the birthday as the directional speed throughout the life. This Simmonite arc supposes that somehow one captures the instantaneous speed of the sun at birth. The Naibod arc was employed in Vivian Robson's The Radix System, considered a classic in the field. Sepharial (Walter Gornold) apparently first introduced this Naibod arc.[15] These directional rates have been applied to primaries as well. This area is rather confusing from the literature at my disposal, but I am fairly sure that these arcs in fact first were used in the primary system (arcs along the equator), no doubt because the traditional primary system of Ptolemy was found wanting when stacked up against reality.

The body of predictive technique ends with the good old technique of transits, the most intuitively obvious technique in that it directly considers the continual movements, subsequent to birth, of the actual motions of the planets in real time. In this connection, the birth chart is just a snapshot of the flux of planetary motions through time. Included in the technique of transits as a subset would be the planetary return chart, interpreted as a subsequent birth cast off from the first birth, and living only until the next planetary return takes place.

Ronald Davison has made a quite incisive insight about the interpretation of transits which serves to unify them with progressions. He has stated that transits can be viewed as day-for-a-day progressions.[16] While the day-for-a-year equation creates secondary progressions or the progressed horoscope, his day-for-a-day equation creates what he calls daily progressions or the daily horoscope. He continues:

> Some years ago I suggested that the daily horoscope might be regarded as the logical extension of the day for a year system of progressions and proposed as auxiliary measures the day for a month and day for a week series, finishing with the day for a day series, . . . I want to continue with this series in ever decreasing amounts of time . . . it is probably valid to equate a day with an hour, a day with a minute and a day with a second.[17]

I have described all of the mechanisms of astrological prediction and now I want to summarize the structure of the body of techniques as it is currently viewed. Here is that structure with the great circle employed for each technique listed along side of the mechanism of the technique, as I suppose it to be commonly conceived:

TABLE ONE

TECHNIQUE	GREAT CIRCLE	MECHANISM
Primary (Equatorial) Directions	Equator	?
Secondary Progressions	Ecliptic	Analogy between two real astronomical cycles (sympathetic vibration as tuning forks in music).
Tertiary Progressions	Ecliptic	"
Longitudinal Directions Solar Arc, One Degree & Symbolic, Naibod Arc, Simmonite Arc	Ecliptic	?
Transits	Ecliptic	Real astronomical time (sympathetic vibration as tuning forks in music).

Note: Minor progressions are for the time being subsumed under tertiary progressions since minors involve lunar periods, like tertiaries.

While I enumerated the several directional techniques over a few categories in the above historical development, I include them all together in the same category in the above table since they are all directions in longitude even though their principles or physical conceptions differ. I stated that solar arc directions are considered loosly connected with secondary progressions in that to get the solar arc, one has to first employ the mechanism of secondary progressions (the physical analogy between the day and the year). This begs the question of whether solar arcs should be included under the category of secondary progressions. Yes, but what about the one being progressions and the other being directions? A lack of fit. This question as we shall see, is a ticket for our current structure of techniques to embark on a ship headed for a land of clarity and unity leaving behind the miasmic grounds upon which our structure of techniques now rests. The other ticket for embarking on this voyage comes from asking how come we have directions on the equator and directions on the ecliptic yet transits only on the ecliptic? Looking back at the table, what about the question marks under the Mechanism column? What is the machinery, what is the mechanism by which directions are created? What are directions, anyway?

Where do we start? Well, let us consider transits first. They are simplest. I have in mind a thought that most of you would give a nod of assent to the theory that the mechanism of transits is accurately likened to sympathetic vibration as in the high school tuning fork experiment. One takes two identical tuning forks, strikes one and holds it next to the other without touching them. Then one dampens the one which was struck, stopping

its vibrating. One now notes that the other one is vibrating. One hears the same note at about the same intensity. They are on the same frequency like two people enraptured over sharing the same esthetic sense. Say each produces middle C. Now we take a tuning fork which produces the note D. We strike it, hold it near either of the C forks, and then dampen the D fork. Now we find the C fork does not respond or vibrate, at least not to our senses: just a little energy would have been transferred due to harmonic considerations.

On the level of transits the analogy is directly comparable. If I have a natal planet at two degrees Aries, it is two degrees distant from natal zero Aries, thus its wavelength is two. A planet at one degree Aries would have a wavelength of one. Frequency (the note, or pitch) would be found by dividing the wavelength into 360 degrees. So frequency and wavelength are reciprocally related. Well, if I have a natal planet at two Aries, I possess a tuning fork of frequency 360/2. Now when a transiting planet reaches two degrees Aries it is emitting a frequency of 360/2. It is two degrees away from zero Aries transiting. So the frequency the sky is emitting is one that I possess, and so I respond through sympathetic vibration. Let me diagram this with N for natal, TR for transiting, and P and Q for any two planets (P may equal Q as well):

$$\text{Aries}_{TR} \overset{X}{\text{----------}} P_{TR}$$

(P_{TR} currently transiting at X degrees, and emits frequency of 360/X)

$$\text{Aries}_{N} \overset{X}{\text{----------}} Q_{N}$$

(Q_N always receives at frequency of 360/X)

I do not write P_{TR} on top of Q_N. There is no physical hitting or geometrical line-up. I do not possess a zodiacal 360 wheel on the crown of my head or a wheel circumscribing my torso someplace. I have no wheel that always keeps its zero Aries direction in the direction of Aries in the sky. I am free to come and go, and rotation is included among my freedoms.

Generalizing this concept further, there is no reason to require Aries to be one of our natal and transiting members or points. Take X and Y as two transiting bodies; A and B as two natal bodies:

$$X_{TR}\text{----------}Y_{TR}$$

$$A_{N}\text{----------}B_{N}$$

Here if Y-X = B-A, then X,Y are emitting at a frequency that A,B can receive.

Now when we go to the level of secondary or tertiary progressions we jump to analogical time.[18] The real time in the ephemeris gets mapped into analogical time which is a very personalizing, internalizing, and

individualizing time. Only two individuals who share the same birth time can be living in the domain of the same analogical time for a given type of progression. So, in progressions, we have planetary positions moving in relation to our fixed natal patterns, just as in transits. Therefore, the same principles of sympathetic vibration apply in progressions as apply in transits. The idea I want to impress upon the reader is that in each of the techniques of transits and progressions, we have two levels, the natal and the dynamic or moving.

Now let us dig into the core of the matter of primary directions. You had better bring along an air purifier to hold over your nose because the whole area is redolent with putrefaction. Our question is the mechanism by which they work. In this technique, the six hours of time following birth are witness to a rotation of the heavens by 90 degrees and as one degree is supposed to signify a year of life, this gives one potentially a 90-year lease on life. After six hours, quadrature is reached, traditionally signifying crisis. Traditionally the fourth house signifies among other things the end of the matter. Even though six hours have elapsed at the 90-degree rotation point or three hours at the 45-degree rotation point (corresponding to age 45 years), curiously, the method does not admit of any consideration of the movements of the planets longitudinally. In three hours, the moon for instance moves 1.65 degrees longitudinally on average. The theory then must suppose some kind of imprinting at the moment of birth on a concentric circle which rotates against the inner circle containing the natal planets. Such imprinting then freezes the pattern of the relative planetary distances in arc. So a copy of the natal chart is somehow created. But where? We have no physical analogue computer as we do in mapping two cycles together in the theory of progressions both secondary and tertiary. Something is fishy here.

I have demonstrated the strong suspicion that the theory of primary directions is lacking. Could it be that those employing primaries were getting approximate results by virtue of the technique's closeness in directional rate to the technique that is now widely acknowledged among careful and thorough astrologers as being highly accurate, namely solar arc directions in longitude?[19] One must realize, in this regard, that there are many variables allowing for errors to at times cancel each other out: the rate of change of RAMC relative to the rate of change of the longitude of the Midheaven, the varying speed of the earth in its orbit and so the varying rate of change of the solar arc with longitude of the progressed sun, and the fact that the MC can be at any angular distance from the sun. Contributing to the plausibility of the theory has been the sloppy technique of working with excessively large orbs of one degree or more. Charles Jayne clearly points out the blunder committed by this older practice of allowing large orbs. By allowing such orbs, the inherent imprecision of the directions by the Naibod arc or the one degree per year arc in longitude would be hidden.[20] The orb allowance when this sort of mind was at work on primaries certainly was similar. Take the case of Robert DeLuce's acknowledging that the formation of the arcs in the ensuing hours after birth does allow for the planets to move longitudinally:

> A little reflection will show that the time required for the formation of the equatorial arcs significant of a lifetime is too brief to permit any appreciable motion of the heavenly bodies in their orbits, for at

> the most six hours would permit the Sun to move in the ecliptic about one-fourth of a degree, while the Moon might move in the orbit approximately three degrees. . . . Therefore the only movement of the heavenly bodies that is important in the system of equatorial arcs is the apparent diurnal motion that carries the whole heavens around the circle of the twenty-four hours.[21]

I do not know what planet he is from, but being content to have a lunar position reach a two-degree error by age fifty say, is curious indeed. Especially since the adjustment to the lunar position would be so easy to make relative to the other lengthy calculations already done. Could this perverse attitude towards accuracy be betraying an underlying realization on DeLuce's part and others who employed this traditional technique, that the technique is bankrupt anyway for any real world results? Could these astrologers be engaging in some bizarre kind of technical, esthetic ritual adopted unconsciously in homage to the great Ptolemy? One really has to stop and wonder.

Now it is time to have a look at this fellow Ptolemy whom so many astrologers revere as though the father of their art. There is a gentleman named Robert Newton who is a creative and dedicated scientist and he has been studying various long-range positional problems in astronomy. He has published a series of books over the last several years. There is one book whose covers I want to open for you now, for it contains a nice little bomb that it is time for me to drop in this paper. In a nutshell, Ptolemy was a fraud. He clails to have made several observations which he did not make and these alleged observations just happen to agree with his theory of planetary motion. Says Newton:

> In sum, four classes of Ptolemy's alleged observations have been tested by rigorous procedures. It turns out that all of these observations that Ptolemy actually uses are fraudulent; that is, they have been fudged for the purpose of establishing erroneous theories.[22]

Since Newton went much farther back than the second century A.D. of the Ptolemy epoch, to Greek Hellenistic times etc., we can rest assured that the errors are not Newton's. Only for Ptolemy does his data make a huge bulge from what it should give, like a big cosmic finger pointing down from the sky.

This man Ptolemy, then, is nobody to trust. He wanted to tell God how things were rather than have God tell him how things were. I leave it to the reader to dwell on the possibility that he was similarly twisted in his astrological vision and entertained a contempt for observation and reality, here too.

Now I am not yet through in trying to get the wart of primary directions off astrology's nose. We have another authority whom we now must put under the light of reflection. You guessed it, Placidus. It looks as though I am being hard on the letter p these days. Now, Placidus has not impeached his own character, so I cannot impeach it, unlike the case of Ptolemy. All I want to say about Placidus is that he may have been a fine fellow and a capable mathematician, but I, for one, have to question his astrological ability. His house system does not work. It is just that

simple. In my book, to say that a house system works is to say that when dynamic techniques, known to work for the rectified angles of the chart, are applied to the chart's intermediate cusps, the events produced are consistently appropriate, over a long span of investigation, to the values of those intermediate houses, and the orbs on timing are consistently similar to those displayed for the chart's angles. This is a necessary condition to make the statement that the house system works or exists. One has no other astrological method of evaluating a theory of house division than this dynamic test, for there are just too many variables in the interpretation of a chart to argue the case statically or natally in a statistical manner, over many charts.

By the above definition of working, only the following house systems work, and the Placidean system is not among them: Campanus, Alcabitius, Koch, and Meridian. This is based on a dynamic study I have made over the past several years among various charts. It appears that a consensus is building among astrologers to reject the Placidean system in favor of Campanus or Koch, mainly. This is a healthy movement for astrology.

To finish off the business of Placidus, if you question or deny the validity of his house system on empirical grounds (Lord knows we do not need any more Medeival Age a priori theorizing) then you must at least be prepared to doubt his statements regarding the primary direction system, not those pertaining to the purely formal, mathematical aspect, but those pertaining to the efficacy of the system astrologically. What I am convinced we have here is another dazzling display of the technical, esthetic ritual. In astrology we need a dialogue between fact and intuition, not chimeras. It must be realized that Placidus' coming into Ptolemy's orbit re-energized the chimera of the old sage, which has had repercussions down to our day as Victorian astrologers stepped into the miasma of the primary directions. I hope that with the widespread use of microcomputers, astrologers will soon evaluate this oblique area, and I surely expect them to come to the conclusions I have.

I have tested primary directions by these four methods: Ptolemaic one degree per year, Naibod arc, Simmonite arc, and the solar arc in right ascension, which was introduced in the early 20th century by Gornold and termed equatorial arcs by DeLuce. Using known, thoroughly rectified charts I got no results at all in taking meridian distances as well as oblique ascensions.[23] I did not even bother about planet-planet interactions when the angles did not even work! Furthermore, I have tested transits in right ascension using tested charts. Here the right ascensions of transiting planets are taken to the right ascensions of natal planets. Nothing. The equator is not an active field plane as the zodiac is in which to work longitudinally in comparable fashion to the ecliptic. A tangent observation, however, is in order at this juncture. Parallels and contraparallels in declination most decidedly do work, a dimension of astrology given due weight by Charles Jayne, among others.

I have now argued theoretically against primaries. I have shown their treacherous history, and I have empirically tested them as well as transits in right ascension to convince myself of their total inefficacy.

Students of the predictive techniques over the past fifty years roughly, have made great strides in empirically determining which techniques have merit and which ones do not. In terms of directions longitudinally, I know of nobody who wastes time with Naibod, Simmonite, or the one degree per year or other symbolic directions. The solar arc direction is widely embraced and valued more than transits or secondary progressions I would venture to say by growing numbers of astrologers. I am not sure precisely who rediscovered the solar arc technique Kepler had employed, but Charles Jayne states that about 45 years ago both E. Richard Wagner and Alfred Witte began using them.[24] In his monograph, Progressions and Directions, no publication date appears, but if we take it to be roughly 1975, then it was around 1930, the discovery date of pluto, when this eventful episode was taking place. So pluto's propensity to "open fresh chapters" (borrowing Charles Carter's phrase)[25] in developments is once more born out.

But old soldiers never die and a little before this time came a desperate, last-ditch effort to get primaries to work after more demanding researchers had rejected the Ptolemy one degree key, the Naibod key, and the Simmonite key. Thus, Sepharial (Gornold) introduced the solar arc in right ascension into the primary system[26] after having already introduced the Naibod arc.[27] The theory of the solar arc in right ascension applied to primaries was embraced by DeLuce and he called them by the name equatorial arcs, probably to distance himself from the dessicated Ptolemy primaries.[28]

Unfortunately, attempting to substitute for a key of uniform speed, such as are the one degree, Naibod, and Simmonite keys, a key of varying speed, which the solar arc key is, is to engage in an illogical and mechanistically unallowable exercise. For primaries are based on the uniform rotation of the earth, the natal places being somehow reproduced concentrically in order to do their magical revolutions against the inner natal positions. As soon as you go to the reality of a cycle on another level, namely the yearly movement of the sun, you are now doing secondary progressions. Recalling that the solar arc direction in longitude is found by subtracting the natal sun's longitude from that of the secondary progressed sun's longitude, we see that by calculating the solar arc in right ascension we are really doing secondary progressions in right ascension. So we cannot have a structure of technique which does primary directions based on solar arc in right ascension. Instead we have two forms of secondary progressions one calculated as a-day-for-a-year movement in longitude, the other as a-day-for-a-year movement in right ascension.

I hope this last point brings home to some the confused thinking that has so long prevailed in primaries. You see, primaries do not exist. The Emperor has no clothes.

O.K., off with your air purifiers, we are back to some fresh air. We just have a little problem to iron out in our structure of techniques and we are ready to investigate the true secondary and true tertiary progressions.

Let us go back to our structural diagram and retrace our ground to see what has been eliminated. On the basis of Charles Jayne's research group and other researchers, the longitudinal directions have been stripped down to just solar arc directions. Primary directions are gone. This leaves us just: secondary progressions, tertiary progressions, solar arc directions,

and transits. You will recall that the minor progressions have been subsumed under the day for the month tertiaries for the time being. So now rearranging the order of the techniques and rewriting the table without the Great Circle heading, because it has been shown that the equator is inactive in terms of right ascensional values, we have this:

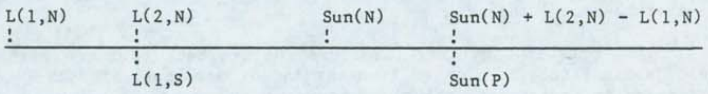
TABLE TWO

TECHNIQUE	MECHANISM
Secondary Progressions	Analogy between two real astronomical cycles (sympathetic vibration as tuning forks in music).
Solar Arc Directions	?
Tertiary Progressions	Analogy between two real astronomical cycles (sympathetic vibration as tuning forks in music).
Transits	Real astronomical time (sympathetic vibration as tuning forks in music).

Now where does the solar arc direction technique fit in? And what is its mechanism? We have grown a little afraid of the word direction given its past track record, but keep the faith because after a bit more mopping up after this restructuring of our body of predictive techniques, we can rename solar arc directions to just solar arcs or even something better, perhaps.

Since the solar arc method of directions is based on taking the secondary progressed sun and subtracting from it the natal sun, it can easily be shown that solar arcs are in reality a harmonic subset of secondary progressions. Let us now see how this is.

If we denote solar arc by S, progressed by P, natal by N, and any zodiacal longitude such as a cusp, fixed star, or any asteroid or planet except the sun by L(I,J), I = 1, 2, 3 . . . and J = S, P, or N, then we can write this diagram illustrating a solar arc at culmination where L(1,N) has come to conjunction with L(2,N) or, longitudinally, L(1,S) = L(2,N):



The solar arc, SA, is defined as, SA = Sun(P) - Sun(N) = L(1,S) - L(1,N), but this is just L(2,N) - L(1,N), so equating and rearranging, we write Sun(P) =Sun(N) + L(2,N) - L(1,N), which states that the progressed sun has arrived at the senstive point [Sun(N) + L(2,N) - L(1,N)], which is a statement of the dynamic, astrological reality of what a solar arc direction really is, namely, the arrival of the secondary progressed sun at the

sensitive point involving the natal sun and two other points, A and B: Sun(N) + A - B. This is interpreted, in practice, with the solar arc direction technique as "B solar arcing to A."

Now since Sun(P) - Sun(N) = L(2,N) - L(1,N) represents the equating of two differences, it should be understood that a difference is intimately related to a harmonic number, HN by:

EQ. 1 $$HN = \frac{360}{ABS[L(2,N) - L(1,N)]}$$

where ABS is the absolute value function. In the terminology of physics, if two differences (wavelengths) are the same they are said to be in sympathetic vibration or in sympathy. Here,

EQ. 2 $$\frac{360}{ABS[Sun(P) - Sun(N)]} = \frac{360}{ABS[L(2,N) - L(1,N)]}$$

expresses such sympathy. Additionally in physics, a frequency, f, is reciprocally related to a wavelength, w, by:

EQ. 3 $$f = \frac{1}{w}.$$

So we should consider calling the difference in arc between any two planets or points, the denominator in EQ. 1 above, by the name wavelength. Thus the pair L(2,N), L(1,N) has a wavelength of L(2,N) - L(1,N). Mercury at one Aries and uranus at 73 degrees (13 degrees Gemini) have a wavelength of 72. To then talk about the frequency for a given pair, we would write the following in place of EQ. 3:

EQ. 4 $$f = \frac{360}{w}$$

where w is the wavelength or angular separation as described.

So returning to Table Two, we see that we can clear up another appendage and bit of confusion. Solar arc directions are just the same as secondary progressions: in solar arcs we are just limiting our attention to one aspect or part of the whole set of secondary positions or the whole secondary progressed chart itself, complete with house cusps. When one employs solar arcs, one is employing the theory of sensitive points as fleshed out by the brilliant Witte and others of his time. I hope this observation gives pause to the orthodox bulk of astrologers who place little or no weight on midpoints, are ignorant of sensitive points (of which Arabian parts are just a small subset), and who shun the analogue computer known as the 90-degree dial. For the technique of solar arcs, which is universally applauded now, is just one neat tool issuing from the vision of chart structure residing in the theory of midpoints and sensitive points.

It needs to be emphasized now clearly, that there is no mechanism of solar arc directions in terms of an astronomical machinery. The only machinery aside from transits is the machinery of progressions, whereby an analogy between two separate natural, astronomical cycles exists.

Starting from the secondary progressed planets' positions, one can calculate lunar arcs as well as solar arcs, mercurial arcs as well as lunar arcs, venusian arcs as well as mercurial arcs, etc. The principles of midpoints and sensitive points is universal and impartial. It does not work for some planets and not for others. Recall that to say mercury solar arc = venus natal is really to say that sun secondary progressed = sun natal + venus natal - mercury natal. Now just put the sun some place else in the chart and put natal mars where natal sun was. Now if progressed mars minus natal mars is the martial arc (and this can have a negative value, provided mars was retrograde), then we have mercury martial arc = venus natal being expressed in the real process, secondary progressed mars = mars natal + venus natal - mercury natal. Now replace mars by Ascendant. The Ascendant arc would be progressed Ascendant minus natal Ascendant, and the progressed Ascendant, we know, is a function of the Midheaven progressed by solar arc, the geographic (not geocentric!) latitude, and the true obliquity of the ecliptic. Now we have the Ascendant arc directions which Charles Jayne et al swear up and down are vital to predictive work.[29]

Now if you are beginning to get the picture that the structure of technique is rapidly expanding, hold on a minute, because I am not finished. Please realize now that the same generalizations as to planetary arcs in the secondary progressions apply in the tertiary progressions, as well! Our body of techniques grows all right, but now in the right places and so we can hope to interpret them in more logical, meaningful, specific, and interconnected ways. For example, by going to secondary progressions as opposed to tertiary progressions, we can see right off that it is most likely correct that secondary progressions, based as they are on cycles of the year (solar), will have an application to areas symbolized by the sun in general, while for tertiaries, the symbolism is related to the moon. Furthermore the jupiterian arcs, being progressed jupiter minus natal jupiter in both domains of secondaries and tertiaries, will have a flavor or level of interpretation bearing on the symbolism of jupiter, etc.

Because it is probably true that secondary progressions have a general meaning related to the sun and tertiary progressions have a general meaning related to the moon, we ought to now give serious consideration to calling secondary progressions by the name solar progressions, and tertiary progressions by the name lunar progressions. And as if that were not reason enough, now that we no longer have primary directions to kick around anymore, do our poor secondaries still have to be kept out of the sun by being relegated to second class citizenship?[30]

I now list Table Three as an object to contemplate in preparation for the theoretical developments to follow regarding true secondary and true tertiary progressions. We can go on to them and we can now appreciate that only progressions and transits exist as dynamic or predictive techniques. There is no such thing as the technique of solar arc directions as an astronomically separate mechanism:

TABLE THREE

TECHNIQUE	MECHANISM
Secondary Progressions	Analogy between two real astronomical cycles (sympathetic vibration as tuning forks in music).
Tertiary Progressions	"
Transits	Real astronomical time (sympathetic vibration as tuning forks in music).

I want to now center our thought on precisely what the physical nature of these cycles are: the day, the month, and the year. We will be uncovering two fundamental flaws in the very way that secondary and tertiary progressions have been viewed or conceived. The premise or concept of equating a day with a year or a month is obviously sound, but the physical interpretation or implementation has not been correct. By adhering literally and rigorously to the concept of equating a day with the revolutional period of an orbiting body, I have formulated a new theory of progressions which applies to both secondaries and tertiaries.

The new secondary progressions have been exhaustively tested in several accurately rectified charts where transits were employed as well as the progressions and solar arcs. As to the tertiary progressions, my experience and that of others tell us that they work, all right, but I personally have not tested them to date as completely as I have the secondaries. My experience with them has not been explicitly concerned with timing accuracy, until just recently. In the past, I have found them very helpful in supplying more information for predictive work and more confirmation of a rectification since outer planets are made to move rapidly and often are brought to powerful aspects to the angles of a chart. Recent insights and computations are sufficient to tell my intuitive side that they are indeed as accurate and precise as secondaries. But some theoretical problems still remain as to how to progress the MC, for example. I will now begin the discussion of secondaries and will return to tertiaries later.

These new secondary progressions have been tested for five years and consistently give very small errors in timing. For example, solar arcs based on the secondary progressed sun are consistently accurate to 10" of arc (one day) or better,[31] while the progressed moon times events to the fraction of a day, if not to the nearest few hours. By way of comparison, the errors using the customary techniques of secondary progressions amount at times to 2' of arc for the sun or solar arc (12 days) and 26' of arc for the moon (12 days). It is very gratifying to have observed that transit timing employing ephemerides to 0.1' (6") accuracy corroborates the timing from these new secondary progressions and from the solar arc directions based on them. Truly, there is now a unity of technique between secondary progressions and transits. The combination is extremely valuable, in fact a necessity, for exacting, reliable work in rectification and prediction.

While the validity of this new theory of secondary progressions is based on a wealth of observations, I have chosen not to cite any examples here. I appreciate that astrologers like to test out new ideas on their own charts which they know best and have rectified the most accurately. A quick and most revealing study would simply be the comparison between the customary technique and the new technique of culminating progressed moon aspects to natal planets, but especially to progressed planets, which I have found to be stronger. Having satisfied oneself of the higher accuracy of the new technique in progressed moon timing, one can proceed to investigate any systematic errors in timing employing the new technique. Any error between the theoretical timing of these new progressions and the observed timing (the symbolic event or feeling) will be systematic, i.e., in the same direction and of substantially the same magnitude (the actual magnitude is a function of the speed of the progressed moon and the progressed planet). This error in timing would be due to an error in the birth time or in the rectified time. Having rectified the time, one could then proceed to study the progressions and solar arcs involving the angles. In this way one checks for internal consistency and further refines the rectification.

We should call these new progressions true progressions while naming the customary progressions mean progressions for the purpose of differentiation in future evaluation and discussion. One might equally well choose the word apparent in place of the word true, but true is more concise and connotes more the idea of exactness in terms of predictive accuracy, which I want to convey. Having created the distinction between the mechanisms of true or apparent progressions and the mechanism of mean progressions, I must hasten to state that only one of these is correct in the sense of existing as an astrologically efficacious mechanism. That mechanism is the mechanism of true progressions. The mean progressions (the customary secondary or day-for-a-year progressions) represent a flawed perception and therefore an incorrect calculational approach to the whole idea of what progressions are all about. Please rest assured that by mean progressions I do not indicate the Naibod arc of 59'08" movement per year regardless of the birth date. The word mean in mean secondary progressions refers to the employing of the calendar, which involves mean motion, to determine the fraction of a year beyond a birthday as will be discussed in a moment.

The reason underlying the choice of the terms true and mean will be explained at length in a moment. For the time being it should be noted that the sense of the words true and mean are taken from astronomy. I feel it is proper and desirable for astrology to adopt a terminology in its physical and mathematical concepts, whenever possible, which parallels existing terminologies in astronomy and physics. The last thing we want to do is to add to the top-heaviness of the terminological Tower of Babel.

Mean in astronomical parlance usually means either (1) the smoothed base line tendency of motion which does not include the various correction terms, perturbations, or oscillations above and below this base line or (2) the average value taken as uniform: as the mean speed of the earth is 59'08" arc per day while the true speed ranges from 57' arc per day to 61' arc per day. In both senses of the word mean, the idea back of mean is that of a first-step approximation towards some calculational end or a value of only intermediate worth or accuracy before correction terms are applied.

The second sense listed above also includes the idea of a group attribute or the idea of summation or integration of individual elements.

Having stated the equivalence between the words apparent and true in our context here of apparent progressions or true progressions, I want to point out that the word apparent should be thought of as connoting perceived or detected by the senses. Thus an apparent position of a planet[32] or the apparent Midheaven degree[33] is the position noted by the senses of the astronomer using his eyes via instruments or by the senses of the astrologer when doing astrology. Just so, the apparent (true) progressions give those positions, and they differ from the mean progressions' positions, where appropriate events occur (are detected by various senses) symbolized by the planets, cusps, or any astrologically efficacious point involved when alignments are exact measured by those positions.

To sum up the distinction in meaning between true or apparent versus mean we see that the true or apparent position is the actual, perceived, detected, effective position while the mean position is an intermediate value or a value based on a group property (an average). As the mean position expresses the property of a group (neptune) it has no real individual existence (uranus). As an illustration, the earth is only travelling at its mean speed of 59'08" per day at two instantaneous points or times in its elliptical orbit.

To apply this idea to the astrological practice of progressions, if mean progressions are employed instead of true progressions, one will sometimes get events happening too late, sometimes too early. While on average one will get events happening on time, one will only rarely get an individual event exactly on time. But with true progressions, one will always get an individual event exactly on time.

One last point is in order before the detailing of the theory of true progressions. From now on I will use the term mean time, mean day etc. to indicate either universal time (UT) or ephemeris time (ET) since the distinction between the two is unimportant for our purposes for the time being. Both UT and ET, it should be realized, were conceived of as being uniform measures of the time at the time of their adoption. UT was based on the rotation of the earth on its axis relative to Aries, while ET was based on the revolution of the moon or earth relative to Aries. UT is the same as GMT or civil time for our purposes here.

The customary practice of computing secondary progressions corresponding to a given date is based on calculating the number of days which have elapsed since the previous birthday and dividing by 365[34] to get the fraction of a year. This fraction is then added to the integer number of years of age and the result equated with days forward in the ephemeris.

We have been doing two things wrong in our customary practice of calculating progressions for a given date:

1) We have been measuring the elapsed portion of the year since the previous birthday with reference to the calendar, when we should have been measuring the elapsed portion of the year since the

previous solar return with reference to the geocentric ecliptical longitude of the sun.[35]

2) We have been using the equation: one mean day = one year when we should have been using the equation: one apparent day = one year.

The fault with 1) lies in the implicit assumption that the sun's apparent speed of revolution about the earth is uniform, which it is not. It ranges from 57'13" per day at aphelion to 61'10" per day at perihelion. Consider Diagram 1, which shows the perihelion-aphelion axis of the sun about the earth, which is 12 degrees Capricorn-Cancer. Note the lables indicating the time of passage from one leg of the axes to another. The perihelion-aphelion axis is an axis of symmetry so that the number of days required for the sun at aphelion to arrive at perihelion is equal to the number of days for the sun at perihelion to arrive at aphelion. This number of days is one half the period of revolution (365.24/2 days = 182.62 days). But if we consider the 12 degrees Aries-Libra axis, or any but the 12 Cancer-Capricorn axis, the above relationship does not hold. To go from 12 degrees Libra to 12 degrees Aries requires 178 days while the other way around requires 187.24 days.

If we have a Libran entity of 12 degrees natal sun and we want to find the position of the progressed sun when the entity is half a year old, we must ask ourselves "Do we mean half a calendar year old or half a zodiacal year old?" When the entity is exactly half a zodiacal year old (transiting sun at 12 Aries, opposed the natal sun), the entity is only 178/365.24 or 0.4874 calendar years old.

Let us now do the calculations side by side for both techniques. After counting the number of birthdays (solar returns) the entity has had, the problem remaining is to determine the fraction of the year which has elapsed since the preceeding birthday (solar return). Then according to the theory of progressions, one equates the age in years with days forward in the ephemeris to arrive at the progressed date. If we call FCAL the fraction of the year measured in the calendar and FZOD the fraction of the year measured in the zodiac, we can write these verbal definitions:

Def. 1. FCAL: We have an actual (event) date for which we want to calculate the corresponding progressed date. Find how many days the actual (event) date is from the previous birthday. Divide this number of days by 365.24 days to get FCAL.

Def. 2. FZOD: We have an actual (event) date for which we want to calculate the corresponding progressed date. Take the transiting sun (0-360 mode) for the actual (event) date and subtract the natal sun (0-360 mode). Add 360 if negative. Divide by 360 to get FZOD.

For purposes of implementation later I now rewrite Def. 2 as an equation. I define the function CIR(X):

EQ. 5 CIR(X) = X IF X IS 0 OR GREATER

X + 360 IF X IS LESS THAN 0

Now denoting transiting by TR, natal by N, FZOD is given by:

EQ. 6 FZOD = CIR(SUN(TR) - SUN(N))/360

where SUN(TR) and SUN(N) are already modulus 360.

Here is an actual example calculation side by side, taking a 12 degree Libran entity (OCTOBER 5 of year YYYY progressed to APRIL 1 of the following year, YYYY + 1):

FCAL = [(APRIL 1, YYYY + 1) - (OCTOBER 5, YYYY)]/365.24
FCAL = 178/365.24
FCAL = 0.48735

FZOD = (12 - 192 + 360)/360
FZOD = 0.50000

The new method of measuring in the zodiac instead of in the calendar is more satisfyig theoretically. The apparent reality of motion of the sun about the earth is the mirror image of the kinematical, astronomical reality of the elliptical revolution of the earth about the sun at varying speeds. As opposed to this natural astronomical reality, the calendar, which assumes uniformity in speed, is a mere fiction.[36] It is a man-made convention for convenience. The mean solar day or civil time with its calendar is based on making each day the same duration when in fact the apparent length of the day varies sinusoidally over the year because the speed of the earth revolving around the sun varies sinusoidally[37] while the rotation of the earth about its poles is relatively uniform.

This last point brings us to the second fault cited above, namely that we have been using the equation of one mean day = one year instead of one apparent day = one year. Our modern ephemerides give positions for the sun for zero hours or twelve hours of mean time. But we should have at our disposal for doing progressions and calculating solar arcs, an ephemeris giving positions for zero hours or twelve hours apparent time.

The length of the apparent day is not constant. In other words, each successive apparent day has a duration measured in uniform or mean time either greater or less than the preceeding apparent day's duration. Since we want to equate a year of life with an apparent day, conceptually what we are doing is making this equation, and then determining how many mean days correspond to this many apparent days. Then we are employing our ephemerides or our computers based on mean time.

When it is noon apparent time at Greenwich, by definition, the sun is exactly in conjuncton with the Midheaven i.e. the sun is due south. But only rarely when it is noon mean time at Greenwich is the sun in conjunction with the Midheaven. At noon mean time at Greenwich the sun can be some four degrees either side of the Midheaven.

The equation which gives the difference between apparent time and mean time is called the Equation of Time. The graph of the negative of the Equation of Time, NEQT, versus the geocentric ecliptic longitude of the sun is presented in Diagram 2 and the tabular version of this function is

presented in Diagram 3A,B. Reference will be made to them later, but for the moment, inspection of Diagram 2 shows the sinusoidal pattern whose cause was described four paragraphs earlier. NEQT can loosely be thought of as the sun's longitude minus the Midheaven's longitude. Therefore when NEQT is positive, the sun in a horoscope is in the tenth house for an entity born at noon civil time exactly on the defining longitude of his particular time zone, say 75 degrees west for zone -5, 60 degrees west for zone -4, etc. When NEQT is negative, the sun is in the ninth house when an entity is born at noon civil time exactly on the defining longitude for the time zone. While the vertical scale is measured in days, I would point out that the 12 degree Scorpio point, the curve's minimum, corresponds to some minus 16 minutes of time or minus 4 degrees of SUN-MC arc while the 21 degree Aquarius point, the curve's maximum, corresponds to some plus 16 minutes of time or plus 4 degrees of SUN-MC arc.[38]

If we inspect our expression, a day-for-a-year, and interpret it literally and in the apparent, astonomical sense, we see that either of two ideas is intended:

(1) to set up a physical analogy between the naturally occurring phenomenon of a daily sunrise and the naturally occurring phenomenon of the yearly spring equinox or

(2) to set up a physical analogy betwen the naturally occurring phenomenon of daily high noon and the naturally occurring phenomenon of the yearly summer solstice.

Both ideas point to a relationship between one natural, phenomenological, apparent, or physical astonomical cycle and another: between the day and the year. But in the case of equating the civil day with a year. We have made no direct relationship or analogy in a natural, phenomenological, apparent or physical sense.

The days referred to in ideas (1) and (2) above consist of the synodical cycles between one of the angles of a chart, the Ascendant and the Midheaven, and the sun. The problem now before us is to choose between idea (1) and idea (2), since (1) or the Ascendant day is not of the same duration as (2) or the Midheaven day. This point was made to me by Rob Hand around 1975 and was something I had missed: I had not considered that an apparent day could be referred to the Ascendant.

I will now refer to these two days formally as the Ascendant-phased apparent day, abbreviated APAD, and the Midheaven-phased apparent day, abbreviated MPAD. The APAD is the interval in time between one sun-Ascendant phase and the next. The MPAD is the interval in time between one sun-Midheaven phase and the next. Diagrams 4 and 5 show how these days are defined and their interrelationships.

In the example of Diagram 5, one notes the difference in solar arc computed by both methods is 4 seconds of arc. Obviously, according to the rate of change of the Ascendant relative to the Midheaven, the APAD will be longer or shorter than the MPAD. Anyway, this 4 arc second difference we can take as a nominal difference in solar arc issuing from the two different

definitions of the day. This is a serious difference because each day will add roughly the same amount of difference and so the difference in solar arc will accumulate each day (year of progression) giving a sizeable difference in the timing of events throughout a life.

Now, let us get back to our problem. Which do we use for our definition of the apparent day? Well, that is where this article rather ends. The MPAD is the basis for all my thorough testing to date over an eight year period and is the apparent day used in the new theory of true secondary and tertiary progressions. I have not yet tested the APAD, but I have a sneaking suspicion that the APAD will not pass the test of events when I do test it.[39]

Now let us take up the formula for the Equation of Time. It is given on page 103 of the Explanatory Supplement:

EQ. 7 EQTIME(HRS) = MOD 24 HRS [12 HOURS + APPARENT SIDEREAL TIME (HRS)] - APPARENT RIGHT ASCENSION OF THE SUN (HRS)

For our purposes later we will want the equation of time expressed in units of days, so we set:

EQ. 8 EQTIME = EQTIME(HRS)/24

Apparent sidereal time is sidereal time to which the nutation in obliquity has been added. The apparent right ascension of the sun is calculated by adding abberation and nutation in longitude to the ecliptic longitude of the sun for the mean equinox of date. Then using the true obliquity of the ecliptic one calculates right ascension from longitude using the right spherical triangle having obliquity of the ecliptic as its smallest angle:

RA = ARCTAN [TAN(LONG) * COS(OBLIQ)]

Here is the procedure, conceptually, for getting the true progressed date based on counting an apparent day and not a mean day for each year of life.

1. CALCULATE: AGE = INTEGER NUMBER OF YEARS OLD + FZOD

2. EQUATE AGE WITH APPARENT DAYS FORWARD IN THE EPHEMERIS.

3. CONVERT THIS NUMBER OF APPARENT DAYS TO MEAN DAYS. (ONE NEEDS A VALUE EXPRESSED IN MEAN TIME IN ORDER TO GO INTO THE PLANETARY ROUTINE OR THE EPHEMERIS).

The third step of the procedure involves obtaining an interval of mean days from an interval of apparent days. To do this we first write the relation,

MT = AT - EQTIME

where,

MT = MEAN TIME EXPRESSED IN DAYS FROM SOME EPOCH
AT = APPARENT TIME EXPRESSED IN DAYS FROM SOME EPOCH
EQTIME = EQUATION OF TIME EXPRESSED IN DAYS

Now let P stand for progressed, N for natal. We write,

$$MT(P) - MT(N) = [AT(P) - EQTIME(P)] - [AT(N) - EQTIME(N)]$$

Rearranging,

$$MT(P) - MT(N) = AT(P) - AT(N) - EQTIME(P) + EQTIME(N)$$

Putting NEQTIME as the negative of EQTIME,

$$NEQTIME = -EQTIME$$

we have,

$$MT(P) - MT(N) = AT(P) - AT(N) + NEQTIME(P) - NEQTIME(N)$$

Now since AT(P) - AT(N) is nothing other than AGE,

$$MT(P) - MT(N) = AGE + NEQTIME(P) - NEQTIME(N)$$

or,

$$MT(P) = MT(N) + AGE + NEQTIME(P) - NEQTIME(N)$$

Now call MT by the name Julian Day, JD,

EQ. 9 $$JD(P) = JD(N) + AGE + NEQTIME(P) - NEQTIME(N)$$

or call MT by the name calendar day, CD,

EQ. 10 $$CD(P) = CD(N) + AGE + NEQTIME(P) - NEQTIME(N).$$

EQ. 9 above is for computer coding, EQ. 10 is for work with the printed ephemeris.

EQ. 9 giving the progressed Julian Day number, JD(P), is exactly solved by iteration since NEQTIME(P) is a function of JD(P). But it turns out that only one iteration is necessary to get accuracy to 0.01 seconds of solar arc or 0.13 seconds of arc on the moon. Here is the algorithm in a verbal sense:

SECONDARY PROGRESSION ALGORITHM FOR COMPUTER

A. ADD THIS TO THE NATAL CHART ROUTINE:

1. CALCULATE JD(N) AND STORE.

2. GET NEQTIME(N) AND STORE.

A. SET T = (JD(N) - 2415020)/36525

B. WITH THIS T, GO INTO EQTIME EQUATION. CHANGE SIGN.

C. RESULT IS NEQTIME(N)

B. TRUE SECONDARY PROGRESSION ROUTINE:

1. CALCULATE TRANSITING SUN (APPARENT, TRUE EQUINOX OF DATE) FOR EVENT DATE/TIME USING A LOGICAL FLAG SO AS NOT TO CALL SOLAR PERTURBATIONS, SINCE THE SUN'S LONGITUDE WITHOUT PERTURBATIONS IS ACCURATE TO 18" ARC WHICH IS ACCURATE ENOUGH FOR OUR PURPOSES HERE.

2. CALCULATE AGE = INTEGER NUMBER OF YEARS OLD + FZOD

THIS STEP CAN BE A BIT TRICKY IN GETTING THE INTEGER NUMBER CORRECTLY. IT IS POSSIBLE TO GET THE INTEGER OFF BY EXACTLY PLUS ONE OR MINUS ONE IF WE ARE NOT CAREFUL HERE. THE PROBLEM COMES ABOUT IN THE EVENT OF A VERY OLD OR VERY NEW CYCLE, I.E. WHEN THE TRANSITING SUN HAS NOT QUITE CONTACTED THE NATAL SUN, OR HAS JUST CONTACTED IT. THIS IS BECAUSE THE INTEGER PART COMES ABOUT BY CALCULATING IN THE MEAN EQUINOX WHILE THE FRACTIONAL PART COMES ABOUT BY CALCULATING IN THE TRUE EQUINOX, WITH NUTATION ADDED. ALSO TO LEAVE A MARGIN OF SAFETY FOR ACCUMULATED ERRORS IN THE PERIOD OF REVOLUTION, THE FOLLOWING ROUTINE NEEDS TO BE IMPLEMENTED, AND THIS IS ESPECIALLY SO FOR USING THE FOLLOWING ROUTINE FOR TERTIARY PROGRESSIONS WHICH WE WILL COME TO LATER.

HERE IS A GLOSSARY OF TERMS AND VARIABLES USED:

EV = EVENT
TR = TRANSITING
N = NATAL
AGE = NUMBER OF RETURNS OF THE BODY TO ITS NATAL PLACE PLUS THE FRACTIONAL PART
AGEINT = NUMBER OF RETURNS OF THE BODY TO ITS NATAL PLACE
GT = GREATER THAN
LT = LESS THAN
EQ = EQUALS
FZOD = FRACTION OF A CYCLE MEASURED IN THE ZODIAC
FMEAN = FRACTION OF A CYCLE MEASURED AS IF ECCENTRICITY = 0
SUN(TR) = TRANSITING SUN IN DECIMAL 0-360 FORM
SUN(N) = NATAL SUN IN DECIMAL 0-360 FORM

THE ROUTINE:

DEFINE FUNCTION CIR(X) = X IF X GT 0
= X + 360 IF X LT 0

IN TERMS OF ERLEWINE'S BASIC ROUTINE, THIS WOULD BE EQUIVALENT TO EMPLOYING THE MODULUS FUNCTION FNU(X) BY SETTING MO = 360 AND THEN USING FNU(X+360)

AGE = (JD(EV) - JD(N))/365.24219878 MEAN AGE
AGEINT = INT(AGE)
FMEAN = AGE - AGEINT

```
FZOD = CIR(SUN(TR) - SUN(N))/360.0
IF (FMEAN.GT.0.75.AND.FZOD.LT.0.25) AGEINT = AGEINT + 1.0
IF (FMEAN.LT.0.25.AND.FZOD.GT.0.75) AGEINT = AGEINT - 1.0
AGE = AGEINT + FZOD
```

3. GET NEQTIME(P).

   A. SET: JD(P)RAW = JD(N) + AGE

   B. NEQTIME(P) IS FOUND BY SETTING:

      T = (JD(P)RAW - 2415020)/36525 AND GOING INTO EQTIME EQUATION WITH THIS VALUE OF T AND THEN CHANGING SIGN.

4. JD(P) IS FOUND BY:

   JD(P) = JD(P)RAW + NEQTIME(P) - NEQTIME(N)

5. FINALLY,

   T = (JD(P) - 2415020)/36525

   GIVES THE VALUE OF T IN JULIAN CENTURIES AS ARGUMENT TO GO INTO THE PLANETARY ROUTINE TO GIVE BACK THE TRUE PROGRESSED POSITIONS. RESET LOGICAL FLAG SO YOU DO ALL PERTURBATIONS ON THE SUN. WE WANT THE PROGRESSED SUN TO BE GOOD TO 1" ARC.

Now to count off our days is easy enough if we use Julian Days of continuous numbering, which we do in a computer program, but in the event that some readers do not own a computer, or in the event that your computer is down and you desperately need to pull your dusty ephemerides off the shelves to calculate some true progressions, I now give a method of counting that obviates errors and is quicker than counting lines in the ephemeris.

CREATE MAP #1, MAPPING MONTH AND DAY INTO A NUMBER FROM ONE TO 365. CREATE MAP #2 IN THE EVENT THE YEAR IS A LEAP YEAR:

MAP	#1	#2	MAP	#1	#2
JAN	0	0	JUL	181	182
FEB	31	31	AUG	212	213
MAR	59	60	SEP	243	244
APR	90	91	OCT	273	274
MAY	120	121	NOV	304	305
JUN	151	152	DEC	334	335

YOU ADD THE VALUE FOR THE MONTH TO THE DAY OF THE MONTH OF YOUR EPHEMERIS (GREENWICH) BIRTHDATE TO ARRIVE AT THE NATAL CALENDAR DAY, CD(N). FOR EXAMPLE, AN ENTITY BORN FEBRUARY 3 AT 12 HOURS ET WOULD ADD 3.5 TO 31 TO GET A CD(N) OF 34.5. AN ENTITY BORN SEPTEMBER 23 at 18 HOURS ET WOULD ADD 23.75 TO 243 TO GET A CD(N) OF 266.75.

NOW ALL ONE NEED DO TO GET A PROGRESSED CALENDAR DAY, CD(P), IS ADD THE AGE TO THE CD(N). THEN THE CALENDAR DATE CORRESPONDING TO THIS CD(P) IS

GOTTEN BY SUBSTRACTING THE HIGHEST MONTH VALUE FROM THE CD(P) WITHOUT GETTING A NEGATIVE NUMBER. TAKING 34.5 AS THE CD(N) AN ENTITY OF AGE 37.05 WOULD HAVE A CD(P) OF 71.55. SUBTRACTING 59 IF A NON-LEAP YEAR (60 IF A LEAP YEAR) GIVES MARCH 12.55 (11.55) AS THE PROGRESSED DATE IN WHICH TO INTERPOLATE IN THE EPHEMERIS.

CONTINUING NOW IN ANALOGUE FASHION TO THE VERBAL ALGORITHM FOR COMPUTERS, HERE ARE THE STEPS EMPLOYING A HARD COPY EPHEMERIS OF THE SUN TOGETHER WITH A TABLE OF NEQTIME VERSUS GEOCENTRIC ECLIPTIC LONGITUDE OF THE SUN (DIAGRAM 3A,B):

SECONDARY PROGRESSION ALGORITHM BY HAND

A. RECORD THESE AS NATAL CHART VITAL STATISTICS:

   1. RECORD CD(N).

   2. EXTRACT NEQTIME(N) FROM DIAGRAM 3A,B AND RECORD.

B. TRUE PROGRESSION ROUTINE:

   1. DETERMINE TRANSITING SUN FOR THE EVENT IN QUESTION.

   2. CALCULATE AGE = INTEGER NUMBER OF YEARS OLD + FZOD (SEE Def. 2)

   3. ADD AGE TO CD(N) TO GET CD(P)RAW. CONVERT CD(P)RAW TO THE CORRESPONDING CALENDAR DATE. INTERPOLATE IN THE EPHEMERIS TO GET THE RAW PROGRESSED SUN POSITION. ENTER DIAGRAM 3A,B TO OBTAIN NEQTIME(P) USING THIS RAW PROGRESSED SUN POSITION.

   4. GET CD(P) BY:

      CD(P) = CD(P)RAW + NEQTIME(P) - NEQTIME(N)

   5. BE SURE TO EMPLOY A SECOND DIFFERENCE ROUTINE OR BETTER IN INTERPOLATIONS OF THE MOON BECAUSE NOW IT IS WORTH YOUR WHILE. DO THE SAME IF USING AN EPHEMERIS WITH TENTH OF A MINUTE OF ARC TABULATED ACCURACY WHEN INTERPOLATING THE INNER PLANETS.

My employing the customary practices of tertiary progressions (both synodic and tropical[40]) one gets an error of 0.057 days in the progressed date, as a worst case, giving these errors in progressed positions:

Moon	44 minutes of arc
Sun	3.4 minutes of arc
Mercury	6.8 minutes of arc
Venus	4.1 minutes of arc
Mars	2.4 minutes of arc, etc.

The nominal error would be half of these. Note that due to the greater eccentricity of the moon's orbit over that of the earth's, the FZOD factor is larger for tertiaries than for secondaries. Also note that while the actual errors in longitude are much greater than for secondaries (recall that the worst to expect on the secondary sun by the the old technique is

two minutes of arc), the error in corresponding real time would be less than for secondaries. The 12-day worst-case error for the secondary sun compares with some 1.5-day error for the tertiary moon.

Now we can go over the verbal algorithm for the tropical tertiaries. Let us refer back to the algorithm for secondaries, which was outlined as A.(1.,2.) and B.(1.-5.). We need not make many changes:

TERTIARY PROGRESSION ALGORITHM FOR COMPUTER

A. SAME AS FOR SECONDARY

B. 1. CALCULATE TRANSITING MOON (APPARENT, TRUE EQUINOX OF DATE).

2. CALCULATE AGE = INTEGER NUMBER OF YEARS OLD + FZOD

AGE = (JD(EV) - JD(N))/27.321582
FZOD = POS360 (MOON(TR) - MOON(N))/360.0

3. SAME

4. SAME

5. SAME

TERTIARY PROGRESSION ALGORITHM BY HAND

A. SAME AS FOR SECONDARY

B. 1. GET TRANSITING MOON FOR EVENT DATE

2. CALCULATE AGE = INTEGER NUMBER OF YEARS OLD + FZOD

FZOD = (MOON(TR) - MOON(N))/360

IF FZOD IS NEGATIVE, ADD 1

3. SAME

4. SAME

5. SAME

Now when we want to do the equally valuable synodical tertiaries, we must have a transiting sun as well as a transiting moon. The period for the synodical month is 29.530589 days and we substitute that for 27.321582 days in (B.2.) of the algorithm for computer. Next we need to generalize our expression for FZOD. The numerator now will contain four variables: MOON(TR), MOON(N), SUN(TR), and SUN(N): The expression is:

EQ. 11 FZOD = CIR((MOON(TR) - SUN(TR)) - (MOON(N) - SUN(N)))/360.

This expression can be used for tropical tertiaries as well. Before using it one sets SUN(TR) and SUN(N) to zero. Then by indexing the routine both

types can be done. At step B.2. AGE must also be rewritten:

AGE = (JD(EV) - JD(N))/P(I)

where,

P(1) = 27.321582 and P(2) = 29.530589, in a dimension statement.

I have found the discipline required to write astrological coding a great exercise in clarifying my thinking about astrological matters. The generality needed in coding, and the strange psychological detachment one needs to slip into the world of computers, cannot but help to bring insights into our body of knowledge. As an example, a month ago as I was doing the coding for tertiaries both tropical and synodical, I was struck by the symmetry of EQ. 11 above. Then it dawned on me that SUN(TR) and SUN(N) could be replaced by URANUS(TR) and URANUS(N), etc. We all know that our solar system is filled with these synodical cycles from all possible pairings of planets, especially if we have read a little Rudhyar.

A little later it dawned on me that SUN(TR) and SUN(N) could be replaced by ARIES. This then gave the tropical tertiary. All is synodical! If we go to the Hamburg School's understanding of ARIES, the world, general events in the open, we start to flesh out our structure of progressions, whether secondary or tertiary: the secondary progressions are actually SUN,ARIES progressions and the tropical tertiary progressions are actually MOON,ARIES progressions.

If this is correct then we ought to find tropical tertiaries pointing to events of a general, impersonal nature involving other people, while synodical tertiaries (MOON,SUN) should point more to a level of dialogue between our inner and outer selves, acting on our emotions, rather than a more heightened emotional responsiveness in the tropical tertiary.

It seems where this leads us is towards more specialization as to application. Everything in the MOON,URANUS progression ought to be interpreted with uranus in mind. Therefore, uranus aspects in the mutual progressed chart and uranus aspects between the progressed chart and the natal chart ought to be given especially high consideration. If other uranian factors, such as transits, had pointed to a good or difficult time, we may want to look to the MOON,URANUS and SUN,URANUS progressions to find amplification or amelioration to enhance our judgment.

In the couple of weeks of brief empirical testing, I can say that I do think these synodical progressions, both solar and lunar, are working. Yet I am very subjective about them at the moment, naturally, so I need to distance myself from them for a while. I would greatly welcome any feedback from other investigators about them.

Another question has probably occurred to many of you by now, and that is, do these synodical progressions always have to include either the sun or the moon? How about the mars,jupiter synodical cycle being equated with an apparent day (M,SUN)? And my putting M,SUN in parentheses was obviously to beg the question of whether one can employ a day based on a planet other than the sun. Would tertiaries work if based on M,MOON = MOON,X rather than

on M,SUN = MOON,X? Or should the question have been asked, would not this be preferable to M,SUN = MOON,X? In solar progressions we have M,SUN = SUN,X where SUN appears in both cycles being equated. Does this make the progression stronger than without this doubled influence?

Clearly there are a lot of questions to be answered. I hope to have interested some of you in taking on some of this research and publishing your findings.

Let me now sum up the ground we have covered. I have argued the weaknesses of the primary system's theory, the sloppy, large orbs employed thus allowing its practitioners to cover their tracks, so to speak, and I posited the possibility of some bizarre, narcotic effect which the authority of Ptolemy and Placidus may have had on the logical faculties of various astrologers. I may be completely wrong here. Perhaps I am just not attuned to the level on which primaries work, if we can entertain a theory of level for a moment. But I think you will agree that the weight of the evidence rests with the case that they do not work. In as much as primary direction devotees have ended up employing the solar arc in right ascension key, and abandoning the three mean-arc keys of Ptolemy, Naibod, and Simmonite, these devotees can not any longer call their technique by the name primary directions, rather they must admit that what they are doing is working with secondary progressions in right ascension. What I want to know from those who would still adhere to these secondaries in right ascension is, how are those other progressed positions working in terms of both mutual progressed and progressed to natal? Also, how do they find transits in right ascension working? I really would like to see somebody publish some evidence for transits in right ascension working. Really.

I have one last thought on primaries and then I will drop the issue. Here is a quote from Charles Jayne, one of the most technically experienced astrologers around and one with a finely honed astrological vision, in my estimation. In summing up his experience with solar arcs, Ascendant arcs, and Vertex arcs, in both longitude and declination, he says, speaking for his research group:

> In our opinion, based on a great deal of testing and practical experience the 6 modes of Direction described in this series ... together comprise Astrology's most valuable timing Technique.[41]

How come primary directions are not stronger and more valuable than these longitudinal directions, since, after all, the planets in primary directions are brought bodily onto the horizon and meridian planes, while in longitudinal directions, the planets are seldom bodily on these planes? Every astrologer I can think of would agree that a planet-planet occultation (bodily line-up) is stronger than a mere conjunction in longitude, since an occultation represents both a conjunction in longitude and a parallel of declination at the same time.

I have repeatedly emphasized the need to consider the apparent astronomical positions in doing astrology. For our purposes, these positions are where points or planets actually are effectively. In contrast mean positions are mere formal constructs not applicable to a given, individual situation, which is what we want for a prediction.

In this light, the theory of embolismic lunations of Placidus (minor progressions in today's currency) is highly dubious, a point I neglected to cover previously, after temporarily subsuming the technique under tertiary progressions as I was doing the weeding in our garden of dynamic techniques. In putting to use what we have learned about being distrustful of mean motions, consider how in minor progressions one goes forward in the ephemeris a lunar period for a year of life. Now, if the sun's (earth's) and moon's orbits had an eccentricity of zero, and they did for our mean-motion champions Ptolemy and Placidus, fixated as they were on rotating spheres, then everything would be all right with minor progressions. But I now leave it to the reader as an exercise to consider why this equation in the theory of minor progressions cannot be done when we have to consider the transiting positions of both the sun and the moon, which we need to do to get each orbit's FZOD value.

In reflecting on the new theory of progression I have outlined in this paper, we will recall that we used the fraction of a cycle of an orbit by considering the orbiting body's transiting position. Since eccentricities are non-zero, orbiting bodies are continually speeding up and slowing down. Because of this, the rate of progression is not uniform, but in fact, mirrors this alternating speed. There has always existed the subtle trap of assuming uniform motion due to the obviousness of it on its face when we have looked at the expression, a-day-for-a-year, say. This is because the interpretation of uniform motion is accurate at values of years which are just integers i.e., at the birthday each year. However, in general, this is the only moment when this interpretation is accurate.

The other aspect to the new theory is the employing of a Midheaven-phased apparent day and not a civil day for each year or month of life. Those of you who employ the progressed Midheaven by adding the solar arc to the natal Midheaven must realize that if you are convinced of this being correct, you are substantiating this aspect of the true progression theory. Just look back to Diagram 5 to convince yourself of this statement.

I now give two examples of the results one should get for the true secondary progressed sun so you can check whether your routines have been correctly done should you care to program these yourself. Michael Erlewine has implemented the true progressions on his new M-65 comprehensive software package should you be set up to go that route. Also he may offer a routine written for earlier software.

EXAMPLE CALCULATIONS

	Natal date:	July 31, 1913; 0 hr. UT
	Natal sun:	7 Leo 09'59"
	EQTNAT:	0.0043 days
A.	Event date(1):	July 31, 1983; 0 hr. UT
	TR sun:	7 Leo 14'27"
	AGE:	70.00021
	Prog sun(mean):	15 Libra 05'37" (customary way)
	EQTPROG:	-0.0086 days
	Prog sun(true):	15 Libra 04'51" (new way)

B.	Event date(2):	July 30, 1983; 22 hr. 01 min. 59 sec. UT
	TR sun:	7 Leo 09'45"
	AGE:	69.99999
	Prog sun(mean):	15 Libra 05'37" (customary way)
	EQTPROG:	-0.0086 days
	Prog sun(true):	15 Libra 04'51" (new way)

We will recall that in addition to the secondary and the two tertiary progressions there exist many more progressions, each based on the synodical cycle from a geocentric viewpoint between any two orbiting points (planets, nodes, stars, etc.). Aries, too, should be interpreted as an orbiting point, infinitely far out with a speed of zero. In doing so, we perceive the whole set of progressions as a unity and we can use EQ. 11 for any case by putting the faster member of a pair for MOON and the slower member for SUN. When ARIES is the slowest member we have MOON,ARIES and SUN,ARIES as the names we should now use instead of tropical tertiary and secondary, respectively. This X,Y nomenclature indicates what the meaning of a given progression is. If X and Y are two different orbiting points, X being the faster, we should call the progressions based on their synodical cycle "X,Y progressions."

We saw that in an X,Y progression any progressed point, whether planet or cusp, generates an arc defined as the difference between the point's progressed and natal positions. Further, because of the principle of sensitive points, all natal points may be directed by this arc. We can say that each member of the set of X,Y progressions has its own family of directions.

In doing the X,Y progression we need to be clear on how we progress the MC for the MPAD or the ASC for the APAD. Here this paper ends. Hopefully, it might turn out to be the case that the sun is the driver of the MC, so that the MC is progressed by the solar arc for any X,Y progression! We also raised the possibility of employing the synodical cycle of the MC to planets other than the sun in generating our day. Here we most assuredly want to work with longitudes and not oblique ascensions and meridian distances from the old Ptolemy school, for reasons demonstrated throughout this paper.

Well our journey is complete. The structure of techniques now seems much more clarified to me and I hope it does to you. A lot of stuff has been eliminated but more has flooded in to take up the slack. At least we have the right things in the right places now, I think. Now we all need to start some empirical work and compare notes to see if we all like the new land to which we have arrived.

FOOTNOTES

1. The words precision and accuracy are frequently used interchangeably, but they should not be. Accuracy refers to how close one is to a true value, while precision refers to how consistent one is in the sense of the tightness or looseness of scatter. If I am target shooting with a bow and arrow and place all my arrows in the bottom, left corner, covering a space of one hand, then I am quite precise in my technique compared to my companion who places his arrows over the space of three hands. Depending on the size of the target, he may be more accurate on average. But if I am told of my systematic error (always in the same direction) then I need only aim for the top, right corner and I would then place my arrows in a hand space centered at the bull's eye. Perhaps there was a wind blowing near the target which I did not know about or that day, God had intervened and locally changed the strength and direction of gravity near the target.

2. Robert DeLuce, Complete Method of Prediction (New York, A.S.I. Publishers, Inc., 1978, Reprint of 1935 ed., with new Foreword by Henry C. Owen, Jr.), p. 11.

3. DeLuce, Op. Cit., p. 7.

4. Henry C. Owen, Jr., Foreword in DeLuce, Op. Cit., p. v.

5. Zipporah Dobyns, private communication, workshop, 1973, Boston, Ma.

6. Richard Svehla, "Introduction to the Uranian System of Astrology," The Aquarian Agent, v. 4, no. 7 (May/June 1975), p. 13.

7. DeLuce, Op. Cit., p. 11.

8. Owen, Foreword in DeLuce, Op. Cit., p. v.

9. DeLuce, Op. Cit., p. 12.

10. Charles A. Jayne, Progressions and Directions, Trident Series, 2nd ed., Astrological Bureau, Monroe, N.Y., p. 3.

11. Owen, Foreword in DeLuce, Op. Cit., p. v.

12. Charles E. O. Carter, The Principles of Astrology (Wheaton, Ill., Theosophical Publishing House, 1963, 5th Rev. ed.), p. 176.

13. Dane Rudhyar, The Astrology of Personality (Garden City, N.Y., Doubleday, 1970, Reprint of 1936 ed.), p. 437.

14. Rudhyar, Op. Cit., p. 437; Rudhyar, The Astrological Houses, The Spectrum of Individual Experience (Garden City, N.Y., Doubleday, 1972), pp. 147-150.

15. Carter, Op. Cit., p. 176.

16. Ronald Davison, "The Daily Horoscope," NASO Journal, v. 2(1975), p. 2.

17. Davison, Op. Cit., p. 2.

18. The term symbolic time has been employed, but that is an inaccurate term. The word symbol has a transcendent connotation as in the statement "the number five symbolizes creativity."

19. Solar arcs almost always come due within an orb of one to two minutes of arc or six to twelve days of calendar time, the way they are currently calculated.

20. Jayne, Op. Cit., p. 6.

21. DeLuce, Op. Cit., p. 16.

22. Robert R. Newton, Ancient Planetary Observations and the Validity of Ephemeris Time (Baltimore, Maryland, Johns Hopkins Univ. Press, 1976), p. 154.

23. Neil Michelsen's Astro Computing Services graciously supplied the calculations for me at discounted, research rates. His routines have been in existence since 1972 and we can rest assured of their being relatively bug-free.

24. Jayne, Op. Cit., p. 6.

25. Charles E. O. Carter, An Introduction to Political Astrology (London, L. N. Fowler and Co. Ltd., 2nd ed., 1969), p. 38.

26. Jayne, Op. Cit., p. 23.

27. Carter, The Principles of Astrology, Op. Cit., p. 176.

28. DeLuce, Op. Cit., p. 7.

29. Jayne, Op. Cit., p. 8.

30. Michael Erlewine was cool to this proposed change in nomenclature, arguing that it might prove confusing. That is quite possible in the short run. But we astrologers, who are serious, must realize that we are in this game over the long haul. It is potentially much more confusing, in this light, to continue with our inappropriate nomenclature. So, send him your votes. He strikes me as being quite democratic.

31. It needs to be realized that with the kind of accuracy I am talking about in these new progressions one needs to consider the problem of whether one should use geometric or apparent positions for the planets' geocentric longitudes. The difference between the two can be as much as 1.5 minute of arc for mercury diminishing to 20 seconds of arc for the outer planets as well as the sun. I have found that the apparent

position is the real or actual position from the standpoint of astrological efficacy, a proposition which can easily be tested by employing these new secondary progressions, solar arcs based on them, and transits.

32. The demonstration has not been made in the astrological literature, at least to my knowledge, of the relative merits of apparent positions versus geometric positions, at least not in an empirical study. The recent publication circa 1975 of a geometric ephemeris by the Hieratic Publishing Company serves as a break from the traditional employment of apparent positions. The discrepancy between apparent and geometric positions can be some 1.5' arc for mercury dimishing to 20" arc for the outer planets as well as the sun. The tabulated accuracy of astrological ephemerides until recently has been only 1' to 2' arc since this was considered by custom to be all the accuracy needed. Some may have considered calculating positions more accurately but the extra effort involved in compiling the ephemeris and the extra effort involved for the user to interpolate in such ephemeris correctly probably had conspired to dampen enthusiasm for such a project. The above mentioned Hieratic ephemeris and Neil Michelsen's recent American Ephemeris for the 20th Century are accurate to 0.1 minutes of arc. Since Michelsen's is an apparent ephemeris while Hieratic's is a geometric ephemeris, one can fruitfully compare timing using both theories. For example, timing of outer planet secondary progressions would usually be weeks or months apart between the two theories.

While apparent positions are positions where planets are seen to be by an observer on earth, geometric positions are abstract positions derived directly from the kinematics of the solar system.

The geometric position is a kind of mean position in that the positions are intermediate in calculation of the apparent positions. The difference in position is called abberation and comes about due to the finiteness of the speed of light. The formula for aberration, AB, is:

$$AB = -0.347*N*R$$

where, AB is in seconds of arc, N is the geocentric geometric speed in minutes of arc per day, R is the geocentric geometric distance in astronomical units.

The aberration is added to the geometric position to get the apparent position. Thus, if motion is direct geocentrically, the apparent position is less than the geometric position and vice versa.

I will be adducing empirical evidence in the future to show that it is via apparent positions that astrological influence manifests.

Credit should go to the Hieratic Publishing Company for having broken the arbitrary, customary, and outdated-in-terms-of-astronomical-theory use of 1 minute of arc accuracy in astrology when it created its 0.1 arc minute accuracy geometric ephemeris. And now with computers at our disposal we are crazy to keep with the 1' accuracy level when astronomical theory currently admits of 0.1' accuracy at worst (neptune and pluto).

Now all astrology will benefit from finding out the truth. I feel that working to the highest accuracy possible will show unforeseen benefits and progress for the science of astrology, just as Kepler's breaking the 8' arc barrier in 1603-1605 brought in the discovery of elliptical orbits.

33. It is the apparent sidereal time and not the mean sidereal time which we want to use to calculate the Midheaven. This is yet another instance of the mean versus apparent issue popping up. To reinterate, one should think of apparent as meaning perceived or detected by the senses. Logically a chart can be rectified to some 1" arc on the Midheaven provided planets' longitudes are available to this same accuracy. To do rectification this accurately requires just astrological knowledge, lots of observations, and correctly calculated charts.

    Since the nutation in right ascension can be on the order of 15 seconds of arc, and since the ratio of arc to time is 15, using the theory of mean sidereal time as opposed to apparent sidereal time would leave the astrologer with at times an error of one second of universal time in deriving the UT from the Midheaven degree. I grant that this is negligible for everyone now, but could prove an important difference down the road when planetary positions catch up in accuracy.

34. Some apparently have used the value 365.24 days as the length of the tropical year to be more exact, but this merely changes the progressed sun on the order of one second of arc. This should be compared to the nominal one minute, maximum two minutes error which ensues from using either the value 365 or 365.24. The distinction cannot logically be allowed anyway, in that the technique of mean progressions simply subtracts the birthdate as an integer number from the event calendar date as an integer number. Already an averge error of half a day is thereby introduced out of an average number of days from birthdate of 182. Therefore 0.5/182 = 1/365, which is a fourfold error over 0.24/365. This serves to point out the underlying flawed perception and lack of definitional rigor in the whole technique, which has no consideration of a zero point or actual point of solar return i.e. date/time of the actual birthday each year.

35. Steve Strimer of Aldebaran Press in Haydenville, Massachusetts originally intuited the idea of measuring the fraction of a year with respect to the zodiac instead of in the calendar. During a discussion with him in November 1976 he had intuited that in tropical tertiary progressions one ought to calculate the fraction of a month by subtracting the longitude of the natal moon from the longitude of the transiting moon and dividing by 360. As he said that I thought to myself that he was on to something. I tried out the idea by applying it to the case of secondary progressions and the results immediately spoke for themselves. His insight was a delightful example of a bolt out of the blue, expunging an oversight or flaw in astrological practice that had existed for years.

36. The calendar or civil day being created by taking the earth's mean speed is just a mathematical construct or artifact and so has no natural, apparent, physical reality or existence.

37. This should be intuitively evident, but is given approximately by:

    SPEED = K1*(K2 + K3*COS(E))

    where the K's are constants and E is the eccentric anomaly, which is zero at perihelion. This can be shown by the differential calculus on Kepler's equations and a few substitutions.

38. Diagram 2 was plotted from the tabulated values of Equation of Time from Ernest Grant's 1776 ephemeris. Due to the slow movement of the earth's perihelion, these values are not strictly correct for working in our current epoch. But the errors in the solar arcs calculated amount to what are negligible errors for most astrological work, something around 0.5 seconds of arc. The errors in the theory of the sun of Newcomb are currently this level or higher, a point I will discuss in a future Matrix article.

39. I have an astrological understanding that the sun and Midheaven axis are closely related in meaning. For one thing the sun is hottest at noon. I have an understanding also that the sun rules Cancer as well as Leo.

    For those interested in examining the idea of employing the APAD, here is the equation for the rate of change of the Ascendant relative to the Midheaven as a function of the Midheaven's longitude and right ascension:

$$\frac{dU}{dV} = \frac{\cos(e) + \tan(l)\sin(e)\sin(RAMC)}{\cos^2(RAMC) + [\sin(RAMC)\cos(e) + \tan(l)\sin(e)]^2}$$

$$\frac{dX}{dY} = \frac{\cos(e)}{[1 + (\tan^2(RAMC)]\ \cos^2(M)}$$

$$\frac{dA}{dM} = \frac{dU}{dV} \cdot \frac{dX}{dY}$$

    where, e = obliquity of ecliptic, l = geographical latitude, RAMC = right ascension of the Midheaven, M = longitude of the Midheaven, and A = longitude of the Ascendant.

    Since dA/dM is how much A changes for a given change of M, one can multiply it by a known incremental amount of M, delta M, to get the corresponding incremental amount of A, delta A. Alternatively one can take the reciprocal and get dM/dA. When dM/dA is multiplied by delta A, a corresponding delta M will be gotten.

    So to do the APAD theory one has first to do the MPAD theory as outlined in this paper and then calculate a progressed Ascendant based on the solar arc progressed Midheaven. Then, using the terminology P for progressed and N for natal we would see what the slippage was of the progressed Ascendant phased to the progressed sun relative to the natal Ascendant phased to the natal sun:

Slippage = A(P) - SUN(P) - [A(N) - SUN(N)]

then,

-Slippage . dM/dA = delta M

gives a delta M. But since delta M = delta SUN, since the sun and M progress at the same rate, we now know that delta SUN needs to be added to SUN(P) to get the SUN(P) for the APAD.

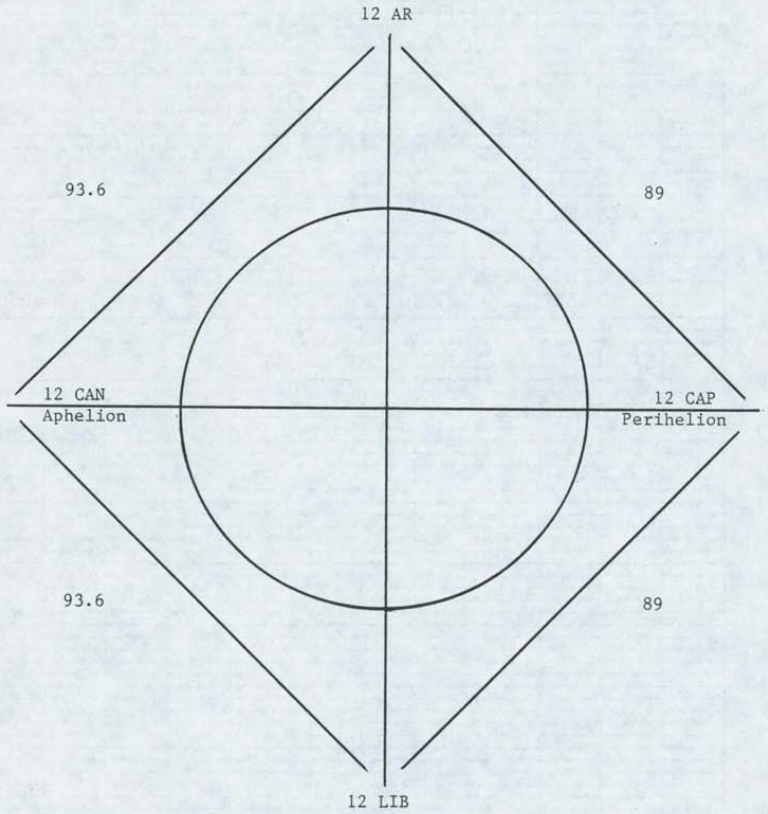
Diagram 5 can fruitfully be employed as an actual example when Day 1 is interpreted as Year 1 and Day 2 as Year 2.

40. The tropical tertiary has erroneously gone under the name sidereal tertiary even though employed by tropical astrologers. That is like letting the fox into the chicken coop! The tropical tertiary equates the period of the tropical month with a day. The sidereal tertiary equates the sidereal month with a day. The tropical month is the periodic time for the transiting moon to recontact the natal moon against the backdrop of the tropical zodiac. The sidereal month is the periodic time for the transiting moon to recontact the natal moon against the backdrop of the sidereal zodiac.

41. Jayne, Op. Cit., p. 21.

DIAGRAM 1

Sun's Apparent Orbit About The Earth



NEQT EXPRESSED IN DAYS

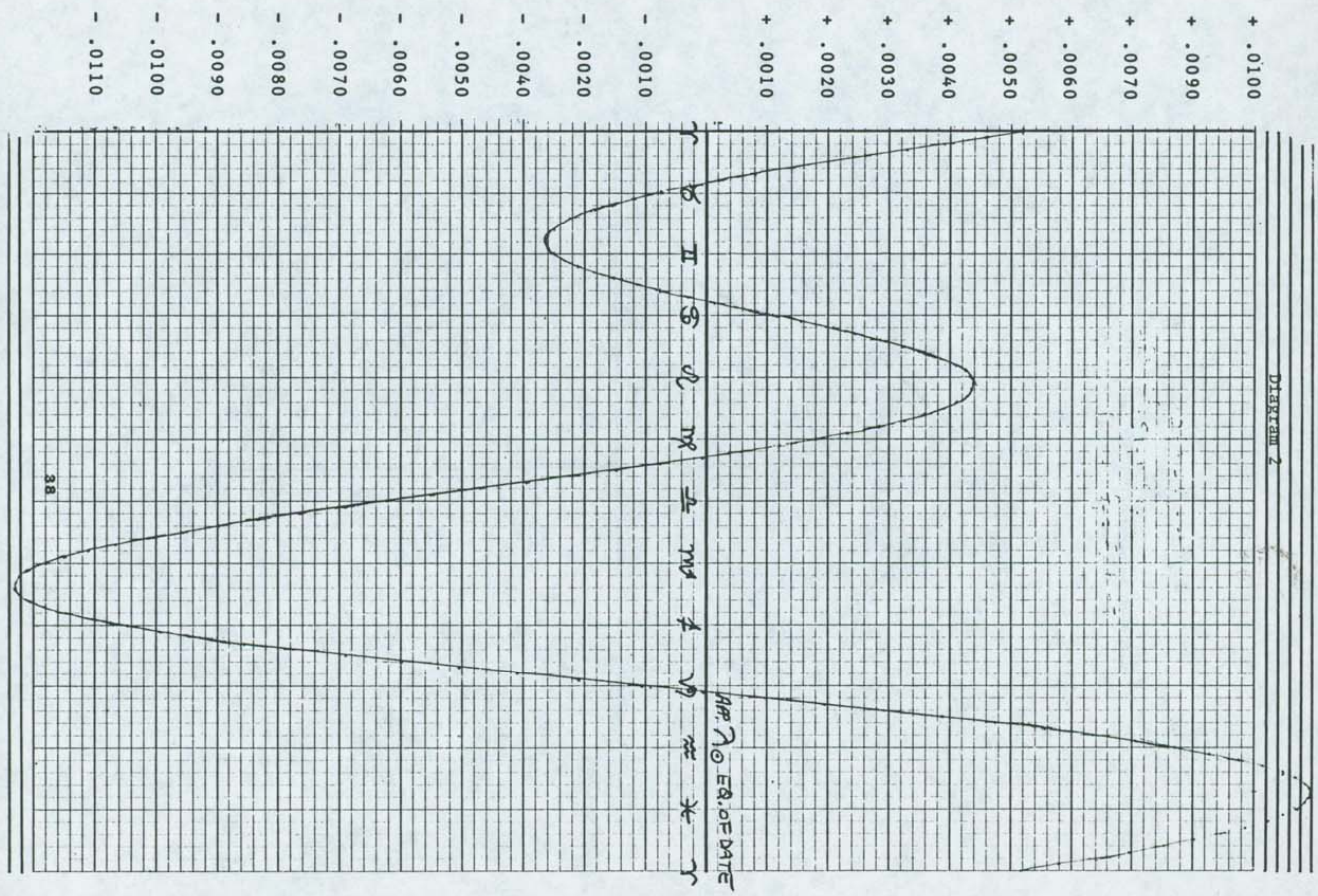


Diagram 2.

DIAGRAM 3A

Degrees	ARIES	TAURUS	GEMINI	CANCER	LEO	VIRGO
0	+.00518	-.00074	-.00249	+.00108	+.00435	+.00180
1	+.00498	-.00089	-.00244	+.00124	+.00437	+.00161
2	+.00477	-.00104	-.00239	+.00140	+.00438	+.00141
3	+.00457	-.00119	-.00233	+.00156	+.00439	+.00121
4	+.00436	-.00132	-.00226	+.00171	+.00439	+.00101
5	+.00414	-.00145	-.00219	+.00186	+.00438	+.00080
6	+.00391	-.00156	-.00211	+.00201	+.00436	+.00059
7	+.00370	-.00167	-.00203	+.00216	+.00434	+.00038
8	+.00348	-.00178	-.00194	+.00230	+.00431	+.00016
9	+.00327	-.00189	-.00184	+.00244	+.00427	-.00006
10	+.00305	-.00199	-.00174	+.00258	+.00422	-.00029
11	+.00284	-.00208	-.00163	+.00272	+.00417	-.00052
12	+.00262	-.00217	-.00152	+.00285	+.00411	-.00075
13	+.00241	-.00225	-.00140	+.00298	+.00404	-.00099
14	+.00220	-.00232	-.00128	+.00311	+.00396	-.00123
15	+.00200	-.00238	-.00115	+.00324	+.00388	-.00148
16	+.00180	-.00243	-.00102	+.00336	+.00379	-.00172
17	+.00160	-.00248	-.00089	+.00347	+.00369	-.00196
18	+.00140	-.00252	-.00075	+.00358	+.00359	-.00220
19	+.00120	-.00256	-.00061	+.00368	+.00348	-.00245
20	+.00101	-.00259	-.00046	+.00376	+.00336	-.00270
21	+.00081	-.00261	-.00031	+.00384	+.00323	-.00296
22	+.00062	-.00263	-.00016	+.00392	+.00310	-.00321
23	+.00043	-.00264	-.00001	+.00401	+.00296	-.00346
24	+.00025	-.00264	+.00014	+.00409	+.00282	-.00370
25	+.00008	-.00263	+.00029	+.00415	+.00267	-.00395
26	-.00009	-.00262	+.00045	+.00420	+.00250	-.00421
27	-.00025	-.00259	+.00060	+.00424	+.00233	-.00447
28	-.00041	-.00256	+.00076	+.00428	+.00216	-.00472
29	-.00058	-.00253	+.00092	+.00432	+.00198	-.00497

DIAGRAM 3B

Degrees	LIBRA	SCORPIO	SAGITT.	CAPRICORN	AQUARIUS	PISCES
0	-.00522	-.01080	-.00955	-.00105	+.00770	+.00973
1	-.00546	-.01089	-.00936	-.00071	+.00790	+.00966
2	-.00570	-.01098	-.00916	-.00037	+.00808	+.00959
3	-.00593	-.01106	-.00894	-.00004	+.00826	+.00950
4	-.00617	-.01112	-.00873	+.00030	+.00843	+.00941
5	-.00641	-.01118	-.00851	+.00063	+.00860	+.00931
6	-.00665	-.01122	-.00829	+.00097	+.00876	+.00921
7	-.00688	-.01126	-.00805	+.00130	+.00890	+.00910
8	-.00711	-.01128	-.00781	+.00164	+.00903	+.00899
9	-.00734	-.01130	-.00755	+.00197	+.00915	+.00888
10	-.00756	-.01131	-.00729	+.00229	+.00927	+.00875
11	-.00777	-.01131	-.00702	+.00261	+.00938	+.00861
12	-.00798	-.01131	-.00675	+.00293	+.00949	+.00846
13	-.00818	-.01129	-.00647	+.00325	+.00958	+.00831
14	-.00838	-.01126	-.00619	+.00356	+.00966	+.00816
15	-.00858	-.01122	-.00590	+.00388	+.00973	+.00801
16	-.00877	-.01117	-.00561	+.00418	+.00979	+.00785
17	-.00895	-.01112	-.00531	+.00447	+.00984	+.00769
18	-.00913	-.01106	-.00500	+.00476	+.00988	+.00753
19	-.00931	-.01098	-.00469	+.00504	+.00992	+.00735
20	-.00948	-.01090	-.00437	+.00532	+.00995	+.00717
21	-.00965	-.01080	-.00404	+.00559	+.00997	+.00698
22	-.00981	-.01070	-.00372	+.00585	+.00998	+.00679
23	-.00996	-.01059	-.00339	+.00611	+.00997	+.00660
24	-.01010	-.01047	-.00307	+.00636	+.00996	+.00640
25	-.01023	-.01034	-.00274	+.00660	+.00994	+.00620
26	-.01036	-.01019	-.00241	+.00683	+.00991	+.00600
27	-.01048	-.01004	-.00208	+.00706	+.00988	+.00579
28	-.01059	-.00988	-.00174	+.00728	+.00984	+.00559
29	-.01070	-.00972	-.00140	+.00749	+.00979	+.00538

DIAGRAM 4

Pictures of M and A Phases To Sun

Ascendant Phase:

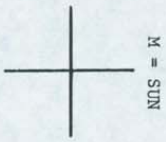


0

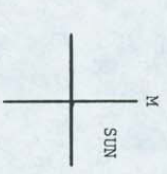


30

Midheaven Phase:



0

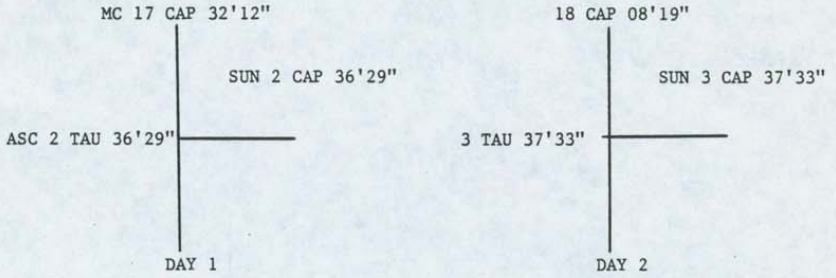


30

DIAGRAM 5

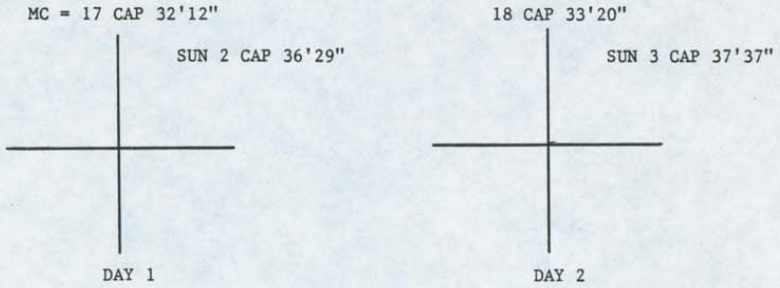
LATITUDE = 42°00' N.
OBLIQ. ECLIP. = 23°45'00"

APAD: PHASE = 120



SA = 1°01'04"

MPAD: PHASE = 14°55'43"



SA = 1°01'08"

Some Thoughts on Interpretive Software Development

Doug Pierce

Before sharing some of my own thoughts on this topic, it would be informative to share some comments from respondents to the Symbolic Perceptions Survey. This survey was proposed and described in Issue VIII (1981) of Matrix Magazine. One item on the survey questionnaire asked astrologers about their "perceptions of computers as interpretive tools". Many astrologers responded to this question; I will include a short sample of responses that are fairly representative of the larger group.

"So far I haven't been impressed with computers as interpretive tools, but I think their speed, versatility, and ability to analyze data have made them the greatest advance in Astrology in this century." -- Male, age 38

"I feel that computers are good, but a facet of their impact upsets me...The conclusion could be drawn that Astrology is merely a correlation of digital data combined in a few algorithms, and that people can be figured out easily so long as the amount of factors is sufficient...if it proceeds to its conclusion, [the computer] will represent Astrology as just another technology." -- Male, age 37

"I'm looking for something that can work with my ideas as they happen and as they evolve right then and there; all I'd have to do is punch in the background with which to play on. Do you have this available?" -- Female, age 25

"I cannot see, as yet, how the computers can synthesize all the individual factors. Mechanical analysis, yes -- personalized interpretive synthesizing, no. I have an open mind -- Convince me!" -- Female, age 66

"The complexity of the horoscope itself limits the perceptive content of the computer as an interpretive tool." -- Female, age 71

"The computer as an interpretive device seems like it could be very useful in applying a truly objective and verifiable approach to astrology...From this standpoint an interpretive program could produce a useful guide for initially getting into a chart...it can never serve the ultimate needs or penetrate the full depth of understanding that astrology can provide. I think that education as to the capacities and limitations of computer astrology is crucial if its great potential is to be realized and its dangers averted." -- Male, age 35

"I feel computers are certainly a welcome asset to astrology. However, as far as interpreting a chart the necessary human exchange is lacking." -- Female, age 34

"Computer analysis and the challenge of clarifying our thinking that this demands must surely be one of the most positive and potentially fruitful developments in astrology." -- Male, age 42

"I feel computers and the work others are doing on programs will be the instruments to turn astrology into a more reputable and accepted activity." -- Female, age 36

"With respect to interpreting a chart for a client, I am sure the computer will prove to be extremely useful. The computer is not impressionable...It will therefore not 'read into' a chart what is not there." -- Male, age 32

"There is a possibility of fairly good computer interpretation, but this will take a great deal of work and time. The lack of integration is the biggest problem now and good intuition adds the extra touch that computers don't have." -- Female, age 45

Obviously, astrologers have a broad range of attitudes toward interprtive computing! One thing that stands out, after reviewing all responses, is that many of us see computer interpretation as something quite isolated from the interpretive process of the astrologer. This is not surprising, given that this really is the general state of affairs in most examples of interpretive systems. We have yet to achieve even a clear vision of a system that would serve as a true and intimate extension of our own interpretive capacities. Developing our concepts of possible future systems demands a substantial leap of imagination. And yet in fulfilling these potentials, we can only start from where we are, with existing systems.

A comprehensive review of the state of the art in interpretive systems is not the purpose of this article. What I propose here is to examine a hypothetical system, the Simple Report Writer; I will call it the SRW. Actual working systems obviously incorporate features not detailed in this illustration, but the essential components are present in the SRW. These processing components are summarized as follows:

1. Retrieve chart data from a disk file as requested by the user.
2. Generate pattern data from chart data.
3. Retrieve text descriptions from knowledge base, using pattern data as search keys.
4. Produce formatted text output.

This brief sequence can easily be expanded to include more detail. For example, step 2 above could be expanded into:

2a. Perform aspect scan of planet positions, with user-defined aspects and orbs.
2b. Generate an array of pattern data (aspects found, sign and house positions, etc.) for use by the text retrieval routine.
2c. Transfer control to the text retrieval routine.

This processing sequence gives us a starting point for describing future developments in terms of refinements to these basic processing components. Ideally, this work goes hand in hand with a process of clarifying and extending our concepts of this whole field of inquiry.

Steps 1 and 4 above can be discussed together as the tasks of an interface component that performs all input and output processing. In the SRW, we have an initial user input requesting a particular chart file, and a straightforward process of printing a formatted report. The programming here is far from trivial, but the flow of control is quite simple. The SRW has minimal interactive capacity; there is essentially one input and one output sequence. In designing future systems, it may be useful to adopt a broader definition of the interface component. This component would not only control input and output routines, it would be a central control or executive program for the whole system. It would mediate all communications between user and system, interpreting information passing in both directions.

While speaking of the interface component, it is important to note one primary constraint on systems of interest here, that of language capacity. I am speaking of systems that can be implemented on 32K-48K micros with floppy disks. The focus here is on smarter, not larger. The development of smarter systems could enormously reduce the redundancy of text storage, as generation of text from simpler language components (say, clauses rather than paragraphs) becomes workable. Language capacity becomes a qualitative rather than a quantitative matter. The issues here cannot be confined to a single component of the system, but they mainly involve the processing components outlined in steps 2 and 3 of the sequence. One aspect of language capacity that is not present in the SRW is the interpretation of user communications to the system. As noted above, this would be a function of the interface component.

Note the use of the term "knowledge base" in step 3 above. This is a general term that in the SRW refers to a random-access disk file of text entries. Each entry corresponds

to, and is accessed by, one of the many possible elements in an array of pattern data (such as a particular planetary aspect). The SRW retrieves these entries in a fairly mindless way, one by one. It has no comprehension of the content of these descriptions. Calling this a knowledge base is really stretching (or rather, shrinking) this term quite a bit. Regardless of how massive its text capacity is, the SRW remains primitive due to its lack of capacity for meaningful synthesis of descriptions.

There are artificial intelligence systems in existence with true knowledge bases. They can handle the full complexity of the English language, in interpreting and generating statements. They have powerful semantic and syntactic analysis routines, and vocabulary entries that define all the possible usages of a given term. They can carry on a coherent conversation with the user, but only on very limited topics. They embody quite sophisticated schemes for representation of knowledge. However, these systems are relatively massive, most requiring support by a mainframe computer. Even if this were not a problem, the nature of the thinking processes of these systems still would remain a problem. These are utterly logical and denotative thinkers, as opposed to the analogical and connotative mode of thought that seems to be essential to astrological interpretation. In Issue V of Matrix Magazine, Lee Holt describes this contrast quite succinctly: "In denotation there is a one-to-one-and-only-one relation between the symbol and its meaning. In connotation there is a one-to-many relation between the symbol and its many meanings...all horoscope interpretation is based on connotative thinking."

It seems that the intelligence of the sophisticated systems described above is not the kind of intelligence that is needed in an interpretive system. Interpretation deals with a different kind of knowledge and a different associative process that can be referred to as connotative in nature. What would a connotative knowledge base look like? Physically, it would still occupy a random-access disk file, but this file would be structured in a unique way. The location of a given element of knowledge--let's just call it a 'descriptor'--(or its pointers) within this file would have a direct correspondence to its connotative meaning within the system's total knowledge. It would share certain associative properties with its neighbors. This kind of relation would not be limited to the physically sequential organization of the file. Descriptors could be connotatively close within any subset of a large number of distinct dimensions of meaning. Thus knowledge would be represented within this system not only in declarative form (by stored descriptive phrases), but also by the inherent structure of the system's total

set of descriptors. This knowledge of connotative relations is at least as essential as the declarative form, since it captures the underlying nuances of meaning that cannot be adequately expressed in declarative form. In this sense, and only in this sense, the system could be said to have knowledge of its descriptors. A small system of this type would be quite limited in its use of grammar, since this type of language analysis requires some of the most massive and lengthy processing components in current artificial intelligence systems. Thus we could have a system that "knows" more than it could ever communicate in a report format. This system could have a sense of connotative relations that would substantially extend the astrologer's capacities in this area, and yet it would rely on the user in composing full descriptions. An essential aspect of this connotative knowledge would be the capacity to relate new information to its current knowledge base in a meaningful way. By this, I mean that the system would be able to draw meaningful parallels and contrasts between existing knowledge and new information, and to decide where new entries should reside within its knowledge base.

The knowledge base would be a literal representation of a connotative space with a large number of dimensions. The term "connotative space" is perhaps an imposing one, but essentially it is quite simple. My AISAR article in Matrix VIII presented a rather primitive connotative space model, using polarities of the four elements as dimensions. To give another simple example, we could define a space in terms of a set of three personality dimensions, such as Introversion/Extroversion, Dominance/Submission, and Creativeness/Conventionality. Thus we may develop a knowledge base using the vocabulary and concepts of the astrologer, the psychologist, or whomever we wish.

Besides the knowledge base itself, the essential processing component of a dynamic interpretive system is a refinement of step 2, where pattern data is generated from chart data. These data represent the system's knowledge of a chart. In the SRW, this is a static representation, a simple list of search keys. Developing more powerful representations of chart dynamics seems essential to advances in interpretive software. What might one expect of a "dynamic" representation of a chart? First, it should provide a way of focusing on a particular chart element or relation, while at the same time taking into account all other relations that affect it. In focusing on a chosen element, the user would literally be affecting the total chart. Rather than simply observing the chart, one would be interacting with it, with the system as mediator. A dynamic representation should provide information about relative prominence of chart elements, with which

the system could generate descriptions that follow a meaningful sequence or priority of reference. Beyond this, the system should be able to use this representation to describe the overall prominence of major configurations and their elements.

These concepts can be extended to a type of analysis that would yield an energy-flow model of chart dynamics. This has been for a number of years a growing orientation, within prominent schools of thought. This is an orientation toward perceiving the energy flow or dynamics of a chart as a whole, and seeing planetary relations as continuous cycles rather than isolated aspects. Within this mode of perception, isolated observations are unified and synthesized in a luminous image of the whole. Yet this orientation remains largely a philosophy rather than a mature methodology. It seems rather paradoxical, but altogether possible, that dynamic computer representations will contribute substantially to this methodology. The paradox, of course, lies in the "mechanicalness" of the computer, in contrast to the creativity of intuitive perceptions. Yet this misses the point, for what is of interest here is the capacity for representing complex symbolic relations. The essence of the computer's potential here lies in the power of certain computable techniques to formulate chart information on a pre-verbal level, an energy-flow level. This is the simplest way I have found to point to this capacity in any non-technical terms.

Even if one could fully perceive a chart as a dynamic flow of energy, communicating these perceptions meaningfully requires a solid grounding in a chosen descriptive territory. In this sense, we each have our own territory, our own grounding in a body of descriptive knowledge that reflects our awareness of human experience. I think this is something like what Michael Erlewine has spoken of in his editorial in Matrix VIII. I share his keen interest in delineating the common ground that astrologers share. And in speaking of territory, we come back to the concept of the knowledge base once again.

Building a knowledge base such as I have described is a demanding art. It is an art of delineating a chosen territory of description, and of cultivating and mapping that territory as a coherent domain of knowledge. It is coherent in terms of its portrayal of real-life relations, rather than relying purely on the structure of the astrological language. Ideally, this mapping is from the experiential to the abstract language of symbolism, rather than vice-versa. At least, this is my own opinion, but the concept itself is quite flexible.

Within one's chosen domain, the artist can be as detailed as he or she wishes in describing its features. These descriptors are like connotative landmarks that will orient the user to possible paths of association that may be explored within a chart. As future systems evolve, they will allow the astrologer more and more freedom of imagination, bringing the chart to life through the dynamics that are played out within any descriptive territory one may choose or conceive of. The astrologer will be able to enter into this territory, participating in these dynamics and learning the chart in a more and more experiential sense. The natural energy flow of the chart will be expressed in the unfolding of any one of its possible paths of interpretive development. This may be a rather poetic way of thinking about possible futures for interpretive systems, but it is not within the realm of pure fantasy.

The preceding descriptions clearly go beyond the capacities astrologers have learned to expect of computers. Judging from the responses sampled earlier, we collectively see computers mainly as powerful tools for generating chart data, aspect grids and graphics, and for doing large-scale research. On the other hand, we remain unimpressed with most attempts to make the leap to complete computer-generated interpretations. There seems to be a great deal of room for development that lies between these extremes of the computer's potential role in astrology. The ideas presented here aim directly at this middle ground. Here, there is much to learn about what tasks are most appropriate to the computer and to the astrologer, and about the point where they meet.

NUMERICAL INTEGRATION: One Step at a Time
A.P.N.A. Vol. XXII
by Mark Pottenger

Numerical integration, at least as concerns astrological programmers, is a technique for ephemeris generation. When done by hand, numerical integration consists in setting up difference and summation tables and extrapolating them by assuming the differences at some order are constant. The assumed constant difference is filled in for the time step ahead and the rest of the difference table filled in to the left. Corrector formulas can now be applied to the extrapolated values if desired, otherwise repeat the procedure for the next time step. The methods used in Volumes XII and XXII of the Astronomical Papers have essentially the same logic, except that a formula getting the next position directly from previous accelerations and positions is used instead of the difference table. The formula used in Volume XXII is of a slightly higher order than that in Volume XII, which is the same thing as taking the difference table to a higher order before assuming the differences will be constant.

The other main difference between the Volume XII and XXII implementations is the starting procedure. Volume XII gives a complete starting table of positions and second summations (the leftward extensions of a difference table) for several dates around the starting epoch. Volume
50 XXII gives a single position and velocity at the epoch and formulas to create a starting table from these values. The Volume XXII form, though slower to start, permits more flexibility since less information is needed to start. I developed the Volume XXII program after having implemented the Volume XII program presented by James Neely in Matrix V because the startup procedure looked like what I needed for work I am doing with asteroids. The asteroid work is still in the testing stage, but the Volume XXII program is presented here for anyone interested.

One additional reason people might want to implement the Volume XXII program is that the orbit of Pluto was considerably better defined than in Volume XII. The Volume XII positions were already off by 10" a decade ago according to Oesterwinter and Cohen (1972). (The orbit used in Volume XII was determined in 1932, that used in Volume XXII in 1967.) The mass used for Pluto in both volumes was determined long ago and differs by a factor of 366 from estimates made since the discovery of Pluto's moon Charon, but I didn't change it for fear it would throw the integration off. (The starting values were determined using the old mass, so they must in a sense be tailored to that mass. If you change the mass you should determine new starting values.)

A brief description of the accompanying program follows. In this description I am using "forward" and "backward" to mean "in the direction the integration is going" and "opposite the direction of the integration". The program is set up to determine whether the time step should be positive or negative from the ending Julian Day Number input.

All arrays are defined and DIMensioned immediately after the questions that start the program going. Provision is included for breaking up the integration by storing a re-start table to disk. If re-starting, the table is read back and several sections of the program get skipped. The coefficients from Volume XXII are all defined next. The Julian Day Number of the epoch and the starting positions and velocities at the epoch are read from DATA statements at the end of the program. The data statements are at the end so that they can be changed easily. They are the only part of the program that needs to be changed to use starting values for another epoch. (Volume XXII gives starting values at 40,000 year intervals for anyone into really ancient charts.) Accelerations at the starting epoch are determined (in a subroutine) and the entire array of accelerations is filled with these values. (The starting table goes 12 time steps forward with both positions and accelerations and the accelerations also go 12 time steps backward from the epoch.)

The starting table is generated iteratively as follows. The position one time step before the epoch is gotten as a function of the 12 accelerations after epoch and the starting position and velocity. Positions forward from the epoch are determined as functions of previous accelerations and positions. This formula includes the acceleration of the time step whose position is currently being determined, so that has to be there from a previous iteration. (That was the reason for filling the acceleration array at the beginning.) This is called a corrector formula because it takes a previously determined value and refines it. After getting positions with the above formula, get new values for the accelerations from these positions. After getting the accelerations, perform a convergence test to see if the starting table is finished. (Note: the convergence test I did is not that described in Volume XXII--it is a bit more simple-minded.) If the table has not converged, extrapolate the accelerations to the -12th time step and start over from getting the -1st position. After completing the starting table, write the resulting positions to disk and start the main integration.

The main integration gets positions as a function of two preceding positions and 13 preceding accelerations. In this form, the formula is called a predictor. After getting the positions, get the accelerations from those positions. If you want super precision and don't care about speed, you can add in the corrector formula at this point (the one used in the starting iteration). Since the authors of Volume XXII don't mention having used it when they got positions for a million years, I doubt that it is really necessary (if your computer's math is accurate enough). After the main integration finishes, the re-start table will be saved if requested.

I have also included a few small programs to complete the package. INVERTER reverses the order of the entries on a disk after running a backward integration. COPYPREC selectively reads positions for a single planet at a requested time interval (which must be a multiple of 40 days) and sets up an individual ephemeris file. It rotates and precesses the coordinates from 1950 equatorial to ecliptic of date. PERTPREC is a modification of that program for fellow fanatics. It applies the perturbations of the outer planets by the inner planets given in Volume XIII Part 5 of the Papers before precessing the positions. COMPXYZ can be used to compare the results of different integrations. PRINTXYZ prints the coordinates in a form suitable for comparison to Volume XII.

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Planetary Co-ordinates Referred to the Equinox of 1950.0


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10 REM VOLUME22--IMPLEMENTATION OF VOLUME 22 FORMULAS FOR NUMERICAL INTEGRATION
20 REM BY MARK POTTENGER
30 REM 838 5TH AVE  LOS ANGELES, CA 90005
40 REM REV 15 JUNE 1980
50 REM MOST OF NOTATION IS AS CLOSE TO VOLUME 22 AS MANAGABLE
60 REM STEP SIZE IS "W" IN NOTATION OF VOL 12 INSTEAD OF VOL 22 "h"
70 REM STEP SIZE IS 40 DAYS
80 REM N IS USED AS STEP INDEX, I IS COEFFICIENT INDEX
90  REM N IS BASED AT 12 INSTEAD OF 0 FOR SUBSCRIPT PURPOSES
100 INPUT #1, "TYPE 0 IF STARTING FRESH, 1 IF READING AN OLD TABLE ",T9
110 INPUT #1, "TYPE THE NUMBER OF THE DRIVE TO BE WRITTEN TO ", D9
120 R0=692 \ REM # OF RECORDS PER 5 INCH DISK
130 IF D9=4 THEN R0=1992 \ REM RECORDS PER 8 INCH DISK
140 INPUT #1, "GIVE ENDING  JULIAN DAY # ",J1
150  REM M()=MASSES OF THE PLANETS IN TERMS OF THE SUN'S MASS AS 1
160  REM M1()=MASS OF SUN PLUS MASS OF PLANET FOR EACH PLANET
170  REM A()=ALPHA COEFFICIENTS FROM VOLUME 22, A1()=ALPHA PRIME
180  REM B1()="b" (SMALL B) COEFFICIENTS FROM VOLUME 22, G()=GAMMA
190 DIM M(5), M1(5), A(12), A1(12), B1(12), G(12)
200  REM X(PLANET, TIME STEP, COORDINATE)=PLANETARY COORDINATE (X=0,Y=1,Z=2)
210  REM X1(PLANET, COORDINATE)=STARTING VELOCITY
220  REM X2(PLANET, TIME STEP, COORDINATE)=ACCELERATION (ATTRACTIONS)
230  REM T(PLANET, COORDINATE)=TEST VALUES FOR CONVERGENCE TEST
240 DIM X(5,24,2), X1(5,2), X2(5,24,2), T(5,2)
250  REM R(PLANET)=RADIAL DISTANCES OF PLANETS FROM SUN
260  REM R0()=SEPARATIONS BETWEEN PLANETS, NAME RE-USED FOR DIRECT PERTERBATIONS
270  REM D(PLANET, PLANET)=DISTANCE BETWEEN PLANETS (SQUARED, THEN CUBED)
280  REM U(PLANET, COORDINATE)=SUN-PLANET ATTRACTION/MASS
290 DIM R(5), R0(5,5,2), D(5,5), U(5,2)
300 IF T9=0 THEN 470
310 REM READ RE-START TABLE--13 SETS OF ACCELERATIONS & 2 SETS OF POSITIONS
320 INPUT #1, "GIVE THE FILE NAME USED FOR THE OLD TABLE ", I$
330 OPEN #2, I$
340 READ #2, J0,W
350 FOR P=1 TO 5
360 FOR X=0 TO 2
370 FOR N=0 TO 12
380 READ #2, X2(P,N,X)
390 NEXT N
400 READ #2, X(P,11,X),X(P,12,X)
410 NEXT X
420 NEXT P
430 CLOSE #2
440 N4=0 \ REM COUNT OF RECORDS WRITTEN TO DISK
450 J0=J0-12*W \ REM OFFSET STARTING JD TO ALLOW FOR OFFSET IN MAIN LOOP
460 REM P1,DEGREE TO RADIAN, RAD TO DEG, RAD TO SECONDS, SEC TO RAD, CIRCLE
470 P1=3.14159265358978\P2=P1/180\P3=180/P1\P5=P3*3600\P6=1/P5\C=360
480 REM MODULUS 360
490 DEF FNM0(U)=(U/C-INT(U/C))*C
500 REM RECIPROCALS OF MASSES OF PLANETS
510 DATA 1047.355,3501.6,22869,19314,360000
520 M(0)=1.00000597682\REM SUN + INNER PLANETS MASS
530 FOR I=1 TO 5
540 READ F\M(I)=1/F\M1(I)=M(0)+M(I)
550 NEXT I
560 REM PAPERS VOLUME 22 ALPHA--COEFFICIENTS FOR STARTUP INTEGRATION
570 DATA 2615348736000\REM LOWEST COMMON DENOMINATOR
580 DATA 150653570023,2662659061044,-1481863453062,3926822700380
590 DATA -6604398106155,8380822992264,-8088023425188,5907495735864
600 DATA -3215663657055,1265630766980,-340671801462,56165516844,-4281164477
610 READ F0
620 FOR I=0 TO 12
630 READ F\A(I)=F/F0
640 NEXT I
650 REM VOLUME 22 ALPHA PRIME--COEF FOR MAIN INTEGRATION
660 DATA 2615348736000\REM LCD
670 DATA 4621155471343,-13232841914656,47013743726958
680 DATA -114321700672600,202271967611865,-266609549584656
690 DATA 264429021895332,-197106808276656,108982933333425
700 DATA -43427592826040,11807143978638,-1962777574776,150653570023
710 READ F0
720 FOR I=0 TO 12
730 READ F\A1(I)=F/F0
740 NEXT I
750 REM VOLUME 22 GAMMA--COEF FOR ACCELERATIONS TO GET X(-1) IN START SWEEP
760 DATA 5230697472000\REM LCD
770 DATA 8153167962181,-30282470160220,101786970400854
780 DATA -244754720525140,430901143447815,-566360031923352
790 DATA 560707147204260,-417423287061288,230582338000515
800 DATA -91816356051340,24948866958246,-4145485036740,318065528209
810 READ F0
820 FOR I=0 TO 12
830 READ F\G(I)=F/F0
840 NEXT I
850 REM VOL 22 b--COEF FOR BACKWARD EXTRAPOLATION IN START SWEEP
860 REM = -1^I*(13!/((I+1)!*(13-(I+1))!) FOR I=0 TO 12
870 DATA 13,-78,286,-715,1287,-1716,1716,-1287,715,-286,78,-13,1
880 FOR I=0 TO 12\READ B1(I)\NEXT I
890 K=.0172020895\REM GAUSSIAN GRAVITATIONAL CONSTANT
900 IF T9=1 THEN 930
910 REM ALL DATA STATEMENTS FROM NOW ON AT END OF PROGRAM
920 READ J0\REM STARTING JULIAN DAY #
930 F1=86.5*1024 \ F2=8 \ REM DISK SPACE, BYTES PER NUMBER
940 IF D9=4 THEN F1=249*1024 \ REM 8 INCH DISK
950 F3=INT(ABS(J1-J0)/40+1) \ REM TOTAL # OF RECORDS IN RUN
960 IF T9=1 THEN F3=F3-13 \ REM CORRECT FOR JD OFFSET IN RE-START
970 F4=F3*16*F2/F1 \ REM RECORDS*(JD & 15 COORDS/RECORD)*BYTES/DISK
980 PRINT #1, "THIS WILL TAKE",F4," DISKETTE(S)"
990 IF T9=1 THEN 1100
1000 REM READ OUTER PLANET STARTING POSITIONS & VELOCITIES
1010 FOR P=1 TO 5
1020 FOR X=0 TO 2
1030 READ X(P,12,X)
1040 NEXT X
1050 FOR X=0 TO 2
1060 READ X1(P,X)
1070 NEXT X
1080 NEXT P
1090 REM PREPARE FILE
1100 GOSUB 2800
1110 REM SET STEP SIZE IN DAYS (40 OR -40)
1120 W=40*SGN(J1-J0)
1130 REM W, K SQUARED
1140 W2=W*W \ K2=K*K
1150 REM SET UP FOR STARTING SWEEP
1160 N=12
1170 IF T9=1 THEN 2220 \ REM RE-START GOES DIRECTLY TO MAIN INTEGRATION
1180 PRINT "GETTING ACCELERATIONS AT EPOCH"
1190 GOSUB 2920
1200 PRINT "DONE--FILLING ARRAY"
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1210 REM FILL ARRAY WITH ACCELERATION AT EPOCH
1220 FOR P=1 TO 5
1230 FOR N=0 TO 24
1240 IF N=12 THEN 1280
1250 FOR X=0 TO 2
1260 X2(P,N,X)=X2(P,12,X)
1270 NEXT X
1280 NEXT N
1290 NEXT P
1300 C0=0 \ REM COUNT OF ITERATIONS
1310 REM STARTING ITERATION--INTEGRATE X, CALCULATE X", EXTRAPOLATE X" BACK
1320 C0=C0+1
1330 IF C0<3 THEN 1410
1340 REM STORE VALUES FOR COMPARISON
1350 FOR P=1 TO 5
1360 FOR X=0 TO 2
1370 T(P,X)=X(P,24,X)
1380 NEXT X
1390 NEXT P
1400 REM GET X(-1)
1410 FOR P=1 TO 5
1420 PRINT "X(-1)=",
1430 FOR X=0 TO 2
1440 T=0
1450 FOR I=0 TO 12
1460 T=T+G(I)*X2(P,I+12,X)
1470 NEXT I
1480 X(P,11,X)=X(P,12,X)-W*X1(P,X)+W2*T
1490 PRINT X(P,11,X),
1500 NEXT X
1510 PRINT
1520 NEXT P
1530 PRINT "STARTING AN INTEGRATION"
1540 REM INTEGRATE X
1550 FOR P=1 TO 5
1560 PRINT "PLANET",P
1570 FOR N=13 TO 24
1580 PRINT "STEP",N-12," XYZ=",
1590 FOR X=0 TO 2
1600 T=0
1610 FOR I=0 TO 12
1620 T=T+A(I)*X2(P,N-I,X)
1630 NEXT I
1640 X(P,N,X)=2*X(P,N-1,X)-X(P,N-2,X)+W2*T
1650 PRINT X(P,N,X),
1660 NEXT X
1670 PRINT
1680 NEXT N
1690 NEXT P
1700 !"FINISHED INTEGRATION ",C0
1710 REM GET ACCELERATIONS FROM INTEGRATED POSITIONS
1720 FOR N=13 TO 24
1730 GOSUB 2920
1740 NEXT N
1750 PRINT "GOT 12 SETS OF ACCELERATIONS"
1760 IF C0<4 THEN 1890
1770 REM TEST FOR CONVERGENCE IN LAST TIME STEP OF STARTING SWEEP
1780  REM THIS IS NOT THE TEST DESCRIBED IN VOL 22
1790 F=0
1800 FOR P=1 TO 5
1810 FOR X=0 TO 2
1820 PRINT "OLD,NEW=",T(P,X),X(P,24,X)
1830 IF X(P,24,X)<>T(P,X) THEN F=1
1840 NEXT X
1850 NEXT P
1860 IF F=0 THEN 2030
1870 IF C0>20 THEN 2030 \ REM THIS IS MY OWN ARBITRARY CUT-OFF
1880 REM EXTRAPOLATE ACCELERATIONS TO -12TH STEP
1890 FOR P=1 TO 5
1900 FOR N=1 TO 12
1910 FOR X=0 TO 2
1920 T=0
1930 FOR I=0 TO 12
1940 T=T+B1(I)*X2(P,12-N+1+I,X)
1950 NEXT I
1960 X2(P,12-N,X)=T
1970 NEXT X
1980 NEXT N
1990 NEXT P
2000 PRINT "EXTRAPOLATED 12 SETS OF ACCELERATIONS BACK"
2010 GOTO 1320 \ REM GO BACK FOR ANOTHER ITERATION
2020 REM WRITE RESULTS OF STARTING ITERATION
2030 J=J0
2040 FILL 3328,2 \ REM SWITCH OUTPUT TO PRINTER
2050 !"ITERATION COUNT IS ",C0
2060 FOR N=12 TO 24
2070 !J
2080 WRITE#1,J
2090 FOR P=1 TO 5
2100 FOR X=0 TO 2
2110 !X(P,N,X),
2120 WRITE#1,X(P,N,X)
2130 NEXT X
2140 !
2150 NEXT P
2160 J=J+W
2170 NEXT N
2180 FILL 3328,0 \ REM SWITCH BACK TO SCREEN
2190 N4=13\REM COUNT OF RECORDS WRITTEN TO FILE
2200 GOSUB 2650
2210 REM START MAIN LOOP
2220 FOR J=J0+13*W TO J1 STEP W
2230 !J
2240 WRITE #1, J
2250 N2=N+1
2260 N3=N-1
2270 FOR P=1 TO 5
2280 FOR X=0 TO 2
2290 T=0
2300 FOR I=0 TO 12
2310 T=T+A1(I)*X2(P,N-I,X)
2320 NEXT I
2330 X(P,N2,X)=2*X(P,N,X)-X(P,N3,X)+W2*T
2340 !X(P,N2,X),
2350 WRITE #1, X(P,N2,X),NOENDMARK
2360 NEXT X
2370 !
2380 NEXT P
2390 N=N+1
2400 GOSUB 2920 \ REM ACCELERATIONS
2410 N4=N4+1
2420 IF N4/R6=INT(N4/R0) THEN GOSUB 2770
2430 IF N=24 THEN GOSUB 2650
2440 NEXT J
2450 IF N4/R0<>INT(N4/R0) THEN CLOSE #1
2460 INPUT #1, "DO YOU WANT TO SAVE A RE-START TABLE? ", I$
2470 IF I$<>"YES" THEN 2630
2480 F=8 \ REM SIZE OF FILE IN 256 BYTE SECTORS
2490 PRINT #1, "PUT IN A DISK WITH ",F," SECTORS FREE & GIVE A FILE NAME ",
2500 INPUT #1, I$
2510 CREATE I$,F
2520 OPEN #2, I$
2530 WRITE #2, J1,W
2540 FOR P=1 TO 5
2550 FOR X=0 TO 2
2560 FOR N2=N-12 TO N
2570 WRITE #2, X2(P,N2,X)
2580 NEXT N2
2590 WRITE #2, X(P,N-1,X),X(P,N,X)
2600 NEXT X
2610 NEXT P
2620 CLOSE #2
2630 END
2640 REM MOVE VALUES DOWN IN ARRAYS
2650 FOR P=1 TO 5
2660 FOR X=0 TO 2
2670 FOR N=0 TO 12
2680 X2(P,N,X)=X2(P,N+12,X)
2690 NEXT N
2700 X(P,11,X)=X(P,23,X)
2710 X(P,12,X)=X(P,24,X)
2720 NEXT X
2730 NEXT P
2740 N=12 \ REM STEP COUNTER
2750 RETURN
2760 REM CLOSE IS CALLED ONLY AFTER FILLING A DISK
2770 CLOSE #1
2780 IF J=J1 THEN RETURN
2790 REM CREATE FILE TO STORE RESULTS ON--256 BYTE SECTORS
2800 PRINT #1, "PUT A BLANK DISKETTE IN DRIVE ",D9, \ INPUT #1, I$
2810 I$=STR$(D9)
2820 I$="XYZ1950,"+I$(2,2)
2830 CREATE I$,R0/2
2840 OPEN #1, I$
2850 RETURN
2860 REM GET ACCELERATION FROM POSITIONS
2870 REM R() IS SQUARE OF SOLAR DISTANCE, THEN CUBE
2880 REM R0() IS SEPARATION BETWEEN PLANETS IN EACH COORDINATE
2890 REM R0() IS LATER RE-USED AS VOLUME 12 T(I,J)/MASS
2900 REM D() IS SQUARE OF DISTANCE BETWEEN PLANETS, THEN CUBE
2910 REM U() IS VOLUME 12 U/MASS
2920 FOR P=1 TO 5
2930 R(P)=X(P,N,0)^2+X(P,N,1)^2+X(P,N,2)^2
2940 R(P)=R(P)*SQRT(R(P))
2950 FOR X=0 TO 2
2960 U(P,X)=-K2*X(P,N,X)/R(P)
2970 NEXT X
2980 FOR P0=P+1 TO 5
2990 FOR X=0 TO 2
3000 R0(P,P0,X)=X(P0,N,X)-X(P,N,X)
3010 NEXT X
3020 D(P,P0)=R0(P,P0,0)^2+R0(P,P0,1)^2+R0(P,P0,2)^2
3030 D(P,P0)=D(P,P0)*SQRT(D(P,P0))
3040 D(P0,P)=D(P,P0)
3050 FOR X=0 TO 2
3060 R0(P,P0,X)=K2*R0(P,P0,X)/D(P,P0)
3070 R0(P0,P,X)=-R0(P,P0,X)
3080 NEXT X
3090 NEXT P0
3100 NEXT P
3110 FOR P=1 TO 5
3120 FOR X=0 TO 2
3130 T=0
3140 FOR P0=1 TO 5
3150 IF P0=P THEN 3170
3160 T=T+M(P0)*(R0(P,P0,X)+U(P0,X))
3170 NEXT P0
3180 X2(P,N,X)=M1(P)*U(P,X)+T
3190 NEXT X
3200 NEXT P
3210 RETURN
3220 REM EPOCH DEPENDENT DATA
3230 DATA 2430000.5\REM STARTING JD
3240 REM JUPITER-PLUTO XYZ,X'Y'Z' FROM VOLUME 22 PART 1 PAGE 14
3250 DATA 3.429474151893,3.353869597109,1.354949017147
3260 DATA -.005571605704487,.005056967832843,.002305785438997
3270 DATA 6.641455425491,5.971569578783,2.182314997275
3280 DATA -.004155707763713,.003656827228077,.001691432132941
3290 DATA 11.26304372073,14.69525767935,6.279605250673
3300 DATA -.003253256691587,.001897060219635,.0008772653227807
3310 DATA -30.15522687593,1.656999664043,1.437857527205
3320 DATA -.0002404762541773,-.002876595326073,-.001172195431741
3330 DATA -21.125116520938,28.448070099397,15.389278950295
3340 DATA -.0017687432476998,-.0021642747741444,-.0001487037136584
```

```
10 REM INVERTER--COPY EPHEMERIS INTO PEVERSE ORDER--ALL DONE ON ONE DISK
20 REM RUN AFTER DOING A BACKWARDS INTEGRATION
30 REM REV 17 JUNE 80
40 REM BY MARK POTTENGER, 838 5TH AVE, LOS ANGELES, CA 90005
50 DIM X(15),X0(15)
60 INPUT #1, "GIVE THE DRIVE NUMBER ", D9$(1,1)
70 R0=692 \ REM # OF RECORDS ON 5 INCH DISK
80 IF D9$(1,1)="4" THEN R0=1992 \ REM 8 INCH DISK
90 OPEN #1,"XYZ1950,"+D9$
100 FOR R=1 TO R0/2 \ REM RECORD NUMBER
110 P=(R-1)*128
120 !"   ",R,P,
130 READ #1 %P, J
140 FOR I=1 TO 15
150 READ #1, X(I)
160 NEXT I
170 P0=(R0-R)*128
180 !P0
190 READ #1 %P0, J0
200 FOR I=1 TO 15
210 READ #1, X0(I)
220 NFXT I
230 WRITE #1 %P0, J
240 FOR I=1 TO 15
250 WRITE #1, X(I),NOENDMARK
260 NEXT I
270 WRITE #1 %P, J0
280 FOR I=1 TO 15
290 WRITE #1, X0(I),NOENDMARK
300 NEXT I
310 NEXT R
320 CLOSE #1
330 END
```

```
10 REM COPYPREC--COPY OUTER PLANET FILES & PRECESS TO ECLIPTIC OF DATE
20 REM FILE IS CREATED FOR EACH PLANET SEPARATELY IN FORMAT FOR CHART PROGRAM
30 REM REV 19 JUNE 80
40 REM BY MARK POTTENGER, 838 5TH AVE, LOS ANGELES, CA 90005
50 REM I USUALLY USE 80,160,320,640,640 DAY INCREMENTS FOR JUP-PLU
60 DIM P(3,3),X(3),P$(40)
70 P$="JUPITER SATURN  URANUS  NEPTUNE PLUTO   "
80 P1=3.14159265358979 \ R=P1/180 \ S=R/3600
90 PRINT #1, "PUT THE DESTINATION DISK IN DRIVE 1"
100 INPUT #1, "GIVE THE DRIVE NUMBER OF THE SOURCE DISK ", D9$(1,1)
110 R0=692 \ REM NUMBER OF RECORDS ON 5 INCH DISK
120 IF D9$(1,1)="4" THEN R0=1992 \ REM 8 INCH DISK
130 INPUT #1, "GIVE THE NUMBER OF THE PLANET (1-5 FOR JUP-PLU) ",K
140 INPUT #1, "GIVE THE FIRST JD, LAST JD, & JD INCREMENT ", J1,J2,J3
150 N=INT((J2-J1)/J3)+1 \ REM # OF DATES
160 F=((N+1)*24)/256 \ IF F<>INT(F) THEN F=INT(F+1) \ REM FILE SIZE
170 PRINT N," DATES--FILE WILL BE",F," SECTORS"
180 CREATE P$(K*8-7,K*8),F
190 OPEN #K, P$(K*8-7,K*8)
200 WRITE #K, N,J1,J3 \ REM 1ST RECORD IN FILE--# OF DATES, 1ST JD, JD INCREMENT
210 OPEN #6, "XYZ1950,"+D9$(1,1)
220 READ #6 %0, J0
230 FOR J4=J1 TO J2 STEP J3
240 P=(J4-J0)/40*128
250 IF P<0 OR P/128>=R0 THEN GOSUB 360
260 READ #6 %P, J5
270 PRINT J5,
280 P2=P+24*(K-1)+8
290 READ #6 %P2, X(1),X(2),X(3)
300 GOSUB 430
310 NEXT J4
320 CLOSE #K
330 CLOSE #6
340 END
350 REM SWITCH SOURCE DISKS
360 CLOSE #6
370 PRINT #1, "PUT NEXT DISK IN DRIVE ",D9$(1,1), \ INPUT #1, I$
380 OPEN #6, "XYZ1950,"+D9$(1,1)
390 READ #6 %0, J0
400 P=(J4-J0)/40*128
410 RETURN
420 REM PRECESS AND ROTATE TO ECLIPTIC OF DATE (ADOPTED FROM NEELY VOL XII)
430 T=(J5-2415020)/36525\T5=(J5-2433282.423)/36524.219879
440 E=(((.00181*T-.0059)*T-46.845)*T+84428.26)*S\C=COS(E)\S0=SIN(E)
450 P(1,1)=T5*T5*(-13*T5-29696)/1E8+1
460 P(2,1)=((221*T5-676)*T5-2234941)*T5/1E8\P(1,2)=-P(2,1)
470 P(3,1)=((96*T5+207)*T5-971690)*T5/1E8\P(1,3)=-P(3,1)
480 P(2,2)=T5*T5*(-15*T5-24975)/1E8+1
490 P(2,3)=-10858*T5*T5/1E8\P(3,2)=P(2,3)
500 P(3,3)=-4721*T5*T5/1E8+1
510 FOR I=1 TO 3
520 S8(I)=0
530 FOR J=1 TO 3
540 S8(I)=S8(I)+P(J,I)*X(J)
550 NEXT J
560 NEXT I
570 H1=S8(1)
580 H2=S8(2)*C+S8(3)*S0
590 H3=-S8(2)*S0+S8(3)*C
600 WRITE#K,H1,H2,H3,NOENDMARK
610 PRINT H1,H2,H3
620 RETURN
```

```
10 REM PEPTPREC--APPLY PERTURBATIONS & PRECESSION TO OUTER PLANETS
20 REM DATE 4 SEPT 80
30 REM BY MARK POTTENGER, 838 5TH AVE, LOS ANGELES, CA 90005
40 REM PERTURBATIONS FROM VOLUME 13, PART 5 OF ASTRONOMICAL PAPERS
50 REM FILE IS CREATED FOR EACH PLANET SEPARATELY IN FORMAT FOR CHART PROGRAM
60 REM I USUALLY USE 80,160,320,640,640 DAY INCREMENTS FOR JUP-PLU
70 DIM P(3,3),P0(3),X(3),P$(40)
80 P$="JUPITER SATURN  URANUS  NEPTUNE PLUTO   "
90 REM PI, DEGREES TO RADIANS, SECONDS TO RADIANS, CIRCLE
100 P1=3.14159265358979 \ R=P1/180 \ S=R/3600 \ C0=2*P1
110 REM CAST OUT EXTRA CIRCLES & CONVERT TO RADIANS
120 DEF FNC1(U)=(U-INT(U))*C0
130 REM MODULUS 360
140 DEF FNM0(U)=(U/360-INT(U/360))*360
150 C9=0 \ REM COMPARISON VALUE TO GET SIZE OF LARGEST PERTURBATION
160 PRINT #1, "PUT THE DESTINATION DISK IN DRIVE 1"
170 INPUT #1, "GIVE THE DRIVE NUMBER OF THE SOURCE DISK ", D9$(1,1)
180 R0=692 \ REM NUMBER OF RECORDS ON 5 INCH DISK
190 IF D9$(1,1)="4" THEN R0=1992 \ REM 8 INCH DISK
200 INPUT #1, "GIVE THE NUMBER OF THE PLANET (1-5 FOR JUP-PLU) ",K
210 INPUT #1, "GIVE THE FIRST JD, LAST JD, & JD INCREMENT ", J1,J2,J3
220 N=INT((J2-J1)/J3)+1 \ REM # OF DATES
230 F=((N+1)*24)/256 \ IF F<>INT(F) THEN F=INT(F+1) \ REM FILE SIZE
240 PRINT N," DATES--FILE WILL BE",F," SECTORS"
250 CREATE P$(K*8-7,K*8),F
260 OPEN #K, P$(K*8-7,K*8)
270 WRITE #K, N,J1,J3 \ REM 1ST RECORD IN FILE--# OF DATES, 1ST JD, JD INCREMENT
280 OPEN #6, "XYZ1950,"+D9$(1,1)
290 READ #6 %0, J0
300 FOR J4=J1 TO J2 STEP J3
310 P=(J4-J0)/40*128
320 IF P<0 OR P/128>=R0 THEN GOSUB 440
330 READ #6 %P, J5
340 PRINT J5,
350 P2=P+24*(K-1)+8
360 READ #6 %P2, X(1),X(2),X(3)
370 GOSUB 530
380 NEXT J4
390 CLOSE #K
400 CLOSE #6
410 !"LARGEST PERTURBATION APPLIED WAS ",C9
420 END
430 REM SWITCH SOURCE DISKS
440 CLOSE #6
450 PRINT #1, "PUT NEXT DISK IN DRIVE ",D9$(1,1), \ INPUT #1, I$
460 OPEN #6, "XYZ1950,"+D9$(1,1)
470 READ #6 %0, J0
480 P=(J4-J0)/40*128
490 RETURN
500 REM APPLY PERTURBATIONS & PRECESS & TRANSFORM TO ECLIPTIC OF DATE
```

```
510 REM MERCURY ANOMALY FROM EXPLANATORY SUPPLEMENT CHAPTER 4
520 REM VENUS THRU URANUS ANOMALIES FROM VOL 13, P 398
530 T=(J5-2415020)/36525\T5=(J5-2433282.423)/36524.219879
540 G1=FNM0(FNM0(415*360*T)+102.279381+(261055.04*T+.024*T*T)/3600)*R
550 G2=FNC1(.8781+.00445036167*J5)
560 G3=FNC1(.2059+.00273778588*J5)
570 G4=FNC1(.5521+.00145561345*J5)
580 G5=FNC1(.2178+.00023080935*J5)
590 G6=FNC1(.8272+.00009294373?*J5)
600 G7=FNC1(.5058+.00003258809*J5)
610 REM PERTURBATIONS TO XYZ FROM VOL 13, P 394
620 F0=COS(G1) \ F1=SIN(G1) \ F2=COS(2*G1) \ F3=SIN(2*G1)
630 P0(1)=-40+15*F0-61*F1+F2-6*F3
640 P0(2)=-72+55*F0+11*F1+5*F2+F3
650 P0(3)=-31+28*F0+12*F1+3*F2+F3
660 F0=COS(G2) \ F1=SIN(G2) \ F2=COS(2*G2) \ F3=SIN(2*G2)
670 P0(1)=P0(1)-1157*F0-1339*F1-4*F2-5*F3
680 P0(2)=P0(2)+1196*F0-1089*F1+4*F2-4*F3
690 P0(3)=P0(3)+612*F0-406*F1+2*F2-F3
700 F0=COS(G3) \ F1=SIN(G3) \ F2=COS(2*G3) \ F3=SIN(2*G3)
710 P0(1)=P0(1)-619*F0-2971*F1-5*F2-24*F3
720 P0(2)=P0(2)+2727*F0-567*F1+22*F2-5*F3
730 P0(3)=P0(3)+1183*F0-246*F1+10*F2-2*F3
740 F0=COS(G4)\F1=SIN(G4)\F2=COS(2*G4)\F3=SIN(2*G4)\F4=COS(3*G4)\F5=SIN(3*G4)
750 P0(1)=P0(1)+443*F0+289*F1+21*F2+10*F3+2*F4+F5
760 P0(2)=P0(2)-186*F0+484*F1-9*F2+19*F3-F4+2*F5
770 P0(3)=P0(3)-97*F0+188*F1-5*F2+8*F3+F5
780 IF K=1 THEN GOSUB 1070
790 IF K=2 THEN GOSUB 1170
800 IF K=3 THEN GOSUB 1270
810 FOR I=1 TO 3
820 P0(I)=P0(I)*1E-9
830 X(I)=X(I)+P0(I)
840 IF ABS(P0(I))>C9 THEN C9=ABS(P0(I))
850 NEXT I
860 REM PRECESS AND ROTATE TO ECLIPTIC OF DATE (ADOPTED FROM NEELY VOL XII)
870 E=(((.00181*T-.0059)*T-46.845)*T+84428.26)*S\C=COS(E)\S0=SIN(E)
880 P(1,1)=T5*T5*(-13*T5-29696)/1E8+1
890 P(2,1)=((221*T5-676)*T5-2234941)*T5/1E8\P(1,2)=-P(2,1)
900 P(3,1)=((96*T5+207)*T5-971690)*T5/1E8\P(1,3)=-P(3,1)
910 P(2,2)=T5*T5*(-15*T5-24975)/1E8+1
920 P(2,3)=-10858*T5*T5/1E8\P(3,2)=P(2,3)
930 P(3,3)=-4721*T5*T5/1E8+1
940 FOR I=1 TO 3
950 S8(I)=0
960 FOR J=1 TO 3
970 S8(I)=S8(I)+P(J,I)*X(J)
980 NEXT J
990 NEXT I
1000 H1=S8(1)
```

```
1010 H2=S8(2)*C+S8(3)*S0
1020 H3=-S8(2)*S0+S8(3)*C
1030 WRITE#K,H1,H2,H3,NOENDMARK
1040 PRINT H1,H2,H3
1050 RETURN
1060 REM ADDITIONAL PERTURBATIONS OF JUPITER
1070 F0=COS(G5) \ F1=SIN(G5) \ F2=COS(2*G5) \ F3=SIN(2*G5)
1080 F4=COS(3*G5) \ F5=SIN(3*G5) \ F6=COS(4*G5) \ F7=SIN(4*G5)
1090 P0(1)=P0(1)-12+246*F0-58*F1+12*F2-3*F3+668*T-15*T*F0+29*T*F1
1100 P0(1)=P0(1)+222*T*F2+940*T*F3+16*T*F4+68*T*F5+T*F6+4*T*F7
1110 P0(2)=P0(2)-3+56*F0+226*F1+3*F2+11*F3-2599*T+185*T*F0-140*T*F1
1120 P0(2)=P0(2)-857*T*F2+210*T*F3-62*T*F4+15*T*F5-4*T*F6+T*F7
1130 P0(3)=P0(3)-1+18*F0+98*F1+F2+5*F3-1099*T-375*T*F0+256*T*F1
1140 P0(3)=P0(3)-384*T*F2+75*T*F3-27*T*F4+5*T*F5-2*T*F6
1150 RETURN
1160 REM ADDITIONAL PERTURBATIONS OF SATURN
1170 F0=COS(G6) \ F1=SIN(G6) \ F2=COS(2*G6) \ F3=SIN(2*G6)
1180 F4=COS(3*G6) \ F5=SIN(3*G6) \ F6=COS(4*G6) \ F7=SIN(4*G6)
1190 P0(1)=P0(1)-4*F0-135*F1-8*F3+787*T+T*F0+8*T*F1+262*T*F2-7*T*F3
1200 P0(1)=P0(1)+22*T*F4-T*F5+2*T*F6
1210 P0(2)=P0(2)-7+125*F0-5*F1+7*F2+38*T-74*T*F0-73*T*F1
1220 P0(2)=P0(2)+9*T*F2+241*T*F3+T*F4+28*T*F5+2*T*F7
1230 P0(3)=P0(3)-3+52*F0+4*F1+3*F2-36*T+177*T*F0+196*T*F1
1240 P0(3)=P0(3)-2*T*F2+106*T*F3-T*F4+8*T*F5+T*F7
1250 RETURN
1260 REM ADDITIONAL PERTURBATIONS OF URANUS
1270 F0=COS(G7)\F1=SIN(G7)\F2=COS(2*G7)\F3=SIN(2*G7)\F4=COS(3*G7)\F5=SIN(3*G7
1280 P0(1)=P0(1)+3-66*F0-12*F1-3*F2-F3+22*T-T*F1+7*T*F2-40*T*F3+T*F4-3*T*F5
1290 P0(2)=P0(2)+11*F0-60*F1-3*F3+112*T-2*T*F0-3*T*F1+37*T*F2+7*T*F3+3*T*F4
1300 P0(3)=P0(3)+6*F0-26*F1-F3+49*T+2*T*F0+8*T*F1+16*T*F2+3*T*F3+T*F4
1310 RETURN
```



```
10 REM COMPXYZ--COMPARE XYZs FROM VOL 22 TO VOL 12 (NEELY)
20 REM LATE 4 JUNE 1980
30 REM BY MARK POTTENGER, 838 5TH AVE, LOS ANGELES, CA 90005
40 LINE 120
50 DIM P$(35), X1(3,4)
60 P$="JUPITERSATURN URANUS NEPTUNEPLUTO  "
70 REM READ STARTING JD, # OF ENTRIES
80 !#1, "PUT VOL 12 DISK IN DRIVE 1"
90 INPUT #1, "GIVE THE DRIVE # FOR THE VOL 22 DATA ", D9$(1,1)
100 INPUT #1,"GIVE STARTING JD, NUMBER OF ENTRIES ",J1,N
110 !"                    DIFFERENCES FROM VOLUME 12"
120 !"          DIFFERENCE IN SENSE NEELY VOL 12 - POTTENGER VOL 22"
130 !
140 OPEN#1,"XYZ1950"
150 OPEN #2,"XYZ1950,"+D9$
160 READ #1 %0, J
170 A0=(J1-J)/40*128
180 READ #2 %0, J
190 A2=(J1-J)/40*128
200 FOR K=0 TO 4
210 !P$((K+1)*7-6,(K+1)*7)
220 FOR L=1 TO 3
230 X2(L)=1E9
240 X3(L)=-1E9
250 NEXT L
260 A=A0
270 A4=A2
280 FOR I=1 TO N
290 READ #1 %A, J
300 !%10F1,J,
310 A1=A+K*24+8
320 READ #1 %A1, X(1),X(2),X(3)
330 A3=A4+K*24+8
340 READ #2 %A3, X0(1),X0(2),X0(3)
350 FOR L=1 TO 3
360 D=X(L)-X0(L)
370 !%18F12,D,
380 D=ABS(D)
390 X1(L,K)=X1(L,K)+D
400 IF D<X2(L) THEN X2(L)=D
410 IF D>X3(L) THEN X3(L)=D
420 NEXT L
430 !
440 A=A+128
450 A4=A4+128
460 NEXT I
470 !"X DIFFERENCES FROM",%18F12,X2(1)," TO",X3(1),"   AVERAGE=",X1(1,K)/N
480 !"Y DIFFERENCES FROM",%18F12,X2(2)," TO",X3(2),"   AVERAGE=",X1(2,K)/N
490 !"Z DIFFERENCES FROM",%18F12,X2(3)," TO",X3(3),"   AVERAGE=",X1(3,K)/N
500 !"AVERAGE FOR ALL 3 COORDINATES=",%18F12,(X1(1,K)+X1(2,K)+X1(3,K))/(3*N)
510 A=A0
520 A4=A2
530 !
540 NEXT K
550 CLOSE #1
560 CLOSE #2
570 FILL 3328,0
580 END
```

```
10 REM PRINTXYZ--PRINT OUT XYZ FOR OUTER PLANETS FROM FILE
20 REM PRINTS ALL FOR ONE PLANET BEFORE STARTING NEXT PLANET
30 REM REV 17 JUNE 80
40 REM BY MARK POTTENGER, 838 5TH AVE, LOS ANGELES, CA 90005
50 DIM P$(35)
60 P$="JUPITERSATURN URANUS NEPTUNEPLUTO  "
70 INPUT #1, "WHAT DRIVE IS THE FILE IN ", D9$(1,1)
80 INPUT #1, "GIVE FIRST JD, # OF ENTRIES TO PRINT ",J1,N
90 OPEN#1,"XYZ1950,"+D9$(1,1)
100 A=0
110 READ #1 %A, J
120 A=((J1-J)/40)*128 \ REM ADDRESS OF 1ST JD
130 A0=A
140 FOR K=0 TO 4
150 !P$((K+1)*7-6,(K+1)*7)
160 FOR I=1 TO N
170 READ #1 %A, J
180 !%10F1,J,
190 A1=A+K*24+8
200 READ #1 %A1, X(K),Y(K),Z(K)
210 ! %15F9, X(K), Y(K), Z(K)
220 A=A+128
230 NEXT I
240 A=A0
250 !
260 NEXT K
270 CLOSE #1
280 FILL 3328,0
290 END
```

THE ISAR DATA BASE PROJECT

July 12, 1982

by Mark Pottenger
838 5th Avenue
Los Angeles, CA 90005

A group of astrologers in Los Angeles has been meeting whenever possible for the last year to start developing a data base system for astrology. The group is primarily drawn from ISAR: Lois Rodden, Ron Tiggle, Brooke Smith, Linden Leisge of Church of Light, myself and several other people occaisionally contributing. The complete system we hope to end up with will include a data collection questionnaire, chart and coded data storage, query and statistical analysis of stored data and research guidelines. So far, the working group in Los Angeles has been defining categories and codes for storing information about a person. When the code definition is finished, we will incorporate it as an extension record for the M-65 Research System from Matrix Software. The M-65 package already supplies the chart calculation and storage and data base query features and will be supporting statistical analyses later on. [see note below. Editor].

The definition of the data structure is mostly finished, and we now want feedback from a larger group of astrologers and researchers. Our structure has sever major divisions: physical, birth & childhood, education & mind, sexual & social, adult relationships & home, work and career, and religion & values. The working group does not include anyone with extensive knowledge of medicine, so that part of the data definition is still vague. Anyone who would like a copy of our description of the structure as so far defined may write directly to me. Please join us in this effort- the more people who contribute now, the better the final working version will be.

Mark Pottenger

Editor´s NOTE: As regards the statistical routines for the M-65 System, statistician/programmer Doug Pierce is relocating to join the MATRIX programming staff on a full time basis. One of Doug´s priority projects will be to design a comprehensive statistical package to complement the M-65.

Excerpts from SPIRITUAL SCIENTIFIC ASTROLOGY

by David B. Black

Editor´s note: The excerpts below are from an unpublished manuscript entitled SPIRITUAL SCIENTIFIC ASTROLOGY by David Black. Aside from being a top notch programmer, Black has a real talent for astrological theory and an ear for poetry. Prose with good images in it is hard to find in modern astrological writing. MATRIX intends to devote more space to writing like the following.

"If the astrological Planets are spiritual beings in the sense we have been discussing, it is reasonable to approach them in a different way. Looked at in a simple way, the process is this: one must find and recognize the elements of what exists in the world (including oneself) at a certain level, and consciously create images of them in the form of feeling-filled concepts. The fact that we are caught in the illusion of the two-fold world can actually be a help here: what we find in the external world of Jupiter must be a transformation of what we find as Jupiter in the internal world. In undertaking this process, we are attempting to do no less than attain a perfect understanding of ourselves. If we already had such an understanding, we would not need to undergo this process. For this is not reformulating our self-understanding in new terms (that is the symbolic approach- the symbols being an overlay of what is really there), but actually coming to it for the first time. Until one has attained perfection, one has only imperfect means for attaining perfection. ("For whosoever hath, to him shall be given, and he shall have more abundance: but whosever hath not, from him shall be taken away event that he hath." Matthew 13:12) This is a thought worth pondering, for it is unlike those we ordinarily encounter. If what you are trying to understand is your self, and it is your self that is trying to understand, you can never achieve your goal, or even make real progress, unaided. This thought should lead us through feelings of helplessness to reverence and gratitude to those powers that generously reward our stumbling efforts with what the efforts in themselves could never attain, but are striving for."

"... For each person, the Sun is the source of personhood, the right to say 'I', rather than being the source of things which he or she possesses as characteristics. It is quite possible for the effect of a person´s Sun Sign to escape him or her entirely, so strong is the lack of any felt possibility for things being different. It is well known that people overlook the familiar, and there is nothing more faimiliar to a person in the whole world than the experience of beind g in his or her Sun."

"... The flower is a revolution from the leaf, and so is the fruit from the flower, and yet there is no leaping, but gradual metamorphosis. The plant works minute by minute to bring about these things, which are no surprises to it. But one morning- flowers everywhere, where before there were none. In working on one´s Venus, one must consider oneself to be the plant which works hard, and knows that it is changing what it already has, bit by bit. In such a way, one may grow flowers in oneself where before there were only thorns, and surprise others by the miraculous revolution one has wrought in oneself."

"... Before entering into a description of members of the Zodiac as they appear in etheric astrology, I would like to indicate the nature of their relation to the Planets, which we have already spent some time with. The Planets are like actors, who create the drama by their speeches and actions, but who are inconceivable without the suporting framework and context of the stage, its lighting, and the background music. An actor could give a speech repeatedly, and the effect on the audience would be different each time if the contextual elements were appropriately varied. A courageous speech could be made foolhardy, a romantic one could be made silly, manipulative, coy, ironic, or deluded, The planets have a set repertoire of speeches; their passage throught the Zodiac throws different lights on them, drastically altering the effective quality of what they say."

"... One could easily imagine that the nodes [Lunar Nodes] stand at the endpoints of a continuum, and that one is always at some point in the continuum. In life, however, one always finds oneself to be in situations. In a situation, each pole struggles to take the situation under its care, to turn the situation into a manifestation of that pole. The struggle does not usually take place in a straightforward way. Better than 'struggle,', the process can be described in terms of transformation and metamorphosis, in which mutually antagonistic transforming agents are working. Thus, the process is one which can never end. Progress of falling back is measured in terms of the level at which the struggle takes place. If a situation is transformed chiefly according to the north node, it is different, and thus a new situation. As such, it is subject like any other new situation to the transforming efforts of the Moon´s nodes. In short, the Moon´s nodes are the active poles of a dialectical process which does not contain within itself the possibility of ending.

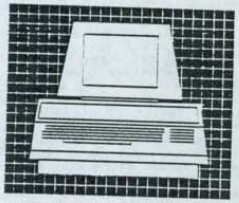
The 'situtations' that were referred to should not be thought of as one ordinarily thinks of the weather. i.e. as something fundamentally external, and having nothing in particular to do with the individual. The language reflects the reality in the highly ambigous phrase 'to find oneself in a situation', One meaning is the discovery that one is, yet again, caught up in a situation. Another meaning is the discovery that, in a situation, a part of one´s own self is to be found. If the self were never a part of the situation, then things would be relatively simple. But of course it is up to the self to change the self, and the state of the situation is an intimate mirror of this process. The situation can only be significantly altered through corresponding self alteration.

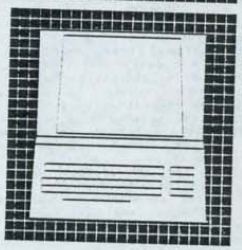
This fact should not make one focus all one´s efforts on inner change, however. Such a focus would reflect the belief that the objective world is found inside, which is no more or less true than the belief that the objective world is found outside. Knowledge of the illusion of the two worlds, inner and outer, should be used to guide the process of change, One´s activity should be in each of the worlds, and should be guided by the mirror that each world finds in the other.

An old terminology for the Moon's nodes can guide us to an intimation of the spiritual reality of the nodes which can be encountered upon our crossing the inner boundary of the spiritual world. The south node was traditinally known as the 'Dragon's tail', and the north node as the 'Dragon's head'. When I first encountered these older terms, I found them offensive. I had associations of long black robes with mystical markings, and of the old sort of mysterious astrologers who would make dire pedictions in enimagtic language. I think that my reaction was proper insofar as one should not indulge strange language in order to evoke indefinite feelings of depth and mystery that have no corresponding understanding. However, as soon as clear, fresh understanding and sympathy are brought to the old terms, their murkiness disappears, and they reveal to a certain extent the wisdom in pictorial form of their origin. The wisdom can only be known in its tru form by means of actual spiritual-scientific perception, but it is possible to gain an intellectual understanding of it from description.

The dragon represents the person's etheric body. The rest of the chart is the body of the dragon. Wherever the dragon goes, it drags its tail along behind it. The tail is that part of the dragon which is most in the past; most of the dragon has already been where the tail is now. But the only part of the dragon's path which is familiar to every part of the dragon is where the tail is. The tail leaves a trail behind it, since it is a big heavy tail. One of our words for such a tail is 'rut', the figurative meaning of which portrays a part of the meaning of the Dragon's Tail, as in the phrase 'the same old rut'. The tail drags on the ground, slowing down the dragon's progress, and making a very noticeable impression on the material earth. The head, on the other hand, is raised above the earth, and leads the rest of the dragon to where it is not now. Unlike the tail, it is not committed to a path. The tail marks the end of the dragon's past, while the head finds the beginning of the dragon's future. The head is the part that thinks. The tail does not need to think to do its job... Dragons are fearsome beasts. They have often been part of ancient pictures of the nature of the human being. In such pictures, they have both been a part of man, but needed to be conquered in order to win a valuable treasure. That the dragon is in us is pictured in the Tail of the Dragon; the path to the overcoming of the dragon is pictured in the Head of the Dragon. Of course, being the dragon, we can never escape it; we can only change our relation to it."







(Continued from page 1)

There is not space in this issue to go into detail on the M-65. A more detailed article is being published in the the new AFA Research Journal. Details are, of course, available from MATRIX on this system.

At this point, M-65 exists in identical form on the Commodore , APPLE and Radio Shack machines. In addition, a version is being readied for the new IBM Personal Computer. A CPM version is under consideration but is not yet in the working stages.

Complete line-by-line documentation for M-65 is being made available and the system has been released in un-locked form. In addition, two M-65 user oriented newsletters are available: User Notes and Working Papers. The first newsletter provides inter-communication between M-65 users and MATRIX while the second is oriented towards the astrological/programmer seeking to modify the system.

A statistics package is in the works and a number of outside programmer/astrologers are working on valuable additions to the system. For example, Michael Munkasey is making his Keyword Phrase generator available. More details in a future issue.

