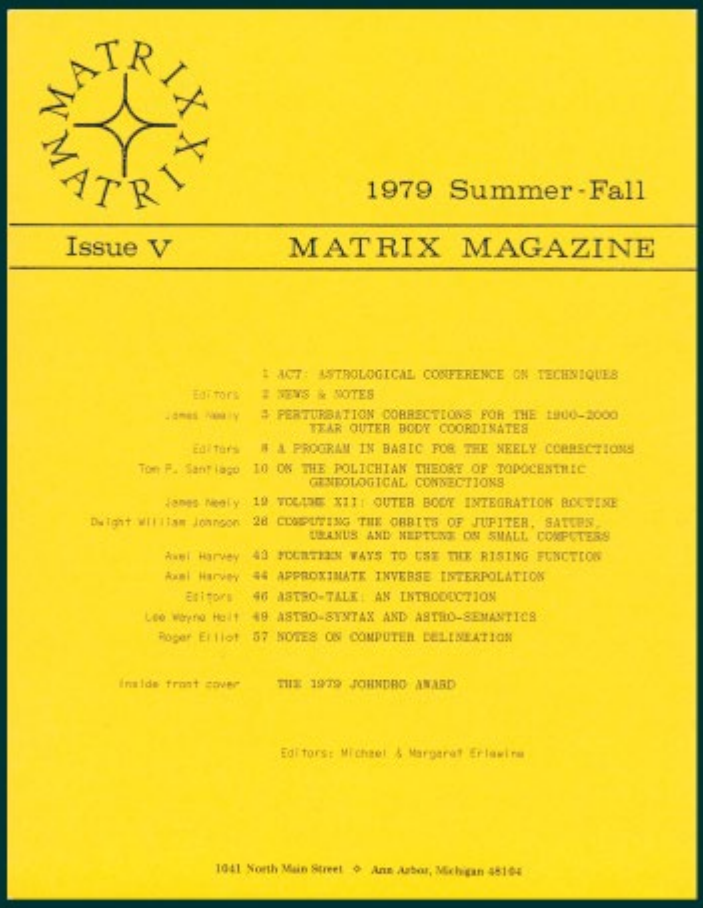
# Matrix Magazine Issues 5-8



1979 Summer-Fall

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Editors: Michael & Margaret Erlewine

1041 North Main Street ◇ Ann Arbor, Michigan 48104

by Michael Erlewine

# Matrix Magazine

# Matrix Journal

## 1978-1992

Volume II

Edited By

Michael Erlewine

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These are not all, but they are the most useful essays from 2023 sorted by the seasons.

I don't have time to 'fine edit' them and still get them out there, but these are certainly in good-enough shape to be readable.

And I don't expect many, but hopefully 'any' folks will find these useful.

They are eclectic, yet the overriding theme is dharma and dharma practice. Those of you who reach a certain point in your own trajectory of dharma practice may find some of these useful.

Michael@Erlewine.net

MATRIX MAGAZINE AND MATRIX JOURNAL

Recently I was discussing the history of modern astrology with a couple of folks, and one of the repeated themes was what led to the series of Neo-Astrology Conferences that Matrix Software, my company, put on in 1989 and why have they turned out to be landmark events of a sort in the history of astrology.

There was something in the air at that time of progress, as if astrology was about to solve all its puzzles and roar ahead. This was especially so when it came to the promise of astrological research, as if we were about to blow away the sceptics with some demonstrable research that testified once and for all that astrology works.

Looking back, that seems more like a pipe dream, probably brought on by the advent of the computer in astrology and for a while all things seemed possible.

When I think back for some way to explain to those who were not there how it all went down, I remembered Matrix Magazine (circa 1978) and Matrix Journal (circa 1990). And when I looked at a couple copies of the magazine, sure enough, that's a perfect picture of what happened back then, who was involved, and when.

Matrix Magazine's first issue was in the winter of 1978, and home computers actually appeared in 1977 so things were just getting started. Actually, the magazine kind of started before the first issue, in order to have something to put in that first issue.

And I realized that while I had the old issues around, that there was no way to share them with others, because they are long gone and out of print. So, I scanned all the issues, not a simple undertaking, being some 700 or so pages for the lot. And then they had to be arranged in book form so I could put them in PDF format. It took a few days.

And of course, I don't expect you to read them, at least all the computer code in them, which is old code at this point. Instead, if you just browse through them, you can get an idea as to how it was back then with us.

What you see is some of the brightest technical minds in astrology coming together and sharing in a magazine that was a harbinger of things to come. It was, in its way, a joyful time indeed. And while it perhaps did not solve all the problems in astrology, back then who knew that it wouldn't, because that was a heady time, like a new paradigm for astrology.

Yet, in Matrix Magazine and later in Matrix Journal, we can see that the mix was in; we all were sharing and celebrating a rebirth of astrology in this modern era. What's become of it all is another story.

After all, Matrix Software was the first astrological software company and the name Matrix was picked by me, not to reflect some mathematical term, but because it came from a Greek, and later a French word for womb, and I chose it because Matrix

Software was intended to be where astrology in this time could be reborn, and to some degree it did.

Some of the contributors to the magazine and journal included:

Michael Erlewine [Editor], Stephen Erlewine, James Neely, Theodor Landscheidt, Robert Knight, John VanZandt, Noel Tyle, Buz Overbeck, Lucy Titunik, Charles Hocking, Pat White, Robert Hand, Tim Smith , Malcolm Dean, Ian McKinnon, John McCormick, Charles A. Jayne, Steve Blake, Alexander Borg, Roger Elliot, Tom P. Santiago, Dwight William Johnson, Axel Harvey, Lee Wayne Hold, David B. Black, David W. Wilsom, Mark Pottenger, Alexander Borg, Fairbain & Wesenberg, Austin Levy, Doug Pierce, Larry Ely, Robert Schmidt, John Townley, Thabit B. Qurra, Vladimir Bogdanov, Tom Bridge.

2023 Michael@Erlewine.net

Michael Erlewine, 1978

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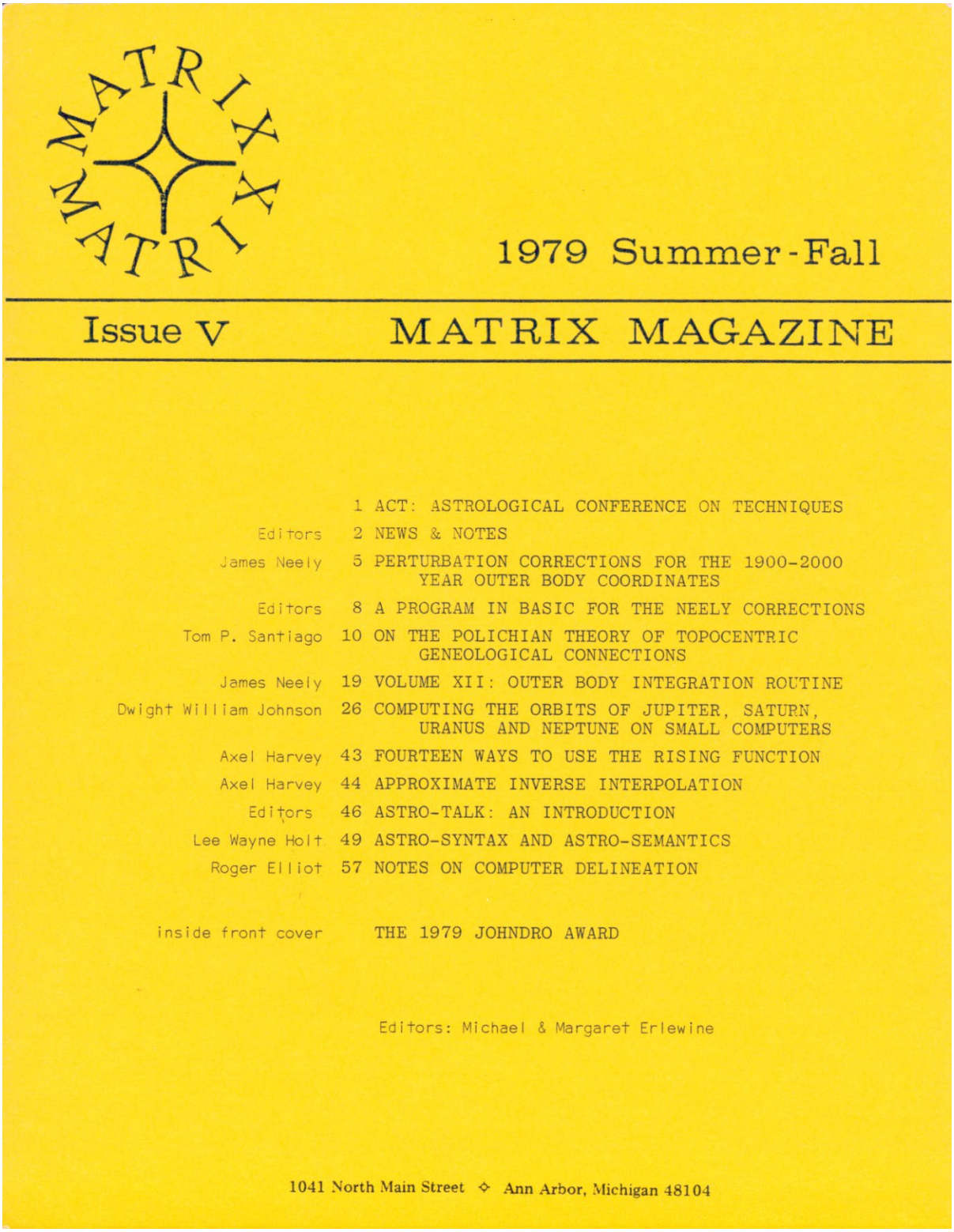

MATRIX

1979 Summer-Fall

Issue V

# MATRIX MAGAZINE


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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 $\Delta x$, $\Delta y$ and $\Delta z$ are computed from the coefficients in Table 1. The general form of the correction is, for example,

$$\Delta x = c_1 + c_2 T + c_3 T^2 + a_1 \cos(f_1 T + p_1) + a_2 \cos(f_2 T + p_2) + \ldots .$$

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 $\Delta z$ for Pluto using the equation

$$\Delta z = 0.0145 - 0.0928T + 0.1195T^2 + 0.0117 \cos(302.6401T - 77.3145) + 0.0020 \cos(528.1363T + 48.5671) - 0.0002 \cos(1000.3720T - 46.1170).$$

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 | | | | | | |
| $\Delta x$: | 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 |
| $\Delta y$: | -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 |
| $\Delta z$: No correction terms required. | | | | | | |
| SATURN | | | | | | |
| $\Delta x$: | -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 |
| $\Delta y$: | -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 |
| $\Delta z$: | 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 |


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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$(14),C(12,2),M(79),H(13
     ),H$(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
```

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# 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 $\phi$.

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 $\phi$ and $\lambda$, 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 ( $\alpha$ ), 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- $\varepsilon$ ), 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

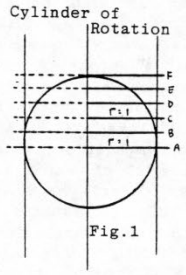

Fig.1

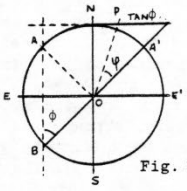

Fig. 3

Right Celestial Cone

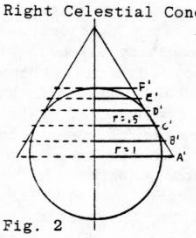

Fig. 2

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 ($\phi$); 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 $\phi$.

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 $\phi$ . When this AD is added or subtracted from the right ascension, we have an OA point which has been taken "under the pole of $\phi$ " (polar elevation or pole is synonymous here to latitude). If we substitute TANGENS $\phi$ with TANGENS $\psi$ , 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 $\psi$ , 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 $\phi$ 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 trigonomotric 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 $\Delta$ 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 $\psi$'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 ($\psi$), 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 $\psi$'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 $\delta$ and tangent $\phi$ :

EXAMPLE:

SA = ARCOSINE(TAN $\delta$ TAN $\phi$) for $\delta$ and $\phi$ 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 $\phi$ , (see Fig. 3), reads thus:
$\psi$ = ARCTANGENT ((MD/SA) TAN $\phi$)
where $\psi$ = topocentric pole
EXAMPLE:
$\psi$ = 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 $\phi$ 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 $\phi$ as in eq. 1.2:

AD $\psi$ = ARSINE(TAN $\delta$ TAN $\psi$ t)
where AD $\psi$ = ascensional difference under $\psi$ for $\psi$ and $\delta$ as above.

EXAMPLE
AD $\psi$ = 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 $\phi$ with a proportion of $\phi$ 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 - AD$\psi$ (oblique ascension upon cone) if east of meridian
ODo = RA + AD$\psi$ (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
$\phi$ = 40 49' 53"+
$\lambda$ = 73 54' 30"-
RAMC= 279 52'45"
RAIC= 099 52'45"

CH2 - Mother
B. Certificate

Jan. 28, 1957
JD= 2435867.560
UT= 142400 hrs
$\phi$ = 40 43' 59"+
$\lambda$ = 40 43' 59"-
RAMC= 269 33'59"
RAIC= 089 33' 59"

CH3 - Son
Stopwatched

Dec. 23, 1978
JD= 2443865.230
UT= 091259 hrs
$\phi$=40 52' 44" +
$\lambda$= 73 52' 49" -
RAMC= 155 55' 45"
RAIC= 335 55' 45"

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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"

15

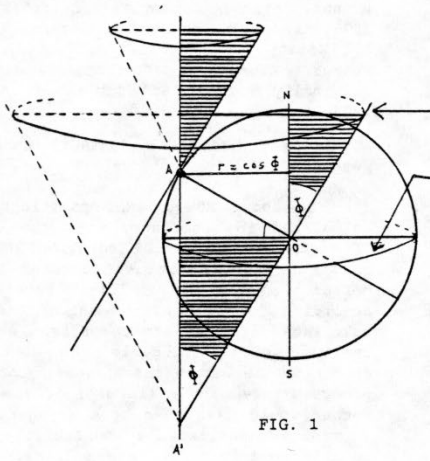


FIG. 1

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
$\phi$ = geographical latitude (elevation of earth's pole angularly over gencentric horizon): note that $\phi$ = 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).

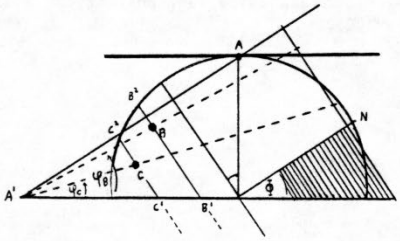


FIG. 2

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 $\phi$ of A. If for example B were to have the same angular elevation as does A, its pole ($\psi$) would be equivalent to $\phi$. $B^1$ $B^2$ & $C^1$ $C^2$ 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

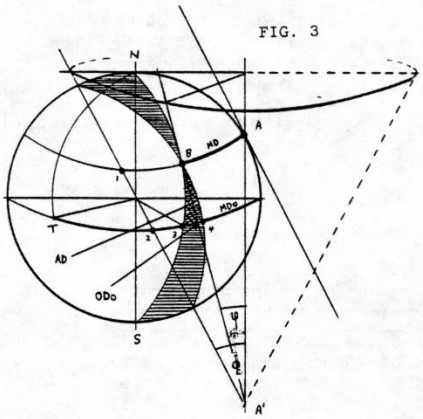


Fig. 3 "PLACIDEAN" VALUES VERSUS TOPOCENTRIC VALUES

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
$\gamma$ = Vernal Equinox
1 = setting point (on geocentric horizon) of B
2 = setting point of OD of B
3 = $\alpha$ of B
4 = oblique descension of B under $\phi$
B34 = ascenional difference of B under $\phi$
MD = meridian distance in $\alpha$ of B
MDo = meridian distance in $\alpha$ of B upon equator (or cone)
$\psi$ = 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 $\phi$ ). 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 $\phi$. 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: AD$\psi$.

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 AD$\psi$, & 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 |


# MERCURY HOUR

**The Astrologer's Astrological Magazine**

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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 364679609802144,314630453798773
     ,126058513799289
202  DATA 343056759900164,335493907199941
     ,135538111299946
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 1139286958199992,14618981250000
     01,624434640400001
402  DATA 1126310446300000,14695336592000
     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 -3014539816399995,1772046007999
     98,148473281599998
502  DATA -3015526882500000,1657003137000
     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 -2105302447995983,2853296420994
     206,1539415696994688
602  DATA -2112384867995637,2844653041993
     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      VOLUME XII
C
       IMPLICIT REAL*8 (A-H,O-Z)
       REAL*8 X(3,5),DX(3,5,5),R2(5),D2(5,5),R3(5),D3(5,5),EM(5),SM(5),
      1  EK1(5),EK2(5,5),S(3,5),T(3,5,5),U(3,5),BX(3,10,5),BXP(3,10,5),
      2  A(10),RATIO(5),TAB(10,3,5),VEL(3,5)
       REAL*4 BN(5)/'JU','SA','UR','NE','PL'/
       INTEGER*4 INDX(20)
C            REAL*8 AXQ(3,5)
C
C         GRAVITATIONAL CONSTANT, EMO = SUM OF SUN AND INNER BODY MASSES
C            AND RECIPROCAL MASSES OF THE OUTER BODIES
C
       GAUSS = 0.01720 20989 5DO
       WK2 = (40.DO*GAUSS)**2
       EMO = 1.00000 59768 2DO
       EM(1) = 1047.355DO
       EM(2) = 3501.600
       EM(3) = 22869.DO
       EM(4) = 19314.DO
       EM(5) = 360000.DO
       INF = 1
C
CC     READ STARTING VALUES - SECOND SUMMATIONS AND ATTRACTIONS
C
       DO 10 I = 1,5
       EM(I) = 1.DO/EM(I)
       SM(I) = EMO + EM(I)
       RATIO(I) = EM(I)/SM(I)
       READ(INF,1000) ((BXP(L,K,I),L=1,3),K=9,10)
       READ(INF,1000) ((BX(L,K,I),L=1,3),K=1,10)
 1000 FORMAT(3F24.14)
   10 CONTINUE
CC
CC        GENERATE COWELL INTEGRATION COEFFICIENTS
C
       A(10) =    1132 57214.DO
       A(9)  = - 4709 82463.DO
       A(8)  =  12079 40748.DO
       A(7)  = -20690 52724.DO
       A(6)  =  24499 52000.DO
       A(5)  = -20232 24114.DO
       A(4)  =  11486 01188.DO
       A(3)  = - 4286 07748.DO
       A(2)  =    948 80274.DO
       A(1)  = -   94 58775.DO
       DO 20 I = 1,10
       A(I) = A(I)/1596 67200.DO
       INDX(I) = I
   20 INDX(I+10) = I
C
C         STARTING DATE AND INITIAL SUBSCRIPT
C
       JD = 2430000
       KL = 9
CCC
CCC      START ITERATION LOOP FOR DESIRED NUMBER OF TIME-STEPS
C
       DO 970 ITIME = 1,2215
C      DO 970 ITIME = 1,30
C      DO 990 ITIME = 1,10
CCC    USE NEXT CARD FOR FORWARD INTEGRATIONS:
CCC    JD = JD + 40
C      USE NEXT CARD FOR BACKWARD INTEGRATIONS:
       JD = JD - 40
       KL = KL + 1
       IF (KL .GE. 20) KL = 10
       KSTO = INDX(KL)
       KSP1 = INDX(KL+1)
       KSM1 = INDX(KL-1)
       ITM = MOD(JD/40,10) + 1
C
C        COMPUTE SECOND SUMMATIONS (BXP) & POSITIONS (X).  (STEP 11)
C              NOTE: STEP NUMBERS REFER TO PAGES XII
C              AND XIII OF APNA VOLUME XII
C
       DO 40 I = 1,5
       DO 40 L = 1,3
       KS = KL - 9
       Q = 0.DO
C            QS = 0.DO
C            KQ = 10
       DO 30 K = 1,10
       KT = INDX(KS)
       Q = Q + BX(L,KT,I)*A(K)
C            QS = QS + BX(L,KT,I)*A(KQ)
C            KQ = KQ - 1
   30 KS = KS + 1
C      AXQ(L,I) = QS
       TEMP = 2.DO*BXP(L,KSTO,I) - BXP(L,KSM1,I) + BX(L,KSTO,I)
       BXP(L,KSP1,I) = TEMP
       TEMP = TEMP + Q
       X(L,I) = TEMP
       TAB(ITM,L,I) = TEMP
   40 CONTINUE
C
CC        COMPUTE COORDINATE DIFFERENCES (STEP 3)
C
       DO 100 I = 1,4
       J1 = I + 1
       DO 100 J = J1,5
       DX(L,I,J) = X(L,J) - X(L,I)
  100 CONTINUE
C
CCC       R(I) SQUARED AND CUBED (STEPS 4 AND 6)
C
       DO 120 I = 1,5
       SUM = 0.DO
       DO 110 L = 1,3
  110 SUM = SUM + X(L,I)*X(L,I)
       R2(I) = SUM
  120 R3(I) = SUM*DSQRT(SUM)
C
CCC       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.DO
       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
CCC        K(I) AND K(I,J) COMPUTATION (STEP 7)
C
       DO 150 I = 1,5
  150 EK1(I) = -WK2*SM(I)/R3(I)
       DO 160 I = 1,4
       J1 = I + 1
       DO 160 J = J1,5
  160 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
```





33

```
      TEMP = EK1(I)*X(L,I)
      S(L,I) = TEMP
  170 U(L,I) = TEMP*RATIO(I)
C
C           T-MATRIX COMPUTATION (STEP8 AND 9)
C
      DO 190 I = 1,4
      JI = I + 1
      DO 190 J = JI,5
      PROD = EK2(I,J)
      DO 180 L = 1,3
      TEMP = PROD*EX(L,I,J)
      T(L,I,J) =  TEMP*EM(J)
  180 T(L,J,I) = -TEMP*EM(I)
  190 CONTINUE
C
C           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,KSP1,I) = SUM
  310 CONTINUE
C     WRITE(6,2000) JD,X
 2000 FORMAT(1X,I7,'.5',7(1X,3F25.15))
C
      IF (ITM .NE. 5) GO TO 970
      IF (ITIME .LT. 10) GO TO 970
C
C                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
C           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(I,L,I),L=1,3),(VEL(L,I),L=1,3)
 7000 FORMAT(A2,1X,I7,'.5',1X,3F13.9,1X,9P3F9.0)
      WRITE(6,6000) BN(I),JDP,(TAB(I,L,I),L=1,3),(VEL(L,I),L=1,3)
 6000 FORMAT(1X,A2,1X,I7,'.5',1X,3F18.9,1X,9P3F14.0)
  360 CONTINUE
C
  970 CONTINUE
C
C                     PRINT AND PUNCH RESTART VALUES
C
      WRITE(6,1001) JD
 1001 FORMAT('1',I7,'.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(7,1002) (BXP(L,KSTO,I),L=1,3)
      WRITE(6,1002) (BXP(L,KSTO,I),L=1,3)
      KS = KL - 9
      DO 980 K = 1,10
      KT = MODX(KS)
      WRITE(7,1000) ( BX(L,KT,I),L=1,3)
      WRITE(6,1002) ( BX(L,KT,I),L=1,3)
      KS = KS + 1
  580 CONTINUE
  990 CONTINUE
C
      STOP
      END
```

```
                VEL. XII FORWARD INTEGRATION STARTING VALUES
+ 3.6467960980214E+ 3.1463045379E773  + 1.26058513799289
+ 3.4305675990031E64  + 3.3549390719994 1  + 1.3553811129994 6
- 0.0187923086251 4  - 0.0043574337021 2  - 0.0014098540343 8
- 0.0184600729558 2  - 0.0054507641506 1  - 0.CC188706163145
- 0.0180454243376 5  - 0.0065188037137 2  - 0.0023554340281 5
- 0.017550902125 4  - 0.007555622099 3  - 0.0028123641837 2
- 0.0169796510096 7  - 0.00855556472458  - 0.0032553484685 0
- 0.016335379353 24  - 0.0095133132284 1  - 0.0036820137029 9
- 0.0156223087899 8  - 0.0104239396636 9  - 0.0040901416996 9
- 0.0148451163397 3  - 0.0112829533349 4  - 0.0044776984661 8
- 0.0140088705528 6  - 0.0120863395141 4  - 0.0048428143459 9
- 0.013118963362 42  - 0.0128305894834 9  - 0.005183874E1919
+ 6.8C597673200141  + 5.823777030001 44  + 2.11410328000041
+ 6.641355344CC012  + 5.57181514995992  + 2.18242664199986
- 0.0047470157588 9  - 0.0026949009229 2  - 0.CCC909255263 14
- 0.CC468675725586  - 0.0028086502503 6  - 0.0009588523334 2
- 0.0046230162225 2  - 0.0029212394975 5  - 0.0010081190893 0
- 0.004555785605 00  - 0.0030325443777 6  - 0.001C570059541
- 0.CC4485C5814354  - 0.0031424412167 1  - 0.0011054637954 2
- 0.0044108271578 9  - 0.0032508088847 5  - 0.CC115344576 50
- 0.0043330879543 7  - 0.0033575307423 8  - 0.0012009019452 2
- 0.0042518398607 1  - 0.0034624962827 0  - 0.0012477916560 6
- 0.0041670886380 9  - 0.0035656021530 0  - 0.0012940717291 3
- 0.004078848906 50  - 0.0036667523257 2  - 0.0013397022984 0
+11.392869581999 92  +14.6189E125000001  + 6.2443466040000 1
+11.263104463000 00  +14.6953365920012  + 6.27963894 7C0CC0
- 0.CCC799403086 32  - 0.0008847786706 8  - 0.0003761274586 3
- 0.0007920894712 2  - 0.0008920083612 8  - 0.00C3793933157
- 0.0007846387662 8  - 0.0008991719037 4  - 0.0003826331994 4
- 0.CCC777C5331617  - 0.C009C626264019  - 0.0003858441273 4
- 0.0007693359801 7  - 0.0009132741685 0  - 0.CCC389023276 24
- 0.C0C761490093 00  - 0.0009202004159 0  - 0.0003921679355 6
- 0.0007535194209 6  - 0.0009270357083 4  - 0.0003952755565 2
- 0.0007454281149 0  - 0.0009337748335 6  - 0.0003983437777C1
- 0.CCC737220661 72  - 0.0009404130958 5  - 0.0004313704509 2
- 0.0007289018352 2  - 0.0009469463606 0  - 0.CCC4043536672 1
-3C.145398161399995  + 1.77204600799998  + 1.48473281599998
-3C.155268E2500000  + 1.65700313700000  + 1.43786002500000
+ 0.0004963888600 2  - 0.0000511080957 1  - 0.0CCC3350369345
+ C.C0C4969141382 2  - 0.0000502081083 5  - 0.0000331687127 3
+ 0.0004975100530 1  - 0.0000492831300 9  - 0.0000328247637 7
+ 0.0004981742027 8  - 0.0000483274929 1  - 0.0000324693536 5
+ C.C0049850361079  - 0.0000473579257  - 0.0000321000927 0
+ 0.0004996947646 3  - 0.0000463029469 0  - 0.0000317147135 6
+ 0.0005005436636 8  - 0.0000452242490 8  - 0.0000313110982 3
+ 0.0005014458736 3  - 0.C0C0440954C790  - 0.0000308872981 1
+ 0.0005023965865 1  - 0.0000429125949 5  - 0.0000304415514 8
+ C.CCC5C3390689 79  - 0.0000416724634 6  - 0.0000299722973 8
-21.053024479959 83  +28.5329642099420 6  +15.3541569699468 8
-21.123848679956 37  +28.4465304199390 3  +15.3822769599440 0
+ C.CCC1455597014 6  - 0.0002406687760 4  - 0.0001261632115 6
+ 0.0001472689083 4  - 0.0002415609621 3  - 0.CCC1268576656 4
+ C.CC0148620320 54  - 0.0002424250531 5  - 0.0001275433482 1
+ 0.0001500512307 1  - 0.0002432561997 4  - 0.0001282177593 2
+ 0.0001515588728 7  - 0.0002440486642 2  - 0.0001288784976 4
+ 0.CCC1531395618 2  - 0.0002447973307 9  - 0.0001295232863 4
+ 0.0001547893206 5  - C.C0024549745658  - 0.CCC1301499965 2
+ C.CCC1560036352 9  - 0.0002461447167 8  - 0.0001307566676 4
+ C.0C0156277814 63  - 0.0002467352417 1  - 0.0001313415258 3
+ 0.0001601165547 4  - 0.0002472656453 1  - 0.0001319039956 5
```



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VOL. XII BACKWARD INTEGRATION STARTING VALUES

| | | |
|---|---|---|
| + 3.2612201366 1305 | + 3.5597430165 2795 | + 1.4449932131 8713 |
| + 3.4305675990 0034 | + 3.3549390719 5972 | + 1.3553811129 9972 |
| - 0.0036551644 4054 | - 0.0165512962 4800 | - 0.0077114017 4172 |
| - 0.0047662127 2909 | - 0.0164101074 6960 | - 0.0069237009 1775 |
| - 0.0058754530 4976 | - 0.0162016597 6647 | - 0.0060871675 4638 |
| - 0.0069775522 4719 | - 0.0159249189 0713 | - 0.0066615095 4247 |
| - 0.0078066552 6540 | - 0.0155793069 9543 | - 0.0064866141 4143 |
| - 0.0091379125 2603 | - 0.0151646887 2744 | - 0.0062825629 6393 |
| - 0.0101345537 5768 | - 0.0146814036 3576 | - 0.0060496446 1633 |
| - 0.0112005246 6950 | - 0.0141302931 7862 | - 0.0057883650 4517 |
| - 0.0121810394 1778 | - 0.0135127215 8502 | - 0.0054994550 8872 |
| - 0.0131189633 6242 | - 0.0128305894 8349 | - 0.0051838748 1919 |
| + 6.4735351070 9228 | + 6.1163065176 7277 | + 2.2494103017 0100 |
| + 6.6417953440 0008 | + 5.9718751500 0000 | + 2.1824266419 5594 |
| - 0.0031356825 6436 | - 0.0044751785 7140 | - 0.0017149045 5226 |
| - 0.0032528465 1806 | - 0.0043954127 5633 | - 0.0016768360 9014 |
| - 0.0033671234 2591 | - 0.0043129307 2181 | - 0.0016377673 2229 |
| - 0.0034784179 3302 | - 0.0042278219 4884 | - 0.0015977403 8162 |
| - 0.0035866381 3411 | - 0.0041401739 0524 | - 0.0015567966 7353 |
| - 0.0036916971 7152 | - 0.0040500716 1852 | - 0.0015149765 9557 |
| - 0.0037935144 4313 | - 0.0039575976 9215 | - 0.0014723193 8542 |
| - 0.0038920130 0670 | - 0.0038628328 9375 | - 0.0014288631 5760 |
| - 0.0039871461 5968 | - 0.0037658573 5935 | - 0.0013846451 6727 |
| - 0.0040788489 0650 | - 0.0036667523 2572 | - 0.0013397022 5840 |
| +11.1326104421 6486 | +14.7707449876 3963 | + 6.3145271363 3278 |
| +11.2631044630 0000 | +14.6953365920 0012 | + 6.2756389470 0000 |
| - 0.0006498894 5413 | - 0.0010006358 5552 | - 0.0004290587 3408 |
| - 0.0006585717 6121 | - 0.0009951352 4800 | - 0.0004265104 9775 |
| - 0.0006679908 6755 | - 0.0009895187 8653 | - 0.0004239129 2914 |
| - 0.0006767941 4920 9 | - 0.0009837856 1534 | - 0.0004212657 8150 |
| - 0.0006858182 3585 | - 0.0009779352 9428 | - 0.0004185689 9180 |
| - 0.0006946615 6233 6 | - 0.0009719678 5205 | - 0.0004158227 0310 |
| - 0.0007033281 4527 | - 0.0009658838 3480 | - 0.0004130272 8477 |
| - 0.0007119503 0196 | - 0.0009596843 4770 | - 0.0004101833 4951 |
| - 0.0007204766 4766 | - 0.0009533710 8700 | - 0.0004072917 6615 |
| - 0.0007289018 3522 | - 0.0009469463 6060 | - 0.0004043536 6721 |
| -30.1646360953 1526 | + 1.5419185935 3656 | + 1.3905572617 0264 |
| -30.1552668250 0000 | + 1.6570031370 0000 | + 1.4378600250 0000 |
| + 0.0005133771 6544 | - 0.0000276313 0239 | - 0.0000245398 0821 |
| + 0.0005122415 6391 | - 0.0000294545 4515 | - 0.0000252555 8435 |
| + 0.0005111000 1169 | - 0.0000312127 6089 | - 0.0000259433 3595 |
| + 0.0005099575 9064 | - 0.0000329049 9750 | - 0.0000266027 7921 |
| + 0.0005088195 9521 | - 0.0000345306 9128 | - 0.0000272338 0218 |
| + 0.0005076914 9285 | - 0.0000360897 0135 | - 0.0000278364 7851 |
| + 0.0005065737 8807 | - 0.0000375823 4036 | - 0.0000284110 7553 |
| + 0.0005054874 2056 | - 0.0000390094 0039 | - 0.0000289580 8408 |
| + 0.0005044422 8080 7 | - 0.0000403721 7317 | - 0.0000294781 8580 |
| + 0.0005033906 8479 | - 0.0000416724 6346 | - 0.0000299722 9738 |
| -21.1945127733 9817 | +28.3598493642 9069 | +15.3822650469 4547 |
| -21.1238486799 5637 | +28.4465304199 3903 | +15.3882769599 4400 |
| + 0.0001781025 9775 | - 0.0002490252 3265 | - 0.0001357493 4779 |
| + 0.0001760333 9329 | - 0.0002491054 2504 | - 0.0001354342 0981 |
| + 0.0001739690 2896 | - 0.0002491172 9656 | - 0.0001350905 6749 |
| + 0.0001715146 3992 | - 0.0002490599 6356 | - 0.0001347193 6708 |
| + 0.0001698755 7380 | - 0.0002489329 2699 | - 0.0001343193 2450 |
| + 0.0001678573 5053 | - 0.0002487361 0683 | - 0.0001338909 3915 |
| + 0.0001658656 1588 | - 0.0002484698 7303 | - 0.0001334345 0666 |
| + 0.0001639068 9165 | - 0.0002481350 7155 | - 0.0001329505 2585 |
| + 0.0001615843 0566 | - 0.0002477330 4482 | - 0.0001324397 1208 |
| + 0.0001601065 5474 | - 0.0002472656 4531 | - 0.0001319029 9565 |

BACKWARD INTEGRATION
FROM 6.0 JANUARY 1941
JD = 2429960.5

HELIO: EQUINOX AND EQUATOR OF 1950.0

| | | | |
|---|---|---|---|
| JU | 3.64562847 | 3.1452971 | 1.26018147 |
| SA | 6.80562946 | 5.82347989 | 2.11399544 |
| UR | 11.3928082 | 14.6189029 | 6.24431296 |
| NE | -30.1453563 | 1.77204243 | 1.48473028 |
| PL | -21.0530113 | 28.5329432 | 15.394146 |

HELIO: EQUINOX AND ECLIPTIC OF DATE

| | | | |
|---|---|---|---|
| JU | 3.65312636 | 3.37892375 | -.0953948121 |
| SA | 6.81931785 | 6.16868753 | -.377737018 |
| UR | 11.4280131 | 15.8711242 | -.0881743403 |
| NE | -30.1403683 | 2.28330635 | .657099005 |
| PL | -20.9813586 | 32.3488577 | 2.76981219 |

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# 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



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of the form

$$A_o+A_1T+A_2T^2+A_3T^3+\ldots$$

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 | $752\times10^{-7}$ |
| Saturn | 4".71 | 7".35 | $1575\times10^{-7}$ |
| Uranus | 3".12 | 1".98 | $1398\times10^{-7}$ |
| Neptune | 4".86 | 0".50 | $3232\times10^{-7}$ |

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,



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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

$\pi$=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-$\pi$+nt)mod360°=mean anomaly of Jupiter

g'=(284°43'0".42+43996".2044t)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 $\delta z$ and $\delta \log \frac{r}{a}$ which follow.)

$\delta z$=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 ) |



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| | | | |
|---|---|---|---|
| +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 ) |

$z_T=(T_E+z+\delta z) \bmod P$

($z_T$ 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.)

$f=(n_d z_T+ 19900".339\sin n_d z_T+599".829\sin 2n_d z_T+25".070\sin 3n_d z_T$
$+1".198\sin 4n_d z_T) \bmod 360°$

(f is the true anomaly.)

$R=27".029\sin(2f+5° 56'.4)$

(R is the reduction to the ecliptic.)

$\lambda=(\Pi+f+R+pt) \bmod 360°$

($\lambda$ is the heliocentric geometric longitude of Jupiter referred to the mean equinox of date.)

$\log r=\log a+\log(1-e^2)-\log(1+e\cos f)+(\delta\log\frac{r}{r})10^{-7}$

$r=10^{\log r}$



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(r is the heliocentric radius vector measured in a.u.)

$m_T=z_T/P$

$\pi-\Lambda=272^\circ\ 57'\ 22".33+161".07m_T$

($\Lambda$ is the ecliptic ascending node of Jupiter's orbit.)

$i=1^\circ\ 18'\ 42".8\ -2".35m_T$=Jupiter's inclination

$\sin\beta=\sin i\sin(f+(\pi-\Lambda))+4".3743lm\sin(f+35^\circ\ 31'\ 23".2)$

$\beta=\sin^{-1}(\sin\beta)$= 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".258141=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° 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° 1' 58".33+109256".639541t)mod360°=Jupiter's mean anomaly

g'=(L-$\pi$+nt)mod360°=Saturn's mean anomaly

g"=(220° 10' 10".35+15425".752t)mod360°=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 ) |



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| | | | | |
|---|---|---|---|---|
| +0.06313 | | sin( - g'+2g"+ | 354° 17'.1 | ) |
| +0.10175 | | sin( -2g'+2g"+ | 336° 43'.3 | ) |
| +0.23440 | | 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 | ) |

$z_T=(T_E+z+\delta z)\text{mod}P$

($z_T$ 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.)

$f=(n_d z_T+23117".641\sin n_d z_T+809".380\sin 2n_d z_T+39".293\sin 3n_d z_T+2".180\sin 4n_d z_T)\text{mod } 360^\circ$

(f is the true anomaly.)

$R=97".774\sin(2f+135^\circ\ 31'\ 44".9)$

(R is the reduction to the ecliptic.)

$\lambda=(\pi+f+R+pt)\text{mod}360^\circ$

($\lambda$ 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.)

$m_T=z_T/P$

$\pi-\Omega=-(22^\circ\ 21'\ 27".04)+550".24m_T$

($\Omega$ is the ecliptic ascending node of Saturn's orbit. Note minus sign.)

$i=2^\circ\ 29'\ 42".36-3".92m_T$=Saturn's inclination



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$\sin\beta = \sin i \sin(f+(\Pi-\Omega)) + 24".2666 m \sin(f+77^\circ\ 3'\ 36")$

$\beta = \sin^{-1}(\sin\beta)$ = 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

$\Delta l = 33".086T^2 - 0".0173T^3 - 0".0622T^4$

$l = (243^\circ\ 21'\ 44".66 + 1547634".44T + 1".109T^2 + \Delta l) \bmod 360^\circ$ = 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".551$T^2$ - 0".516$T^3$ - 0".014$T^4$

| | | | | |
|---|---|---|---|---|
| -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".721$T^2$ - 0".067$T^3$ + 0".016$T^4$

| | | | | |
|---|---|---|---|---|
| +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) | |



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+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.)

$u=(L-\mathcal{N})\bmod 360^\circ$





$R=-9".38\sin 2u$

(This is the reduction to the ecliptic.)

$\lambda=(L+R)\bmod 360^\circ$

($\lambda$ 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.)

$\beta_0=\sin^{-1}(\sin i\sin u)$

($\beta_0$ 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)

$10^8(r.c.1)=555-724+1175T-12980T+164T^2+54T^3+1T^4$



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+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-72$T^2$

+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=1.28333714-0.020414114cosg-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

$\Delta l$=0".41+0".56T-22".401$T^2$+0".014$T^3$+0".042$T^4$

$\Delta h$=0".12-17".673T+0".503$T^2$+0".159$T^3$+0".007$T^4$
+0".687T

$\Delta k$=-0".17+1".061T+12".192T+1".962$T^2$+0".027$T^3$-0".006$T^4$

l=(85° 1' 30".63+791505".84T+1".109$T^2$+$\Delta l$)mod360°=Neptune's mean longitude

g=(41° 16'.173+13108'.007T+$\Delta l$)mod360°=Neptune's mean anomaly

$\Omega$=130° 40' 44".0+3963".93T+2".30$T^2$+0".067$T^3$=Neptune's ascending ecliptic node

i=1° 46' 45".32-33".07T-0".015$T^2$-0".005$T^3$=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°.015$T^2$)mod360°

II =$l_1$-g'=(180°.966+1003°.999T+0°.147$T^2$-0°.01$T^3$)mod360°

III=$l_2$-g'=(153°.264+2816°.243T-0°.01$T^2$+0°.017$T^3$)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.1)=+2Δk

+4".299 sin (I) -0".734cos (I)

-4".850 sin2(I) +9".194cos2(I)

+0".836 sin3(I) +1".647cos3(I)

(v.c.1)=-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+0.5$T^2$-0.33$T^3$

-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.1)=-3+357.5T-10.5$T^2$-3$T^3$

-1 sin (I) -50 cos (I)

+57 sin2(I) +28 cos2(I)

$10^7$(r.c.1)=+4-278.5T-41.5$T^2$-1$T^3$

+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.1)sing+(v.c.1)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.)

β=$\sin^{-1}$(sinisinu)

(β is the heliocentric geometric latitude.)

loga=1.47814314

logr=loga+0.00000790-0.00370591cosg

-0.00002372cos2g-0.00000019cos3g

+((r.c.0)+(r.s.1)sing+(r.c.1)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. | Ave. long. residual | Ave. lat. residual | Algorithm helio lat. | A.P.A.E. helio lat. | Ave. lat. rad. Vector | A.P.A.E. R. | Algorithm rad. Vector | Ave. r res.$\times 10^{-9}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 07/Jul/1653 | 330°24'38" | 330°24'44" | -6".87 | 0".07 | 0°-43'-48" | 0°-43'-48" | 0".23 | 5.059117626l | 5.059175l40l | +591l0 |
| 02/08/1666 | 352 36 36 | 352 36 46 | -10 | .13 | -45 | -46 | .23 | 4.96300295 | 5.4l5078lllll | -15027Q |
| 09/04/1666 | 157 26 51 | 157 26 46 | +5 | .13 | -45 | -46 | .23 | 4.96296020 | 5.4l98888639 | +42758 |
| 03/31/1673 | 193 7 20 | 193 7 19 | +1 | .22 | -22 | -18 | .78 | 4.977814ll77 | 5.4l98l8ll39 | -43205 |
| 10/26/1679 | 35 27 37 | 35 27 38 | -1 | .46 | -46 | -30 | .11 | 5.01996805 | 5.12l68695 | -09608 |
| 03/22/1713 | 323 25 57 | 323 24 57 | +1 | .11 | -56 | -30 | .11 | 5.01998566 | 5.12l68695 | -17617 |
| 08/07/1717 | 83 51 36 | 83 51 36 | 0 | .68 | -59 | -52 | .25 | 5.12l677l4l7 | 5.l308l0361l | -81444 |
| 02/07/1767 | 165 43 44 | 165 43 42 | +2 | .25 | -52 | -52 | .25 | 5.l3075597l7 | 5.l3075597l7 | -81444 |
| 12/02/1791 | 282 26 07 | 282 26 10 | -3 | .18 | -39 | -36 | .76 | 5.1839758200 | 5.1839787879 | -96720 |
| 08/23/1821 | 19 58 19 | 19 58 19 | 0 | .92 | -17 | -17 | .38 | 4.9500722265 | 4.9501700l88 | -97823 |
| 01/Jul/1846 | 306 07 58 | 306 08 05 | -7 | .96 | -09 | -09 | .82 | 4.9778014l4l5 | 5.2l0582l450 | -58177 |
| 11/08/1875 | 222 21 46 | 222 21 55 | -9 | .63 | -05 | -05 | .63 | 4.9778014l4l5 | 5.l2l6l7l059l | +60628 |
| 09/08/1902 | 315 44 08 | 315 43 57 | +11 | .85 | -45 | -07 | .68 | 5.0581396?l | 5.0582014317 | -6l6l46 |
| 07/08/1929 | 58 07 12 | 58 07 16 | -4 | .86 | -52 | -09 | .65 | 5.0380528l56 | 5.0151l40168 | -17l63l |
| 04/29/1950 | 321 30 56 | 321 30 55 | +1 | .65 | -52 | -20 | .65 | 5.037960852 | 5.037966729 | -5878 |
| 02/26/1977 | 6l 59 27 | 6l 59 31 | -4 | .16 | -45 | -10 | .21 | 5.0381522?l | 5.0381522?l | -99815 |
| 07/Jul/2001 | 17l 01 05 | 17l 01 06 | -1 | .59 | -11 | -20 | .72 | 5.l382?l0l47 | 5.l38l85091l8 | -23807l |
| 11/30/2031 | 277 45 57 | 277 45 57 | 0 | .29 | -10 | -08 | .61 | 4.96125928l2 | 5.22ll928l8l | -63661 |
| 03/13/2058 | 359 39 51 | 359 39 51 | 0 | .81 | -10 | -08 | .61 | 4.96125928l2 | 5.96120587l | +5353l |



– 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 | 9.651336461 | -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 | 9.824519044 | 9.824206937 | +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 |

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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 -44 -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 | 18.752333114 | + 38288 |
| 01/21/1839 | 341 57 46 | 341 57 46 | -0 .48 | 0 -46 -18 | 0 -46 -19 | 0 .74 | 20.088057853 | 20.088111015 | - 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 | 19.785553497 | -185777 |
| 01/16/2023 | 47 40 02 | 47 40 04 | -2 .85 | 0 -20 -39 | 0 -20 -40 | 0 .62 | 19.667432001 | 19.667904559 | -472558 |
| 10/11/2048 | 162 02 38 | 162 02 31 | 7 .33 | 0 46 20 | 0 46 23 | -3 .10 | 18.291437359 | 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 |

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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 △SPP' is close to being a right triangle and so, knowing PŜP', we may calculate PÊP', since

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$^{-9}$ |
|---|---|---|---|---|---|---|---|---|---|
| 12/21/1653 | 263°27'34" | 263°27'17" | 16".41 | 1°15'48" | 1°15'49" | -1".01 | 30.260864049 | 30.259912677 | +951372 |
| 05/08/1681 | 323 20 29 | 323 20 19 | 10 .26 | 0-28-04 | 0-28-04 | -0 .38 | 30.012636343 | 30.012303545 | +332798 |
| 03/08/1708 | 22 57 58 | 22 57 57 | 0 .77 | -1-43-50 | -1-43-50 | -0 .25 | 29.825351735 | 29.824709560 | +641774 |
| 01/06/1735 | 82 54 37 | 82 54 36 | 0 .87 | -1-17-24 | -1-17-23 | -0 .66 | 29.870868487 | 29.870850967 | + 17521 |
| 03/15/1760 | 138 36 56 | 138 36 56 | 0 .17 | 0 17 42 | 0 17 42 | -0 .57 | 30.084648929 | 30.085005768 | -356839 |
| 01/13/1787 | 197 04 19 | 197 04 21 | -1 .95 | 1 39 18 | 1 39 18 | -0 .24 | 30.291596113 | 30.291304923 | +291191 |
| 04/27/1813 | 253 57 30 | 253 57 29 | 0 .47 | 1 28 46 | 1 28 45 | -0 .30 | 30.290205021 | 30.289656914 | +548107 |
| 08/09/1839 | 311 14 56 | 311 14 53 | 2 .59 | 0-02-19 | 0-02-18 | -0 .83 | 30.078614372 | 30.078613437 | + 936 |
| 11/20/1865 | 9 27 35 | 9 27 37 | -1 .81 | -1-31-50 | -1-31-49 | -0 .51 | 29.854582368 | 29.854356200 | +226168 |
| 03/03/1892 | 68 13 25 | 68 13 26 | -0 .78 | -1-34-37 | -1-34-37 | 0 .13 | 29.837287352 | 29.837163239 | +124114 |
| 06/16/1918 | 126 33 42 | 126 33 45 | -2 .58 | 0-08-01 | 0-08-02 | 0 .17 | 30.040988511 | 30.040615476 | +373034 |
| 04/15/1945 | 185 11 13 | 185 11 19 | -5 .67 | 1 26 10 | 1 26 11 | -0 .76 | 30.271131709 | 30.271002557 | +129152 |
| 07/28/1971 | 242 05 21 | 242 05 27 | -5 .95 | 1 39 32 | 1 39 33 | -1 .17 | 30.319687335 | 30.319529374 | +157961 |
| 11/08/1997 | 299 13 34 | 299 13 36 | -1 .50 | 0 23 03 | 0 23 03 | -0 .31 | 30.146020635 | 30.146004417 | + 16218 |
| 02/20/2024 | 357 12 46 | 357 12 35 | 10 .79 | -1-15-13 | -1-15-13 | 0 .32 | 29.901634763 | 29.902338656 | -703893 |
| 12/20/2050 | 57 09 15 | 57 09 01 | 14 .33 | -1-42-24 | -1-42-24 | 0 .25 | 29.816287729 | 29.816696884 | -409156 |
| 12/07/2060 | 79 24 54 | 79 24 38 | 16 .00 | -1-24-35 | -1-24-36 | 0 .64 | 29.863125722 | 29.862911655 | +214067 |

$$P\hat{E}P' = \tan^{-1}(SP \tan P\hat{S}P'/EP)$$

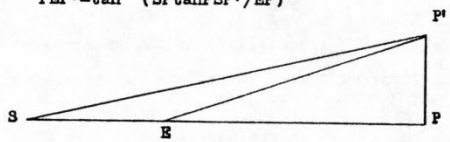


Figure 1

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 $P\hat{E}P'$. We wish to determine when $P\hat{E}P'$ will be a maximum. Assuming the orbits are circular, i.e., holding SE and SP constant, we have

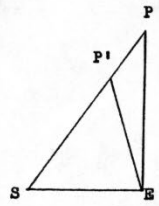


Figure 2

$$\sin P\hat{E}P' = \frac{PP' \sin S\hat{P}E}{SE}$$





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.

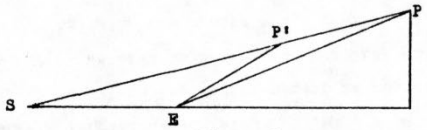


Figure 3

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',

$$SP \approx 9 \text{ a.u.}, PP' = .0001575, E\hat{S}P \approx 2^\circ.5$$

$$P\hat{E}P \approx \sin^{-1}\left(\frac{(1575 \times 10^{-7}) \sin 2^\circ.5}{(1+9^2 - 2(9)\cos 2^\circ.5)^{\frac{1}{2}}}\right) \approx 0''.18$$

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

$$\delta\log\frac{r}{r}=\sum_n\left[A_n\cos(a_n+B_n)\right] \text{ where}$$

$$\cos(a_n+B_n)=\cos a_n\cos B_n-\sin a_n\sin B_n$$

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

$$CB(n)=\cos B_n,\ SB(n)=\sin B_n$$

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



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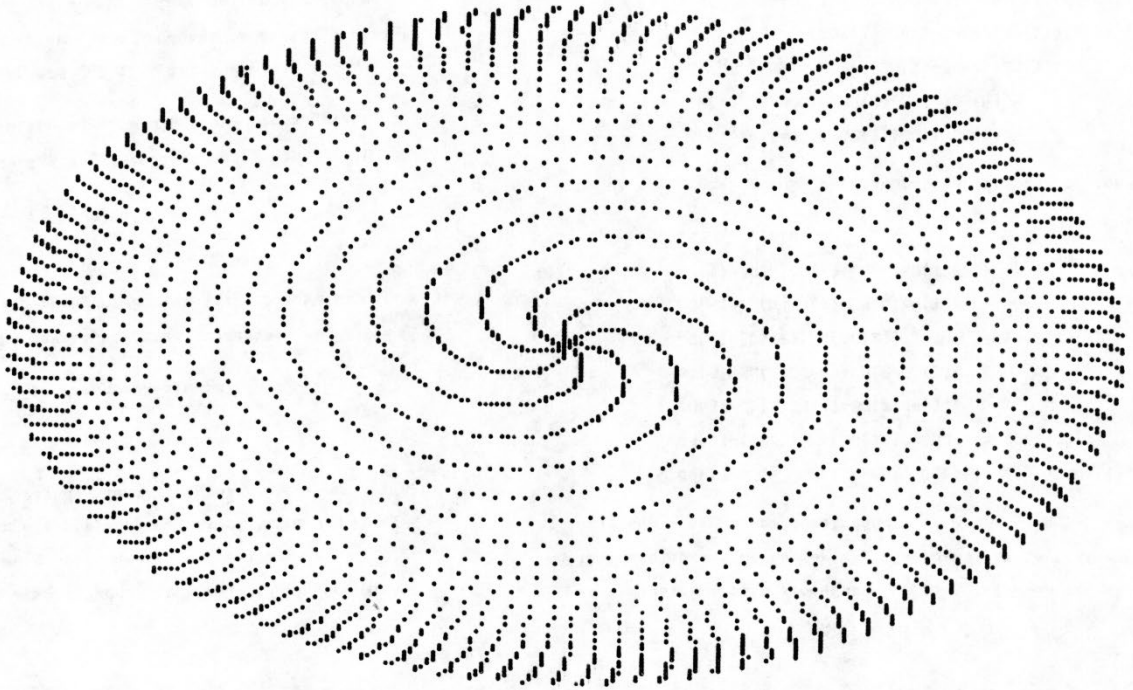
$$\delta \log \frac{r}{F} = \sum_n \left\{ A_n \left[ (CGP(i_n)CG(j_n) + SGP(i_n)SG(j_n))CB(n) \right.\right.$$
$$\left.\left. -(SGP(i_n)CG(j_n) - CGP(i_n)SG(j_n))SB(n) \right] \right\}$$

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.





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## 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:

$\phi$ Geographic or geocentric latitude
$\alpha_0$ Right ascension of the zenith meridian
$\alpha_p, \delta_p$ Right ascension and declination of a point, such as a planet.
$\alpha_k, \delta_k$ Right ascension and declination of a Placidus cusp.
$\lambda, \beta$ longitude and latitude , Ecliptic
A Azimuth
$\varepsilon$ 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 | $\alpha_0$ | $\phi$ |
| MIDHEAVEN | $\alpha_0 - 90°$ | 0 |
| VERTEX | $\alpha_0 + 180°$ | $90° - \phi$ |
| LONGITUDE | $\alpha_p$ | $\delta_p$ |
| | $\lambda = R - 90°$ | |
| RT. ASCEN. | $\lambda$ | $\beta$ |
| | Let $Z = -\varepsilon$; $\alpha_p = R - 90°$ | |
| AZIMUTH | $\alpha_p - \alpha_0 - 90°$ | $\delta_p$ |
| | 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 | $\alpha_0 - 60°$ | ATN(1/2 TAN $\phi$ ) |
| XII | $\alpha_0 - 30°$ | ATN($\sqrt{3}$/2 TAN $\phi$ ) |
| II | $\alpha_0 + 30°$ | ATN($\sqrt{3}$/2 TAN $\phi$ ) |
| III | $\alpha_0 + 60°$ | ATN(1/2 TAN $\phi$ ) |

TOPOCENTRIC

| | | |
|---|---|---|
| XI | $\alpha_0 - 60°$ | ATN(1/3 TAN $\phi$ ) |
| XII | $\alpha_0 - 30°$ | ATN(2/3 TAN $\phi$ ) |
| II | $\alpha_0 + 30°$ | ATN(2/3 TAN $\phi$ ) |
| III | $\alpha_0 + 60°$ | ATN(1/3 TAN $\phi$ ) |

KOCH G.O.H

| | | |
|---|---|---|
| XI | $\alpha_0 - 2/3k - 60°$ | $\phi$ |
| XII | $\alpha_0 - 1/3k - 30°$ | $\phi$ |
| II | $\alpha_0 + 1/3k + 30°$ | $\phi$ |
| III | $\alpha_0 + 2/3k + 60°$ | $\phi$ |

$k = \text{ARCSIN}(\text{SIN } \alpha_0 \text{ TAN } \phi \text{ TAN } \varepsilon)$

EQUAL "M"

| | | |
|---|---|---|
| XI | $\alpha_0 - 60°$ | 0 |
| XII | $\alpha_0 - 30°$ | 0 |
| I | $\alpha_0$ | 0 |
| II | $\alpha_0 + 30°$ | 0 |
| III | $\alpha_0 + 60°$ | 0 |

| AZIMUTH | | |
|---|---|---|
| XI | $\alpha_0$ - 90°- ATN(1/$\sqrt{3}$ SIN$\phi$) | 90° - ARCCOS(1/2 COS$\phi$) |
| XII | $\alpha_0$- 90° - ATN(1/$\sqrt{3}$ SIN$\phi$) | 90° - ARCCOS($\sqrt{3}$/2 COS$\phi$) |
| II | $\alpha_0$ + 90°+ ATN($\sqrt{3}$ SIN$\phi$) | 90° - ARCCOS($\sqrt{3}$/2 COS$\phi$) |
| III | $\alpha_0$ + 90° + ATN(1/$\sqrt{3}$ SIN$\phi$ ) | 90° - ARCCOS(1/2 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, $\phi$ 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 $\delta$, f($\delta$), right ascension being a function of declination as follows:

for cusp XI, f($\delta$) = $\alpha_0$ + 30° + 1/3 ARCSIN(TAN $\delta$ TAN $\phi$)
for cusp XII, f($\delta$) = $\alpha_0$ + 60° + 2/3 ARCSIN(TAN $\delta$ TAN $\phi$)
for cusp II, f($\delta$) = $\alpha_0$ + 120° + 2/3 ARCSIN(TAN $\delta$ TAN $\phi$)
for cusp III, f($\delta$) = $\alpha_0$ + 150° + 1/3 ARCSIN(TAN $\delta$ 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 $\delta'$, f($\delta'$) such that

TAN $\delta'$ = SIN f($\delta'$) TAN $\varepsilon$

By substituting, one can see that this amounts to solving for cusp XI, $\alpha_k = \alpha_0 + 30° + 1/3$ ARCSIN(SIN $\alpha_k$ TAN $\phi$ TAN $\varepsilon$) etc.; $\alpha_k$ is the right ascension of the cusp. This is solved recursively. In other words one takes the function

$\alpha_0$ + p + q ARCSIN(SIN $\alpha_k$ TAN $\phi$ TAN $\varepsilon$)

with p = 30, 60, 120 or 150 degrees and q = 1/3 or 2/3, and inserts any dummy variable for $\alpha_k$ ; the resulting value is taken and used as the variable $\alpha_k$ ; 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 $\alpha_k$ , one can then get its longitude directly through the relationship

$\lambda$ = ATN(TAN$\alpha_k$/COS$\varepsilon$ )

but this requires a check for quadrant. An alternative method is to compute the declination

$\delta_k$ = ATN(SIN$\alpha_k$TAN$\varepsilon$ )

and to convert $\alpha_k$, $\delta_k$ 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(YEAR + MONTH/12 + 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 $\Omega$ and Sun $\odot$ , and so calculate a rough nutation.

.00255833 COS $\Omega$ + .00015306 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 $\lambda_{-1}$ , $\lambda_0$ , $\lambda_1$ and $\lambda_2$ ; 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 $p = q\left[1-\frac{(1-q)(r+s)}{2(r-s)}\right]$ where p is the fraction of the tabular interval (usually 24 hours) which will have elapsed while the body moved from $\lambda_0$ 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 | $\lambda_{-1}$ | 13°33' 56" |
| 18th | $\lambda_{0}$ | 26°43' 23" |
| 19th | $\lambda_{1}$ | 39°31' 08" |
| 20th | $\lambda_{2}$ | 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. Horoscope 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 synomomous 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 horoscope 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.



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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 numner 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 ☉
2. The Moon ☽
3. The Ascendent A

   The Sun is the central character in the horoscope drama; and, therefore, is first in importance.
   The Moon is the main supporting player in the horoscope drama; and, therefore, is almost as important as the Sun.
   The Ascendent is the first scene of the horoscope drama; and, therefore, is more important than any other scene.

4. Rising Planet(s)
5. Other Angular Planets

   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.
   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 ☌ □ ☍
7. Hard Major Aspects to Mercury, Venus, and Mars ☌ □ ☍

   Because the Sun and the Moon are the stars of the horoscope drama, their conflicts with other players comprise the main plot.
   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 mono-logue. Such a dialogue can be reproduced by a client-machine relation-ship, 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 sub-ject, 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.


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"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.



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## 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

# MATRIX MAGAZINE ISSUE SIX –SUMMER/FALL 1979

1979 Summer-Fall

Issue VI

MATRIX MAGAZINE


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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$=BODY NAME; NP-NO. OF PERTUR
     BATION TERMS; TE-CENTRAL EPOCH
315  REM  DT=NUMBER OF VALID DATES FOR THE CHEBY
     SHEV EXPANSION;
316  REM  AM=SEMI-MAJOR AXIS; EC=ECCENTRICITY; S
     O=ARGUMENT OF PERIHELION;
317  REM  IC=INCLINATION; BO=LONG. OF THE ASCEND
     ING NODE; SM=RECIPROCAL MASS;
318  REM  GZ=MEAN ANOMALY AT THE EPOCH; AND SZ=M
     ASS OF THE INNER BODIES.
320  READ BN$,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  REM  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,-200,-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,-9,-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
10
```
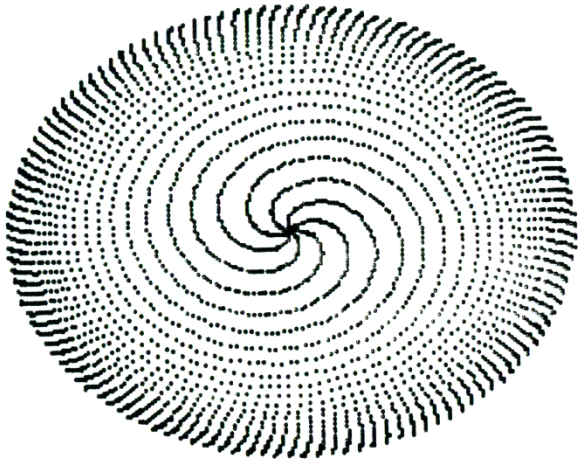

```
16000  DATA  CHIRON,80: REM  LINES 16000-16999.
     FOR 17 JULY 1889 THRU 1 APR 2001
16001  DATA  2431600.5,40800
16002  DATA  13.7342411011,.3838168359,338.82830
     63946,6.9225246891
16003  DATA  208.76913180007,35000000,358.178236
     8507,5.97682E-6
16920  DATA -1,0,0
16921  DATA -1,0,0
16922  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 = 0.029D0 *DCOS(GMV     + 5.166174586D0)
     1     + 0.092D0 *DCOS(-(GPV  ) + 4.269075351D0)
     2     + C.067D0 *DCOS(-(GPV2) + 4.272566009D0)
     3     + 0.210D0 *DCOS(-(GPV3) + 4.267330021D0)
     4     + 0.031D0 *DCOS(-(GPV4) + 1.141445331D0)
     5     + 0.126D0 *DCOS(-(G-J2) + 4.687954371D0)
      DBPL = 0.676D0*DSIN(F) - 0.047D0*DSIN(F-GL)
      ELAT = (DBPP + DBPL) * STRAD
      ELONG = DMOD(ELONG,TWOPI)
      IF (ELONG .LT. 0.D0) 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 GETEQU(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.D0
      RETURN
      END
C*********************************************************************
      SUBROUTINE SETCON
C
C     GENERATE AND SET UP CONSTANTS
C
      IMPLICIT REAL*8 (A-Z)
      COMMON /PI$/RAD,PI,PI02,TWOPI,PI04,STRAD
      PI04 = DATAN(1.D0)
      PI02 = PI04 + PI04
      PI   = PI02 + PI02
      TWOPI = PI + PI
      RAD = 45.D0/PI04
      STRAD = 1.D0/(3600.D0 * RAD)
      GAUSS = 0.01720209895D0
      EMU = 1.D0 + 1.DC/329390.DC
      RETURN
      END
C*********************************************************************
      SUBROUTINE INPCHB
C
C     INPUT CHEBYSHEV DATA FOR THE BODY
C
      IMPLICIT REAL*8(A-H,O-Z)
      REAL*8 YC(730,3),MOTION,MOTR
      COMMON/MOT$/MOTION,MOTR
      COMMON/NSYM$/NSYM(18)
      COMMON /PI$/RAD,PI,PI02,TWOPI,PI04,STRAD
      COMMON /CHEB$/YC,NFIRST,NPTS
      COMMON /EPS$/EPS,SEPS,CEPS,TEPS
      COMMON/GAUSS$/GAUSS,TEPOCH,DTCHEB,SA,SE,SO2,SI2,CO2,SM,SGZ2,SMINNR
      INFILE = 9
      IHFILE = 10
C     INPUT CENTRAL EPOCH, DAYS OF VALIDITY, MEAN ORBITAL ELEMENTS
C     AND MASSES:
      READ(IHFILE,999,END=40)NSYM,TEPOCH,DTCHEB,SA,SE,SO2,SI2,CO2,SM,
     1   SGZ2,SMINNR
  999 FORMAT(18A4/2F15.7/(4F18.11))
      EMU = 1.D0 + SMINNR + SM
      CAPGAU = GAUSS*DSQRT(EMU)
      MOTR = CAPGAU/(SA*DSQRT(SA))
      MOTION = RAD*MOTR
      I1 = 1
      NFIRST = 11
      NP = -2
   10 CONTINUE
      NP = NP + 2
      I2 = I1 + 1
C     INPUT PERTURBATION COEFFICIENTS
      READ(INFILE,1030,END=30) K,((YC(I,J),J=1,3),I=I1,I2)
 1000 FORMAT(I8,6F12.4)
      I1 = I1 + 2
      IF (K .LT. 1000) GO TO 10
      I1 = I1 - 2
      NPTS = NP
   20 CONTINUE
      RETURN
   30 WRITE(6,2000)
 2000 FORMAT('OPREMATURE END OF DATA IN INPCHB. STOP'//)
   40 STOP
      END
C*********************************************************************
      SUBROUTINE PQRGEN
C
C     CONVERT MEAN ORBITAL (ECLIPTIC) ELEMENTS TO MODIFIED DIRECTION
C     COSINE MATRIX TO GENERATE 1950.0 EQUATORIAL POSITIONS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON /PQR$/PQR(3,3)
      COMMON /PI$/RAD,PI,PI02,TWOPI,PI04,STRAD
      COMMON/GAUSS$/GAUSS,TEPOCH,DTCHEB,SA,EC,SO2,SI2,CO2,SM,SGZ2,SMINNR
      EP1950 = 84404.84D0/3600.D0
      EP50R = EP1950/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
```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```
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION N1(3),N2(3),N3(3),N4(3),N5(3),N6(3)
      COMMON /PI$/RAD,PI,PIO2,TWOPI,PIO4,STRAD
      COMMON /RECT$/XYZS(3)
      COMMON /BODY$/XYZH(3),XYZG(3)
      COMMON /JULYN$/DAYJ
      COMMON/GAUSS$/GALSS,TEPOCH,DTCHEB,SA,SE,SO2,SI2,CO2,SM,SGZ2,SMINNR
      GAUSS = 0.0172020989500
      JDFIN = 1
      JSTART = 1
      JDINC = 1
      CALL SETCON
      CALL INPCEB
      CALL PORGEN
    5 CONTINUE
C     WRITE(6,1234)
C1234 FORMAT('READ JSTART,JDFIN,JDINC'/1X,'XXXXXXX XXXXXXX XX')
C
C     JSTART = STARTING JULIAN DAY NUMBER
C     JD = FINAL JULIAN DAY NUMBER
C     JDINC = THE NUMBER OF DAYS TO BE INCREMENTED (STEPSIZE).
C
      READ(5,1235,END=9999)JSTART,JDFIN,JDINC
 1235 FORMAT(I7,1X,I7,1X,I2)
      JD = JSTART
      WRITE(6,2005)
 2005 FORMAT(///)
      JDTOT = (JDFIN-JSTART)/JDINC + 1
      DO 50 JNO = 1,JDTOT
C     WRITE(6,8000)
 8000 FORMAT(//)
      DAYJ = DFLOAT(JD) + 0.500
      CALL TIME(DAYJ)
      CALL FUNARG
      CALL SUN
C     WRITE(6,8001)XYZS
      CALL OUTER
C     WRITE(6,8001)XYZH
      CALL PRECES(XYZH,XYZH)
C     WRITE(6,8001)XYZH
 8001 FORMAT(10X,3(3X,F20.15))
      DO 10 I = 1,3
      XYZG(I) = XYZH(I) + XYZS(I)
   10 CONTINUE
      CALL LONG(XYZG,ELONG,ELAT)
      CALL GECEQU(ELONG,ELAT,RA,DECL)
      CALL LONG(XYZH,HLONG,HLAT)
      ELONG = ELONG*RAD
      ELAT = ELAT*RAD
      HLONG = HLONG*RAD
      HLAT = HLAT*RAD
      CALL JDATE(DAYJ,ND,MO,NYR)
      CALL DMS(ELONG,N1,NS1)
      CALL DMS(ELAT,N2,NS2)
      CALL DMS(RA,N3,NS3)
      CALL DMS(DECL,N4,NS4)
      CALL DMS(HLONG,N5,NS5)
      CALL DMS(HLAT,N6,NS6)
      RV = DSQRT(XYZH(1)**2 + XYZH(2)**2 + XYZH(3)**2)
      WRITE(6,2000)DAYJ,MO,ND,NYR,N1,NS2,N2,N3,NS4,N4,N5,NS6,N6,RV
 2000 FORMAT(1X,F9.1,3X,I2,'-',I2,'-',I4,3(3X,3I3,2X,A1),I2,2(I3),3X,F09.4
     1)
      JD = JD + JDINC
   50 CONTINUE
      GO TO 5
 9999 STOP
      END
C*********************************************************************
      SUBROUTINE TIME(DJN)
C
C     DJ = THE NUMBER OF DAYS FROM JAN 0.5, 1900. OTHER VARIABLES
C     ARE USED BY FUNARG.
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON /TIME$/DJ,T,BD,BD2
      DJ = DJN - 2415020.0D0
      BD = DJ/10000.D0
      T = DJ/36525.D0
      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$/RAD,PI,PIO2,TWOPI,PIO4,STRAD
      ELONG = DATAN2(VEC(2),VEC(1))
      IF (ELONG .LT. 0.D0) ELONG = ELONG + TWOPI
      ELAT = DARSIN(VEC(3)/DSQRT(VEC(1)**2+VEC(2)**2+VEC(3)**2))
      RETURN
      END
C*********************************************************************
      FUNCTION SATAN2(X,Y)
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON /PI$/RAD,PI,PIO2,TWOPI,PIO4,STRAD
      SATAN2 = DATAN2(X,Y)
      IF (SATAN2 .LT. 0.D0) SATAN2 = SATAN2 + TWOPI
      RETURN
      END
C*********************************************************************
      SUBROUTINE FUNARG
C
C     COMPLTE 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$/RAD,PI,PIO2,TWOPI,PIO4,STRAD
      COMMON /TIME$/DJ,T,BD,BD2
      COMMON /FARG$/LL,D,LS,Q,V,J,M,SN,TE,LO,GL,GS,F,D
      GS = 358.475845D0 + 0.985600267D0*DJ - BD2*(1.12D-5 + 7.D-8*BD)
     1     + 2.99D-7 * BD)
      GL = 296.104608D0 + 13.0649924465D0*DJ + BD2*(2.89D-4
      LL=(0.751206018D0 + DJ*(0.03660110146335600 + DJ*(-235980.D-20
     1    + DJ*1077.D-25)))
      LL = DMOD(LL,1.D0) * TWOPI
      D = (0.719953541672D0 + DJ*(-147094228332.D-15 + DJ*(432630.D-20
     1    + DJ*1266.D-25)))
      D  = DMOD(D,1.D0) * TWOPI
      LS = (0.779353216C5D0 + DJ*(2737909264963.D-15 + DJ*63044.D-20))
      LS = DMOD(LS,1.D0) * TWOPI
      Q = (0.493003202160D0 + DJ*113676C7782806.D-15)
      Q = DMOD(Q,1.D0) * TWOPI
      V = (0.950192021600D0 + DJ*445D362451095.D-15)
      V = DMOD(V,1.D0) * TWOPI
      J = (0.659311998450D0 + DJ*230808970898.D-15)
      J = DMOD(J,1.D0) * TWOPI
      M = (0.814026875600D0 + DJ*145564706807.D-15)
      M = DMOD(M,1.D0) * TWOPI
      SN = (0.738526412030D0 + DJ*92943729984.D-15)
      SN = DMOD(SN,1.D0) * TWOPI
      TE = (0.274996535490D0 + DJ*2737803094025.D-15)
      TE = DMOD(TE,1.D0) * TWOPI
      LO = (0.749267330240D0 + DJ*366009952924l8.D-15)
      LO = DMOD(LO,1.D0) * TWOPI
      GL = GL/RAD
      GS = GS/RAD
```

```
      F   = (0.0312524691400 + DJ*(3674819569168B.D-15 + DJ*(-668609.D-20
     1     - DJ* 190.D-25)))
      F = DMOD(F,1.D0) * TWOPI
      D   = (0.9742767947500 + DJ*(3386319219839 3.D-15 + DJ*(-299023.D-20
     1     + DJ*1077.D-25)))
      D = DMOD(D,1.DJ) * TWOPI
C     WRITE(6,2000)LL,O,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$/RAD,PI,PIO2,TWOPI,PIO4,STRAD
      COMMON /TIME$/DJ,T,RD,BD2
      COMMON /FARG$/LL,O,LS,Q,V,J,M,SN,TE,LO,GL,GS,F,D
      COMMON /RECT$/XYZS(3)
      COMMON /COORD$/ELONG,ELAT,RA,DECL
      COMMON /VEL$/VELVEC(3,10)
      DLS = (6.4000  * DSIN((231.190 + 20.200 * T)/RAD)
     1     + (1.882 DO  - 16.D-3*T)*DSIN((57.2400 + 150.2300*T)/RAD)
     2     + 0.266DC * DSIN((31.800 + 119.000 * T)/RAD)
     3     + 0.202 DO * DSIN((315.600 + 893.300 * T)/RAD) ) * STRAD
      LSC = LS + DLS
      G   = GS + DLS
      G2  = G  + G
      G3  = G  + G2
      RU  = 1.00014033DO - 70.D-8*T
     1     + (-0.0167492E00 + T*(4179.D-8 + T*126.D-8)) * DCOS(G)
     2     + (-0.0001402700 + T*70.D-8) * DCOS(G2)
     3     + (-0.0000017600 + 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
      DRP =       543.2D-8 *DCOS(-(TV)  +  3.141592654D0)
     1     +      1575.4C-8 *DCOS(-(V2)  +  2.094395103D-3)
     2     +       204.6D-8 *DCOS(-(V3)  +  4.712388981D-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     +        36.8C-8 *DCOS(GMV2  + 3.490658504D-3)
     7     +       200.1D-8 *DCOS(-(GPV2) + 2.94087979D0)
     8     +       344.7D-8 *DCOS(-(GPV3) +  2.93128047 9D0)
     9     +        45.1D-8 *DCOS(-(GPV4) + 6.087708431D0)
      DRP = DRP  + 44.7D-8  *DCOS(-(G2+V3) +  5.62345C85DC)
     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   + 0.010471975 5D0)
     1     +       473.6C-8 *DCOS( M2 -  5.235987756D-3 )
     2.    +        3E.7D-8 *DCOS( M3 + 3.181735227D0)
     3     +        34.8D-8 *DCOS( -(G-M2) + 0.713839664D0)
     4     +        49.5D-8 *DCOS( -(G-M3) + 3.975866C36D0)
     5     +       110.1C-8 *DCOS( -(G-M4) + 3.960501139E0)
     6     +        24.6D-8 *DCOS( -(G-M5) + 0.860447321 3D0)
     7     +        24.2C-8 *DCOS( -(G2-M4) + 4.845034004D0)
     8     +        20.5D-8 *DCOS( -(G2-M5) + 1.870230094D0)
     9     +        32.0D-8 *DCOS(-(G2-M6) + 1.656317 6D0)
      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 + 3.145432376D0)
     2     +         64.7D-8 *DCOS(J3 + 3.070034154D0)
     3     +         47.9D-8 *DCOS(G+TJ + 0.411897703 5D0)
     4     +         23.7D-8 *DCOS(G+J2 + 3.029891582D0)
     5     +         56.2D-8 *DCOS(-(G-TJ) + 4.366813784D0)
     6     +        336.0D-8 *DCOS(-(G-J2) + 3.535667955D0)
     7     +        184.9D-8 *DCOS(-(G-J3) + 1.522450707D0)
     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 + 98.8C-8 *DCOS(TS + 6.283185308D-3)
     1     +        37.3D-8 *DCOS( S2 + 3.143337983D0)
     2     +        25.8D-8 *DCOS(-(G-S2) + 3.186971214DC)
      DRL = 3076.2D-8*DCOS(D) + 85.D-8*DCOS(D+GL)
     1     - 306.0D-8*DCOS(D-GL) - 32.D-8*DCOS(D+G) + 83.E-8*DCOS(D-G)
      RVEC = RU * (1.DO + DRP + DRL)
      C = (6910.057DO + T*(-17.240DO - T*0.052DO))*DSIN(G)
     1  + (72.338DO - T*0.361DO)*DSIN(G2)
     2  + (1.054DO  -T*1.D-3)*DSIN(G3)
      DLP = 4.858DO *DCOS(-TV + 4.712388981DO)
     1     + 5.526DO *DCOS(-V2 + 1.572890722DO)
     2     + 0.666DO *DCOS(-V3 + 1.577952177DO)
     3     + 0.210DO *DCOS(-V4 + 1.567305668DO)
     4     + 0.116DO *DCOS(+GMV2 + 1.583013632DO)
     5     + 2.497DO *DCOS(-(GPV2) + 4.498586147DO)
     6     + 1.559DO *DCOS(-(GPV3) + 4.502251339DO)
     7     + 0.144DO *DCOS(-(GPV4) + 1.378810109DO)
     8     + 1.024DO *DCOS(-(G2+V3) + 4.029092578DO)
     9     + 0.152DO *DCOS(-(G2+V4) + 3.968878719DO)
      DLP = DLP + 0.123DO *DCOS(-(G2+V5) + 0.869173967 5DO)
     1     + 0.154DO *DCOS(-(G3+V5) + 3.736749929DO)
      DLP = DLP + 0.273DO *DCOS(TM + 1.581268302DO)
     1     + 2.043DO *DCOS(M2 + 1.566607537DO)
     2     + 0.129DO *DCOS(M3 + 4.764748858DO)
     3     + 1.770DO *DCOS(-(G-M2) + 5.345419900DO)
     4     + 0.425DO *DCOS(-(G-M3) + 5.544911034DO)
     5     + 0.500DO *DCOS(-(G-M4) +  5.531646532DO)
     6     + 0.585DO *DCOS(-(G2-M4) + 3.243170816DO)
     7     + 0.204DC *DCOS(-(G2-M5) + 3.237585703DO)
     8     + 0.154DO *DCOS(-(G2-M6) + 3.228859116DO)
     9     + 0.101DO *DCOS(-(G3-M6) + 0.940732466 9DO)
      DLP = DLP + 0.106DO *DCOS(-(G3-M7) + 0.930260491 4DO)
      DLP = DLP + 7.208DO *  DCOS(TJ + 1.589820416DO)
     1     + 2.731DC *DCOS(J2 + 4.716752304DO)
     2     + 0.164DO *DCOS(J3 + 4.628613770DO)
     3     + 0.163DO *DCOS(G+TJ + 1.923352836DO)
     4     + 2.600DO *DCOS(-(G-TJ) + 3.050311934DO)
     5     + 1.610DO *DCOS(-(G-J2) + 5.106833392DO)
     6     + 0.556DC *DCOS(-(G-J3) +  3.094643297DO)
     7     + 0.210CO *DCOS(-(G2-J3) + 3.371976115DO)
      DLP = DLP + 0.419DO *DCOS(TS + 1.576730446DO)
     1     + 0.108DO *DCOS(S2 + 4.714134310DO)
     2     + 0.320DO *DCOS(-(G-TS) + 4.524242487DO)
     3     + 0.112DO *DCOS(-(G-S2) + 4.766494187DO)
      DLL = 6.454DO*DSIN(D) + 0.177DO*DSIN(D+GL) - 0.424DO*DSIN(D-GL)
     1     + 0.172DO*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     TRU 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.D0 - ECC*CE
      FAC = (EM-E+ESE)/ECE
      E = E + FAC - 0.5D0*FAC*FAC*ESE/ECE
      CE = DCOS(E)
      SE = DSIN(E)
   10 CONTINUE
      CK1 = CE - ECC
      ECE = 1.D0 - 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)
      B2 = B1
      B1 = BZ
   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
   60 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     HELICCENTRIC 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 = 0.5D0
      T = (DAYJ - 2415020.313D0 - 36524.2158790D0*TZ)/36524.219879D0
      XI = (((0.018D0*T+0.302D0)*T+2304.2500+1.396D0*TZ)*T)*STRAD
      Z = XI + (T*T*(0.791D0 + T*0.001D0))*STRAD
      THETA = (T*((2004.682D0-0.853D0*TZ)-T*(0.462D0+T*0.042D0)))*STRAD
      CX = DCOS(XI)
      SX = DSIN(XI)
      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.D0
      DO 10 J = 1,3
      TEMP(I) = TEMP(I) + PREC(I,J)*XYZI(J)
   10 CONTINUE
   20 CONTINUE
```

```
      XYZ0(1) =  TEMP(1)
      XYZ0(2) =  CEPS*TEMP(2) + SEPS*TEMP(3)
      XYZ0(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*D-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
  5.2029747          0.0483525422        274.169895          1.308122
 99.8480697          0.0009547861        239.954874          0.0000059768 2
      0      41.0068    -964.6742     10.3494    -50.3624   -127.7253   -11.9975
      2      60.0357    -817.3009      9.6772    -92.9013    -43.4000   -11.4463
      4      56.1745    -254.3264      8.3875   -117.8735   -213.1945   -13.5004
      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   -13.8608
     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     129.0287    -13.5748    -42.9846    203.7106     2.6959
     18      16.7849     233.1693    -10.3020     23.2458    234.2475    12.1237
     20     106.8185     150.8379     -0.7374     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    -5.4107
     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    -41.2314    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     87.5261     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    -4.3748
     44     131.4694     161.9853      1.5852     63.3958   -235.6212    -5.5795
     46     -56.5534      19.2558     -8.8873     82.2052    -71.1815     8.7577
     48    -113.9560    -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     57.6334    -3.5656
     56      -0.8246      30.2461     -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    264.1143     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    -58.1602     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      1.1202     0.1181
     78       3.1821       8.1044     -0.0560      6.0530     -3.7889    -0.0575
     80      -0.7673      -6.5837     -0.3939     -2.2715      1.6458    -0.0593
     82       0.0172      -4.0928      0.4837     -8.0865      1.1558    -0.1304
     84       0.5067      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     15.4827    -13.0274     0.2848
     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      4.4375      0.6581    -0.1407
100       2.2057      -2.7382      0.0309     -0.0066     -2.5806     0.0330
102      -2.0042      -1.9774     -0.0418     -2.5268      1.7663     0.0514
104      -0.0494       3.8788      0.1039      2.9298     -0.0565    -0.0916
106       0.8534      -2.2503     -0.0931     -0.1186     -0.0081     0.1054
108       0.5323      -2.2460      0.0042     -3.3024     -1.4600    -0.0803
110      -2.3731       4.1177      0.0560      2.7004      2.7967     0.0280
112       3.4051      -0.9590     -0.0774      0.4261     -3.4803     0.0313
114      -3.8689      -2.0228      0.0990     -1.2100      3.7220    -0.0027
116       3.6750       1.1441     -0.0937     -0.3980     -3.0528    -0.0046
118      -2.4109       1.1631      0.0476      1.7274      1.3798     0.0084
120       0.6711      -2.7535     -0.0061     -2.6468      0.3242    -0.0052
122       0.6635       4.0900     -0.0082      3.6265     -1.3755    -0.0089
124      -1.3730      -4.8812      0.0088     -3.7969      1.6904     0.0160
126       1.2817       4.4581      0.0005      3.0393     -1.1252    -0.0023
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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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

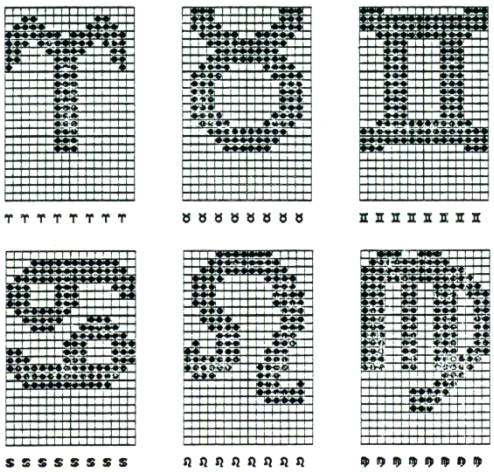
The technical enthusiasts will be glad to know that they dont have to read Spanish to benefit from this book, as the 1st chapter on the tecnica matematica of Cosmobiology (all numbers!) includes a fairly hard-to-come-across compilation of various

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.

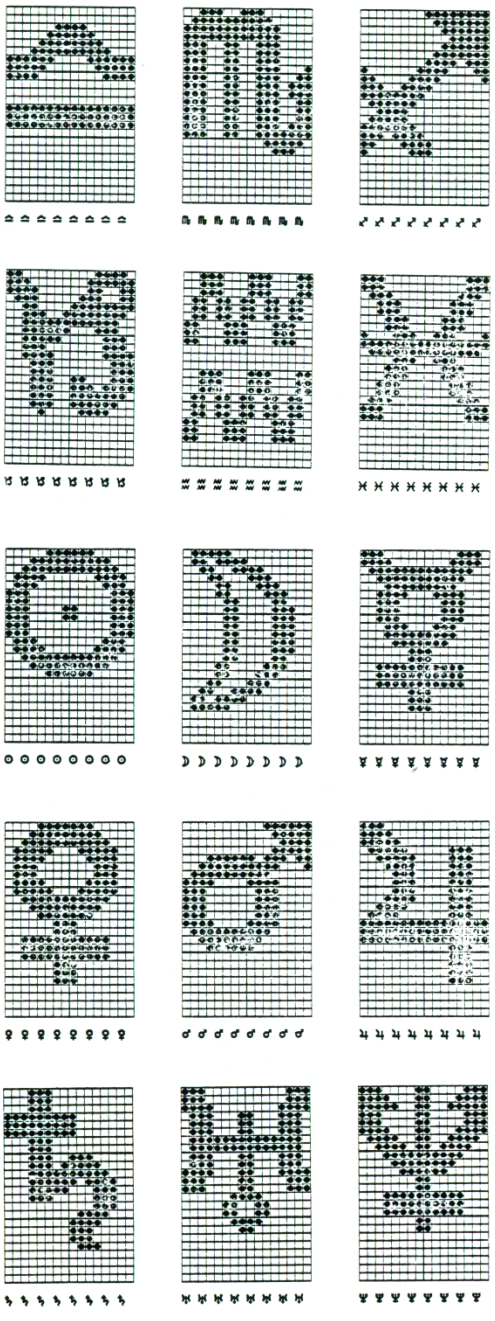
Michelsen has been using an Interdata mini-computer with an internal RAM capacity of 64-kilobytes along with a 10-megabyte hard disk for additional storage. The Interdata is a mini-computer as opposed to the micro-computers used for most home computing. The difference between a mini and a micro computer 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 <u>in principle</u> 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

$$DDECL=\arctan[(R-\tan(DECL))/(1+R\tan(DECL))]$$

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 all 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

$$1 \text{ AU} = 149{,}597{,}900 \text{ km.}$$

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





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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







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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.





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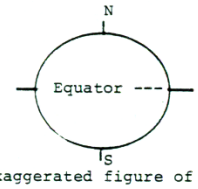
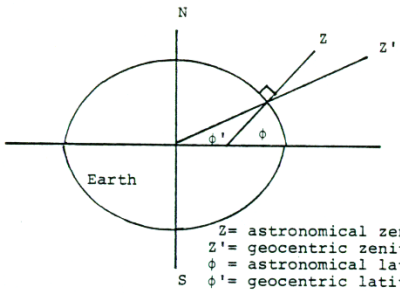



Exaggerated figure of the Earth

FIGURE 5




Z= astronomical zenith
Z'= geocentric zenith
φ = astronomical latitude
φ'= geocentric latitude

RHW THE EFFECTS OF GEOID

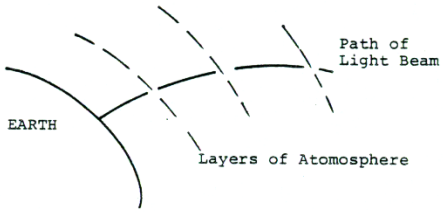



FIGURE 6 EFFECTS OF REFRACTION

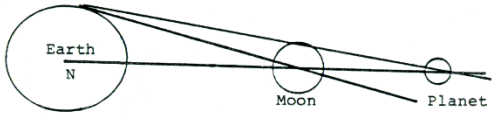



Figure 4 Lunar Equatorial Horizontal Paralax and the Effects of Parallax on conjunction

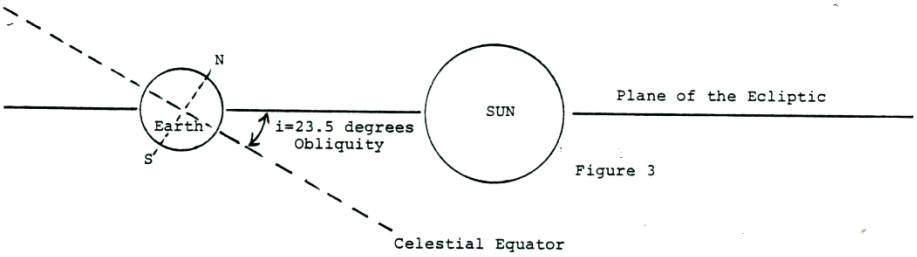



Figure 3

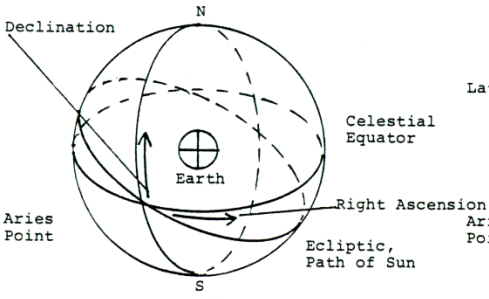



Figure 1 GEOCENTRIC COORDINATES

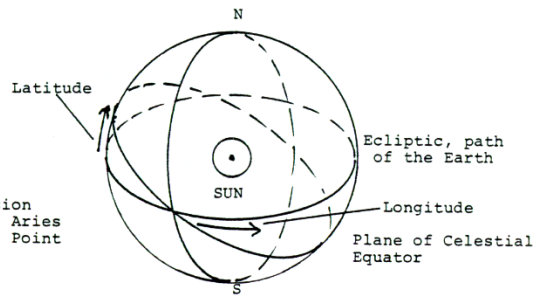



Figure 2 HELIOCENTRIC COORDINATES

pieces.

## N O T E S

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 does'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" journal, 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 $\delta$, (Greek Delta), for Declination, $\lambda$, (Greek Lambda), for Longitude, (get it?), and $\phi$, (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 miatakes 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.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## 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 enlosed 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

$x = JDo - 1720981.5, \quad y = \left[\frac{x - 122.9}{365.25}\right], \quad m = \left[\frac{x - 365.25 * y}{30.6001}\right]$

(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.

$\lfloor 365.25 * 1938 \rfloor = \lfloor 707854.5 \rfloor = \underline{707854}$

$\lfloor 30.6001 * 14 \rfloor = \lfloor 428.40 \rfloor = \underline{428}$

Now $\frac{14 - 2}{12} = 1.0$, so, $\lfloor 1.0 \rfloor = 1$, and, $\{1.0\} = .0$

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 $\lfloor \text{integer} \rfloor$ or $\{\text{fraction}\}$ 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. $\alpha$ - l.c. Alpha | Right Ascension |
| 2. $\beta$ - l.c. Beta | Planetary latitude |
| 3. $\delta$ - l.c. Delta | Declination |
| 4. $\Delta$ - u.c. Delta | The difference between two quantities |
| 5. $\epsilon$ - l.c. Epsilon | The Obliquity of the Ecliptic |
| 6. $\lambda$ - l.c. Lambda | Planetary longitude |
| 7. $\phi$ - u.c. Phi | Geographic latitude |
| 8. $\Omega$ - 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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97 Virginia Park
Detroit, MI

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.

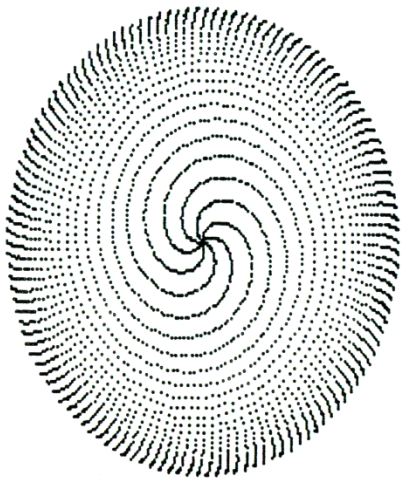
If R is the radius or length of the clock hand and A is the angle which had been swept out by the clock hand, and if the radius is set proportional to the angle, then the spiral is expressed byu R = KA. So in polar coordinates the point (R,A) = (KA,A). To plot this point on the screen we must translate 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. | |
| $\lambda$ = 357°.5134 | $\lambda'$ = -0°.5677 |
| $\beta$ = 1°.5865 | $\beta'$ = -0°.2629 |
| $\alpha$ = 357°.0878 | $\alpha'$ = -0°.4162 |
| $\delta$ = 0°.4669 | $\delta'$ = -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

$\lambda_A$ = 357.5134 - 0.003514(-0.5677) = 357°.5154

$\beta_A$ = 1.5865 - 0.003514(-0.2629) = 1°.5874

$\alpha_A$ = 357.0878 - 0.003514(-0.4162) = 357°.0893

$\delta_A$ = 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.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**The Astrologer's Astrological Magazine**

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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.

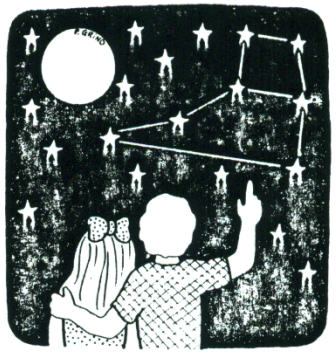
Our Mechanical Resources

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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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.
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## 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.

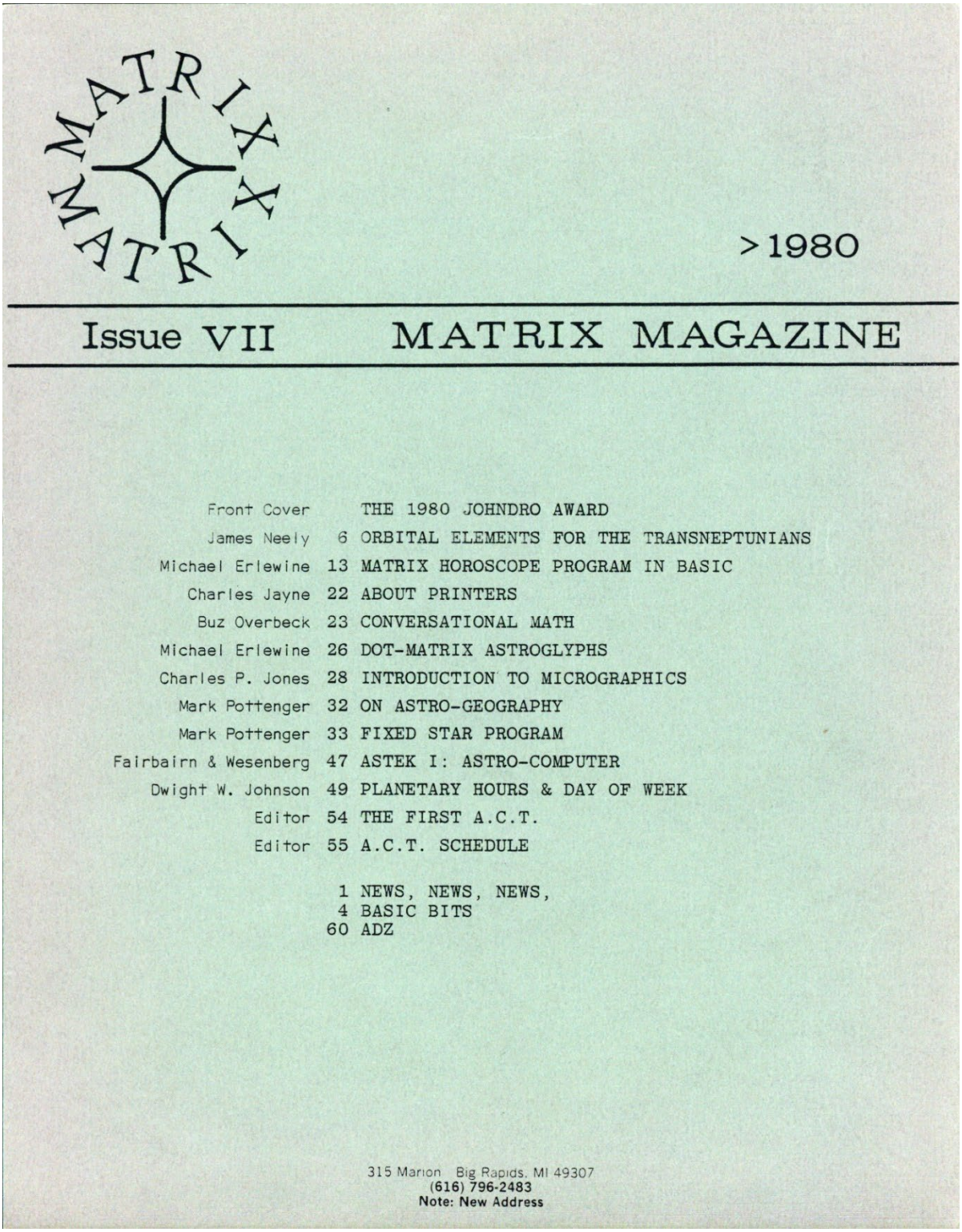
## ASTROLOGICAL PROGRAMMING MANUAL
by Michael Erlewine

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

# MATRIX MAGAZINE ISSUE SEVEN – 1980



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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

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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):

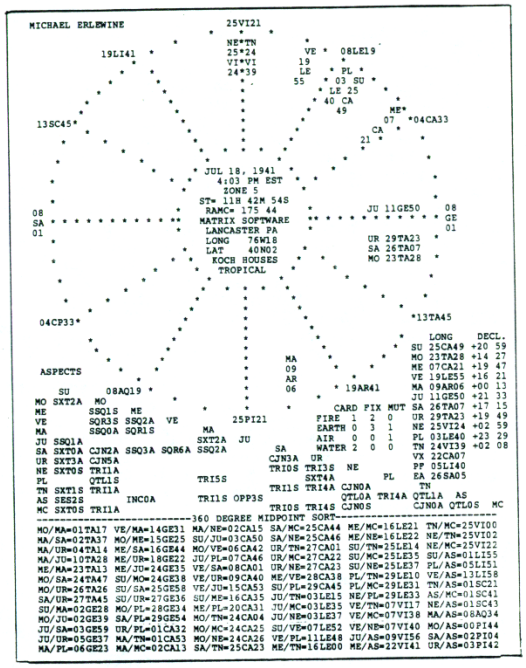
```
AT=ATN(Y/(X-1E-9*(X=0)))-PI*(X<0):
AT=AT-TP*(AT<0)
```

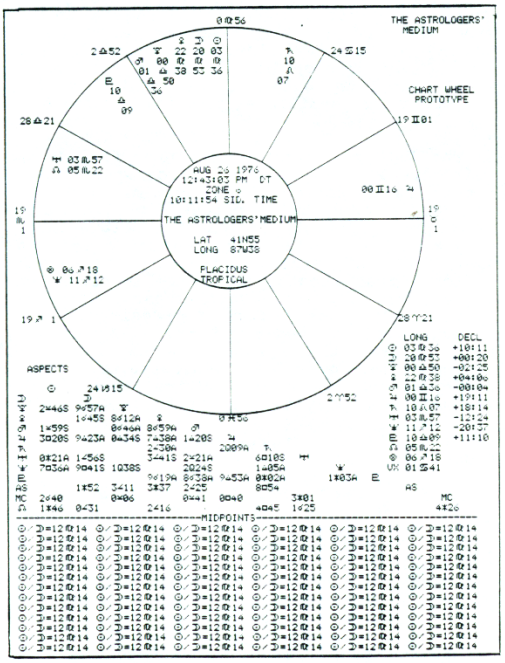
ARCCOSINE (AC=ARCCOS(X)):

```
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

BY JAMES NEELY
P.O. Box 1902
Carmel, CA 93921

## 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

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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 |



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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 |



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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 | 2389669.38 | 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 C$ 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$(13),C(14),K(13),H$(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   ZA$="ARTAGECALEVILISCSACPAQPI"
670   REM 'MO' IS USED IN MODULUS FUNCTION (FNU)
680   MO=360
690   REM CONVERTS NUMBER ENTERED IN DEGREES AND M
      INUTES TO DEGREES AND DECIMALS
700   DEF FNQ(X)=SGN(X)*(INT(ABS(X))+(ABS(X)-INT(ABS
      (X)))*100/60)
710   REM 'QW$','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$="PM" THEN U=U+12
1030   REM JULIAN DAY NUMBER ROUTINE
1040   JD=367*Z-INT(7*(Z+INT((X+9)/12))/4):JD=JD+INT
       (275*X/9)+Y+1721013.5:I=1
1050   JD=JD-.5*SGN(100*Z+X-190002.5)+.5:C=(JD-2415
       020)+U/24
1060   REM 'T' IS CENTURY INCREMENT WITHOUT DELTA T
        CORRECTION
1070   T=C/36525
1080   REM 'RA' IS SIDEREAL TIME (RAMC) CALCULATED
       IN DEGREES AND THEN TO RADIANS
1090   RA=DR*FNU((6.6460656+2400.0513*T+2.58E-5*T*T
       +U)*15-L5)
1100   REM MEAN LUUNAR NODE AND NUTATION ROUTINE
1110   GOSUB 2690
1120   REM CALCULATE OBLIQUITY OF ECLIPTIC
1130   OB=DR*(23.452294-.0130125*T)
1140   REM CHECK FOR SIDEREAL OPTION
1150   IF SD=1 THEN GOSUB 5050
1160   REM CENTURY INCREMENT 'T' INCLUDING DELTA T
       CORRECTION
1170   T=(C+DT/86400)/36525
1180   REM CHART ANGLES SUBROUTINE
1190   R2=RA:O=-OB:B=LA:GOSUB 2780:C=MC
1200   REM PRINT OUT CHART ANGLES IN UPPER LEFT HAN
       D CORNER OF SCREEN
1210   PRINT SPC(20)"[145][145][145][145]RAMC="FNW(
       RD*RA):GOSUB 2110:PRINT SPC(20)"  MC= "AS
1220   C=AS:GOSUB 2110:PRINT SPC(20)" ASC= "AS
1230   C=VT:GOSUB 2110:PRINT SPC(20)" VTX= "AS:C(12
       )=AS:C(13)=MC
1240   REM PRINT PLANET POSITION HEADER
1250   PRINT "[17]HELIO"SPC(14)"GEO":A$="    LONG
        LAT":PRINT ASSPC(5)A$: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 C$(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 R$=" [18]R[146]"
1850   REM CONVERT RECTANGULAR TO SPHERICAL COORDIN
       ATES
1860   GOSUB 2310
1870   REM ASSIGN LONGITUDE TO 'C' ARRAY, LATITUDE
       TO 'M' ARRAY
1880   C(I)=SS:M(I)=P:PRINT
1890   REM STORE AS NEGATIVE NUMBER IF RETROGRADE
1900   IF XK<0 THEN C(I)=-SS
1910   NEXT I
1920   REM PRINT OUT MOON AND NODE POSITIONS
1930   C=C(2):P=LT:PRINT TAB(19);:I=2:RS="  ":GOSUB
       2420
1940   P=0:C=C(11):I=11:PRINT :PRINT TAB(19);:GOSUB
       2420:PRINT
1950   REM MENU TITLE
1960   PRINT "[17][18]W[146]HEEL [18]N[146]EW [18]M
       [146]ORE [18]R[146].A.";:GOTO 2440
1970   REM LUNAR ROUTINE
1980   MO=360:LL=973563+1732564379*T-4*T*T:G=101239
       5+6189*T:M=3600
1990   G1=1203586+14648523*T-37*T*T:L=(LL-G1)/M:D=1
       262655+1602961611*T-5*T*T
2000   L1=((LL-D)-G)/M:F=(LL-LN*M)/M:ML=22639.6*FNS
       (L)
2010   D=D/M:Y=2*D:ML=ML-4586.4*FNS(L-Y)+2369.9*FNS
       (Y)+769*FNS(2*L)-669*FNS(L1)
2020   REM 'ML' IS LUNAR LONGITUDE
2030   ML=ML-411.6*FNS(2*F)-212*FNS(2*L-Y)-206*FNS(
       L+L1-Y)+192*FNS(L+Y)
2040   ML=ML-165*FNS(L1-Y)+148*FNS(L-L1)-125*FNS(D)
       -110*FNS(L+L1):R$="  "
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
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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  ZZ$=RIGHT$(STR$(1000+INT(((U-Z3)*60+.5))),2)

2180  REM 'BS' CONTAINS THE TWO-LETTER ZODIAC SIGN

2190  BS=MID$(ZA$,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$(ZZ$,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  Z$=LEFT$(C$(I),2)+" "+XS+BS+RIGHT$(ZZ$,2)
2280  REM DEGREES-ZODIAC SIGN-MINUTES STRING
2290  AS=RIGHT$(Z$,6):RETURN
2300  REM RECTANGULAR TO SPHERICAL CONVERSION ROUT
      INE
2310  X=XX:Y=YY:GOSUB 2570
2320  REM ADD NUTATION AND ABERRATION TO POSITION
2330  K=A:C=RD*A+NU-BR
2340  REM ADD 180-DEGREES IF EARTH/SUN
2350  IF I=1 AND AB=1 THEN C=FNU(C+180)
2360  REM STORE PLANET LONGITUDE IN 'C'AND 'SS'
2370  C=FNU(C+SD):SS=C
2380  REM CALCULATE PLANET LATITUDE
2390  Y=ZZ:X=R:GOSUB 2570:IF A>.35 THEN A=A-2*PI
2400  P=RD*A
2410  REM PRINT LONGITUDE & LATITUDE
2420  GOSUB 2110:P$=Z$+R$:C=P:GOSUB 2110:PRINT P$D
      $"  ";:RETURN
2430  REM MENU SELECTION ROUTINE
2440  GOSUB 3040:REM GET ROUTINE
2450  REM SELECT FOR MORE OPTIONS
2460  IF Q$="M" THEN 2880
2470  REM SELECT RIGHT ASCENSION & DECLINATION
2480  IF Q$="R" THEN 5170
2490  REM SELECT BETWEEN TWO HOUSE SYSTEMS
2500  IF Q$="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 Q$="H" THEN 3990
2920  REM GEO VARIABLE SET-UP
2930  NM=45:CN=9:NN=10
2940  REM GRID, ANGULAR SEPARATION AND ASPECT NAME
       ROUTINES
2950  GOSUB 3440:GOSUB 3100:GOSUB 3590
2960  REM MENU SELECTION
2970  PRINT "[18]M[146]IDPT GRID [18]C[146]ONT [18]
      R[146]UN":GOSUB 3040
2980  REM MIDPOINT ROUTINE
2990  IF Q$="M" THEN GOSUB 3150:GOSUB 3040
3000  REM OPTION SELECTION
3010  IF Q$="R" THEN 2880
3020  GOTO 3210
3030  REM 'GET' ROUTINE
3040  GETQ$:IF Q$="" THEN 3040
3050  REM RUN PROGRAM FROM START
3060  IF Q$="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 UPSTAB(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
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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]"B$"
      [146]":XZ=Q*30:JI=JI+1
3390  PX=M(A):GOSUB 3850
3400  REM 360-DEGREE NOTATION FLAG
3410  IF XC=1 THEN X$=RIGHT$(" "+STR$(INT(C)),3)
3420  PRINT SPC(Y)"[157]"X$" "YY$: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]"CS(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  A$=RIGHT$("  "+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 W$SPC(Y)A$"*":WS=WS+"[17][17]
      ":NEXT I:N=N-1:Y=Y+4:TS=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$,X-1):GOTO 3870
3880  REM BACK OUT PLANETARY COMBINATION FROM SORT
       ARRAY
3890  AS=RIGHT$(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):H$$="PLACIDUS "
4090  R1=RA+DR*60:FF=1.5:GOSUB 4150:M(6)=FNU(L+180
      ):FF=1:GOSUB 4150:M(1)=L
4100  R1=RA+DR*120:FF=1.5:Y=1:GOSUB 4150:M(2)=L:R1
      =RA+DR*150:FF=3
4110  GOSUB 4150:M(3)=L:M(4)=FNU(MC+180-SD):FOR I=
      1TO6:M(I)=FNU(M(I)+SD):NEXT I
4120  FOR I=1TO6:C=FNU(M(I)+180):M(I+6)=C:GOSUB 21
      10:H$(I+6)=A$
4130  C=M(I):GOSUB 2110:H$(I)=A$:NEXT I:GOTO 4220
4140  REM SUBROUTINE USED IN PLACIDUS ROUTINE FOR
      ITERATIONS
4150  X=-1:IF Y=1 THEN X=1
4160  FOR I=1TO10:XX=FNY(X*SIN(R1)*TAN(OB)*TAN(LA)
      ):IF XX<0 THEN XX=XX+PI
4170  R2=RA+(XX/FF):IF Y=1 THEN R2=RA+PI-(XX/FF)
4180  R1=R2:NEXT I:L=ATN(TAN(R1)/COS(OB)):IF L<0 THEN
      L=L+PI
4190  IF SIN(R1)<0 THEN L=L+PI
4200  L=RD*L:RETURN
4210  REM RECTANGULAR CHART WHEEL FORMAT ROUTINE
4220  PRINT "[147]";:FOR I=1TO5
4230  PRINT K$"[18]"MID$(H$(11),I,1)"[146]"K$"[18]
      "MID$(H$(10),I,1)"[146]"K$;
4240  PRINT "[18]"MID$(H$(9),I,1)"[146]":NEXT I:PRINT
      "[18] "H$(12)"  "MID$(H$(11),6);
4250  PRINT K$MID$(H$(10),6,1)K$MID$(H$(9),6,1)"
      "H$(8)" [146]"
4260  FOR I=1TO5:PRINT TAB(9)"[18] [146]"TAB(29)"[18]
       [146]":NEXT I
4270  PRINT "[18] "H$(1)"   [146]"TAB(29)"[18]""
       "H$(7)" [146]"
4280  FOR I=1TO5:PRINT TAB(9)"[18] [146]"TAB(29)"[18]
       [146]":NEXT I
4290  PRINT "[18] "H$(2)"  "MID$(H$(3),1,1)H$$MID$
      (H$(4),1,1);
4300  PRINT " HOUSES  "MID$(H$(5),1,1)"  "H$(6)" [146]
      ":FOR I=1TO5:PRINT K$;
4310  PRINT "[18]"MID$(H$(3),I+1,1)"[146]"K$"[18]"
      MID$(H$(4),I+1,1)"[146]"K$;
4320  PRINT "[18]"MID$(H$(5),I+1,1)"[146]":NEXT I:
      PRINT OSTAB(15)E$
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$=O$: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][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$(K),3))):X$="   *"
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 U$TAB(12)"[18]A[146]SPECTS [18]N
      [146]EW [18]M[146]ORE":I=1
4850  GOSUB 3040
4860  REM ERASE PORTION OF SCREEN
4870  PRINT "[19][17][17][17][17][17][17]";:FOR K=
      1TO11:PRINT TAB(10)"                ":NEXT
      K
4880  REM IF 'GET' CHARACTER ON MENU, SET 'I'
4890  IF ASC(Q$)>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$(I)=A$:NEXT
      I:HS$="  KOCH   ":GOTO 4220
5160  REM RA & DECLINATION ROUTINE
5170  PRINT O$;:FOR I=1TO14:PRINT "
        ":NEXT I:R$="  "
5180  PRINT O$;"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 ES= 07.181941
860 X,Y,Z= 7  18  1941
880 A$= PM
900 U= 4.03
920 V= 5
940 C,L5= 76.18  76.3
960 C,LA= 40.02  .698713477
980 DT= 24
1000 U= 9.05
1020 U= 21.05
1040 JD= 2430193.5
1050 JD,C= 2430193.5  15174.3771
1070 T= .415451802
1090 RA= 3.06699085
2690 LN= 175.640562
1130 OB= .409225393
1170 T= .41545181
2780 X,MC=-.914877553  175.342552
2800 A$= 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
```

20

```
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 them 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
$Rg = GMST \times 15$
$GMST = tg + (23925.836+8640184.542T+0.0929T^2)/3600 \text{ (Mod 24)}$
$T = (tg/24 + JD\ (1900) - 0.5)/36525$
$tg$ = 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)

$$\begin{aligned} & (1.8/24 + 27869 - 0.5) \\ = & (0.075 + 27869 - 0.5) \\ = & (\quad 27868.575 \quad) \end{aligned}$$

Then $T = 27868.575/36525 = 0.7630$

GMST

This is the next variable, and stands for Greenwich Mean Sidereal Time.

GMST = tg + $(23925.836 + 8640184.252T + 0.0929T^2)/3600$ (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 = $1.8 + (23925.836 + 8640184.252 \times 0.7630 + 0.0929 \times 0.7630^2)/3600$

The value within the parenthesis = 6616386.474

Try it and see what you get...

If you got a different answer, follow this:

a. $0.7630^2 = 0.58217$
b. $0.0929 \times 0.58217 = 0.05408$
c. $8640184.252 \times 0.7630 = 6592460.584$

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!



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MATRIX GRAPHICS

by Michael Erlewine

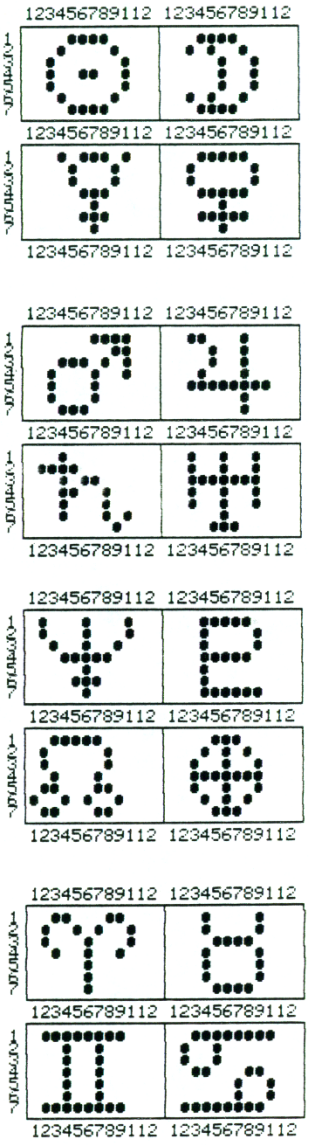
'Matrix' here refers to the matrix grid used in dot-matrix printers. Many of us have dreamed of having the astrological symbols as a built-in feature of our hard copy devices. How many petitions have been circulated trying to get the astro-glyphs on an IBM typewriter element? I know that I have been 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.

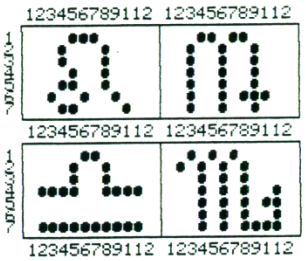
In MATRIX VI we ran a copy of Neil Michelsen's beautiful 16x24 dot-matrix astro-glyphs. Unfortunately, I can't quite swing the 8 grand or so that is needed to purchase the Versatec printer-plotter that Michelsen uses. While some dot-matrix printers have a 7x9 character matrix, most printers have a 5x7 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.

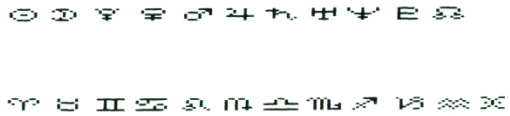
Most printing programs available today use two-letter combinations to represent the zodiac symbols. Thus 'SU' stands for Sun, 'MO' for moon and so forth. By using two-characters for each of the planet and Zodiac symbols, some quite nice looking astro-glyphs are possible. Here are the set of astro-glyphs that we use here at MATRIX Software on the Commodore printer.

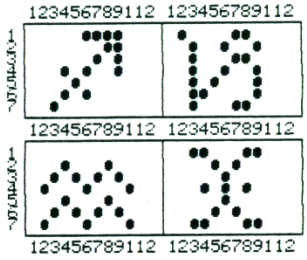
A few remarks on creating these symbols. I have been designing astro-glyphs since the late sixties. My brother Stephen designed an entire PRESS-TYPE sheet for use with our CIRCLE BOOKS CALENDAR. To look at these matrix characters, one might think that a set like this could be put together in a half-hour 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.

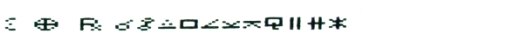
Both the regular and the oversize matrices were produced on a Commodore PET using the tractor-feed 2022 dot-matrix printer. It is hoped that this set of symbols will prove useful to those of you seeking to produce astro-glyphs on some of the new hi-speed dot-matrix line printers.

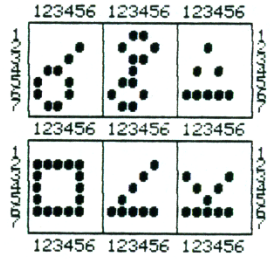


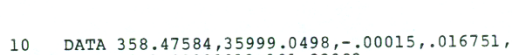


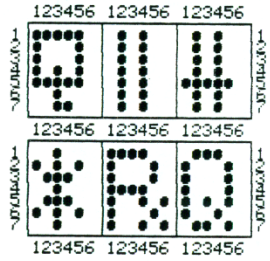



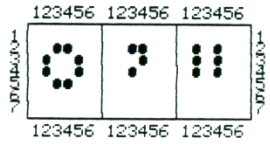







```
10    DATA 358.47584,35999.0498,-.00015,.016751,-.
      41E-4,0,1.00000013,101.22083
12    DATA 1.71918,.00045,0,0,0,0,0,0,102.27938,14
      9472.515,0,.205614,.2E-4,0
14    DATA .387098,28.75375,.37028,.00012,47.14594
      ,1.1852,.00017,7.00288,.00186
18    DATA -.1E-4,212.60322,58517.8039,.00129,.006
      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
```

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# AN INTRODUCTION TO MICROGRAPHICS

by Charles Paul Jones
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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-

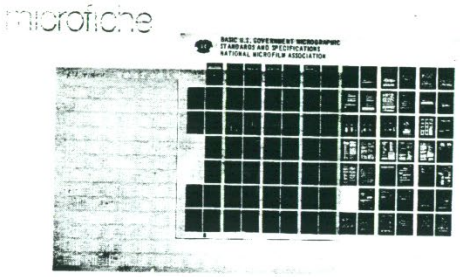
Microfilm catridges function as convenience packaging for rolls of microfilm. Unlike microfilm on reels, which require threading, cartridges can be self threading. Microfilm in cartridges is well protected, and not subject to fingerprints and other possible sources of damage.

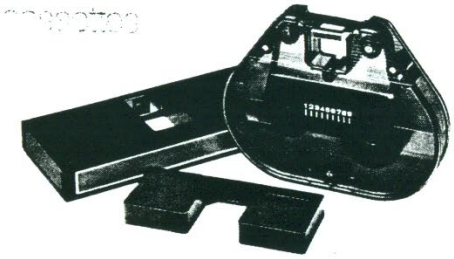
JACKETS-

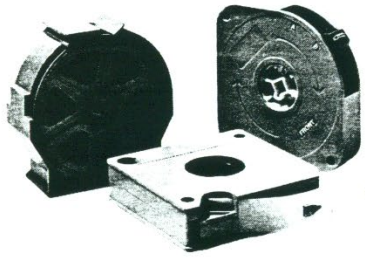
A jacket is a plastic carrier with single or multiple sleeves or channels designed to accept strips of 16mm or 35mm film. Jackets both protect the microfilm and also facilitate organization of material. Images may be copied or read directly from the jacket without removing the film. Jackets can be visibly titled for quick, easy file reference and update.

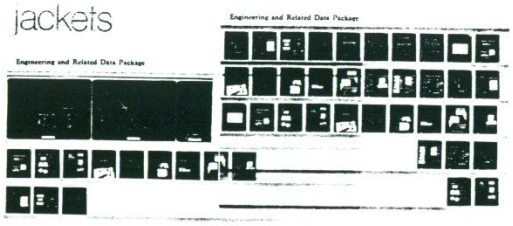
This form is the one I would choose in setting up a system. The cost is a bit more than roll film, but since jackets are formatted the same as microfiche, the two systems use the same readers and printers. Also, microfiche can be generated directly from jackets at any time, should more microfilm copies 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.

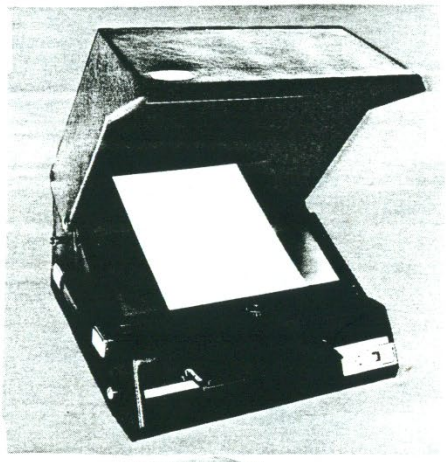
Many manufactures offer a list of accessories as well, such as extra lenses, floor stands, combination stands and microfilm storage units, adaptors for other types of microfilm, and other capabilities. The number of operating features, controls and accessories on any unit is directly related to its intended functions and affects costs.

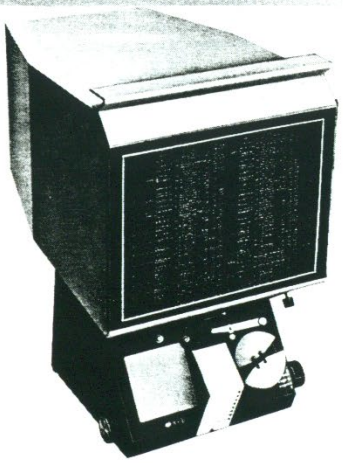
READER-PRINTERS-

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.

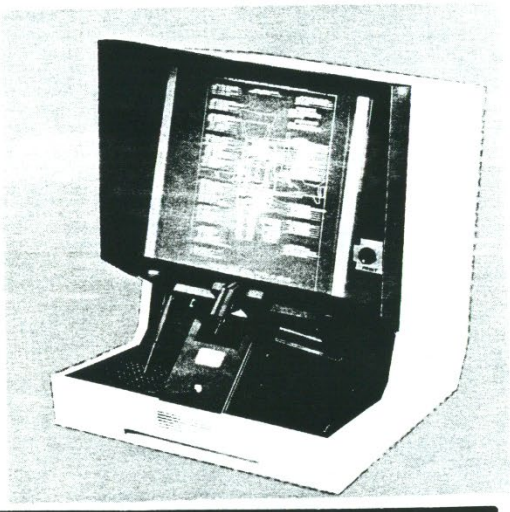


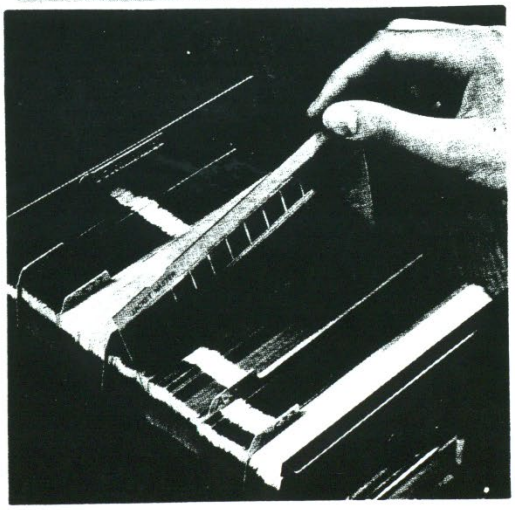


Readers and printers also vary greatly in cost, depending again on the type of microform you are using, and the features you are willing to pay for. A lap reader, such as the one illustrated, costs less than $100. Reader-printers are from $200 up to $6000 and more. All of these units can also be rented 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=XW1: Y=YW1: 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 ANTARES"
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 ELGENUBI 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 !FREE(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), N0$(10), N1$(30), P$(80), T$(10)
90 REM STRINGS FOR DIRECTION OF LONGITUDE & LATITUDE
100 E$="WE"
110 N$="NS"
120 REM PLANET NAMES
130 P$(1,40)="SUN MOONMERCVENUMARSCEREPALLJUNOVESTJUPI"
140 P$(41,80)="SATUURANNEPTPLUTMC  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= 3.14159265358898
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(U3*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+(-.00000164+.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 FLOOP)
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 *****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,Z
1240 W1=FND1(L1)
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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=C0-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
```

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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$(I*38-37,38*I),R(I),P0(I),D(I),P1(I)
2130 NEXT I
2140 CLOSE #1
2150 REM SET # OF LINES PRINTED ON PAGE SO FAR
2160 N3=28
2170 REM SET # OF PAGES
2180 N4=1
2190 REM GET PRECESSIONAL CONSTANTS
2200 REM TROPICAL CENTURIES
2210 T1=36524.21988
2220 REM REDEFINE T FOR TROPICAL CENTURIES FROM 1950.0
2230 T=(J-2433282.423)/T1
2240 T2=T*T
2250 T3=T2*T
2260 REM ZETA SUB ZERO IN SUPPLEMENT
2270 C=2304.948*T+.302*T2+.0179*T3
2280 REM Z IN SUPPLEMENT
2290 Z=2304.948*T+1.093*T2+.0192*T3
2300 REM THETA IN SUPPLEMENT
2310 C0=2004.255*T-.426*T2-.0416*T3
2320 C=C/3600
2330 Z=Z/3600
2340 C0=C0/3600
2350 REM SINE THETA
2360 C1=FNS(C0)
2370 REM COSINE THETA
2380 C2=FNC(C0)
2390 REM START MAIN LOOP--ADD PROPER MOTION, PRECESS, GET LONGITUDE
2400 REM & LATITUDE, RISE, SET, LOWER CULMINATE TIMES, & COMPARE TO PLANETS
2410 REM R1=RA, D=DEC, L4=LONG, L5=LAT, R0=RISE, S=SET, R2=LOWER CULMINATION
2420 REM FORCE OUT OF RANGE TIME FOR STARS THAT DON'T RISE OR SET
2430 FOR I=1 TO N
2440   R(I)=R(I)+(P0(I)*(T*100))/3600
2450   D(I)=D(I)+(P1(I)*(T*100))/3600
2460   C3=R(I)+C
2470   C4=FNC(D(I))
2480   C5=FNS(D(I))
2490   C6=FNC(C3)
2500   D=FNA1(C2*C5+C1*C4*C6)
2510   C7=C4*FNS(C3)
2520   C8=C2*C4*C6-C1*C5
2530   C9=FNA4(C7,C8)
2540   P1=C9+Z
2550   R1=FNM0(P1)
2560   L4=FNL(P1,D)
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 10 REM FIXSTAR--FIXED STARS COMPARED TO NATAL PLANETS
 20 REM STAR COORDINATES PRECESSED & CORRECTED FOR PROPER MOTION
 30 REM DATE 5/6/79 REV 7/17
 40 REM REV 7/30/79 SECONDS DROPPED TO FIT COORDS ON ONE LINE WITH NAME
 50 REM REV 18 DEC 79 TO PUT PROPER MOTION CORRECTION BEFORE PRECESSION
 60 LINE 110
 70 DIM M(13), D1(20), L(20), L1(20), R1(20)
 80 DIM R0(20), R2(20), S(20)
 90 DIM C$(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 LONGITUDPISING      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$="ArTaGeCnLeViLiScSaCpAqPi"
210 REM TYPE OF TIME STRING
220 T$=" 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 OUTPP 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 RESTORING
800 REM RETURNS J (JULIAN DAY #)
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
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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),P0)
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
```



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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 MISPREAD.
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 | G0 | 3.6 | 5430 | 4 25 41.6 | .008 | 19 4 16 | -.04 |
| ALAMAK | SEE ALMACH | | | | | | | |
| ALARAPH | SEE ZAVIJAVA | | | | | | | |
| ALPALDAH | 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 |

| STAR NAME | CONSTELLAT | SP | MAG | GC # | RA | PM | DEC | PM |
|---|---|---|---|---|---|---|---|---|
| ALFIRK | SEE ALPHIRK | | | | | | | |
| ALGEDI | SEE GIEDI | | | | | | | |
| ALGEIBA | SEE ALGIEBA | | | | | | | |
| 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 50 | -.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 JABBAH | 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 28 | .01 |
| ALRAI | 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 | MP | 1.2 | 22157 | 16 26 20.2 | -.001 | -26 -19 -22 | -.03 |
| ANTILICUS | SEE KORNEPHOROS | | | | | | | |
| ARCTURUS | ALPHA BOO | K2 | 0.2 | 19242 | 14 13 22.8 | -.078 | 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 |
| ATPIA | 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 | K0 | 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 PORRIMA | | | | | | | |
| CAPULUS | 33Hvi PEP | C | 4.4 | 869 | 2 15 30.0 | .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 ASTERION | | | | | | | |
| CHELEB | SEE KELB ALRAI | | | | | | | |
| CHEPTAN | SEE COXA | | | | | | | |
| CHORT | 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 | | | | | | | |

| STAR NAME | CONSTELLAT | SP | MAG | GC # | RA | PM | DEC | PM |
|---|---|---|---|---|---|---|---|---|
| DABIH | BETA CAP | F0 | 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 | .018 | -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 48.8 | -.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 | 32000 | 22 54 53.5 | .025 | -29 -53 -16 | -.16 |
| FORAMEN | ETA CAR | 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 | 16740 | 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 |
| HARIS | 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 |



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| 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 ALRAI | BETA OPH | K1 | 2.9 | 24048 | 17 41 .0 | -.003 | 4 35 11 | .15 |
| KEPH | 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 28 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 | -.08 |
| 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 |
| MIRA | OMICRO CET | M6 | VAR | 2796 | 2 16 49.0 | -.001 | -3 -12 -13 | -.23 |
| MIRACH | BETA AND | M0 | 2.4 | 1400 | 1 6 55.5 | .014 | 35 21 22 | -.11 |
| MIRAK | SEE IZAR | | | | | | | |
| MIRAM | 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 ALDEBARAN | | | | | | | |
| 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 PHACT | | | | | | | |
| 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 POREMU | LEO | K3 | 4.1 | 13590 | 9 49 55.4 | -.016 | 26 14 36 | -.06 |
| RASSALAS | SEE RAS ELASED BOREALIS | | | | | | | |
| RASTABAN(B DRA) | SEE ALWAID | | | | | | | |


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| 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 | 0 -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 | | | | | | | |
| SAIPH | KAPPA ORI | B0 | 2.2 | 7264 | 5 45 23.0 | .000 | -9 -41 -9 | .00 |
| SALM | SEE KEPH | | | | | | | |
| 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 | 38 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 | 2309 | 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 | P8 | 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 |
| TUPEIS | 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 8 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 48 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 23 | 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 | 29 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 23 | 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 21 | 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 35 |
| -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 32 | 151 W 58 |
| 60 | 20 E 4 | 27 E 25 | 147 W 24 | 151 W 51 |

45

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 | 23 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 45 | 17 55 | 23 45 |
| 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 50 |
| 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 | | 9 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 10 |
| 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

Euro-American Astrology
P.O. Box 24334
San Jose, California 95154

## 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





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

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.

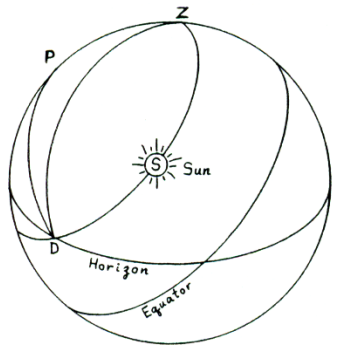


figure 1

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



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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

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right ascensions of the Sun's declination circle at time z (if $a_A \geqslant 24$, then $a_A = a_A - 24$, and, if $a_D < 0$, then $a_D = a_D + 24$);

4) if $a_D < a_S \leqslant a_A$, the Sun is above the horizon; otherwise, it is below the horizon;

5) find the smallest $i=1,2,\cdots,12$, such that $a_A - iZ_D/12 < a_S$, if the Sun is above the horizon, or find the smallest $i=13,14,\cdots,24$, such that $a_D-(i-12)Z_N/12 < a_S$, if the Sun is below the horizon; i 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 $i > 12$ 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 $a < x \leqslant b$ depends upon noting the position of the $24^h = 0^h$ boundary. The following logical procedure may be employed to determine if $a < x \leqslant b$:

1: m=1;

2: if $a > b$, go to 5;

3: if $a < x$ and $x \leqslant b$, go to 6;

4: m=0 and go to 6;

5: if $a \geqslant x$ and $x > b$, go to 4;

6 if m=1, then $a < x \leqslant b$.

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).



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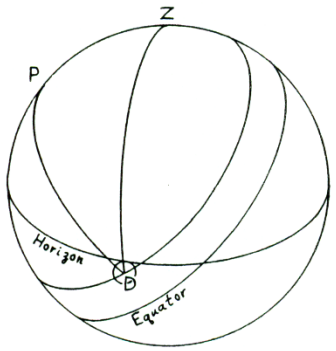


figure 2

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 $z=90°50'+1'.17h^{\frac{1}{2}}$. 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 $a_D$=$8^h.72$<$a_S$=$17^h.30$≤$18^h.56$, 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 i=2 the smallest i such that $a_A-iZ_D/12$<$a_S$;
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) $I_1$=7$F_0$=7(0.57)=4;
8) i=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)mod7, or j=(6+2-1)mod7=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.


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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
Henry Weingarten

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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]
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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.

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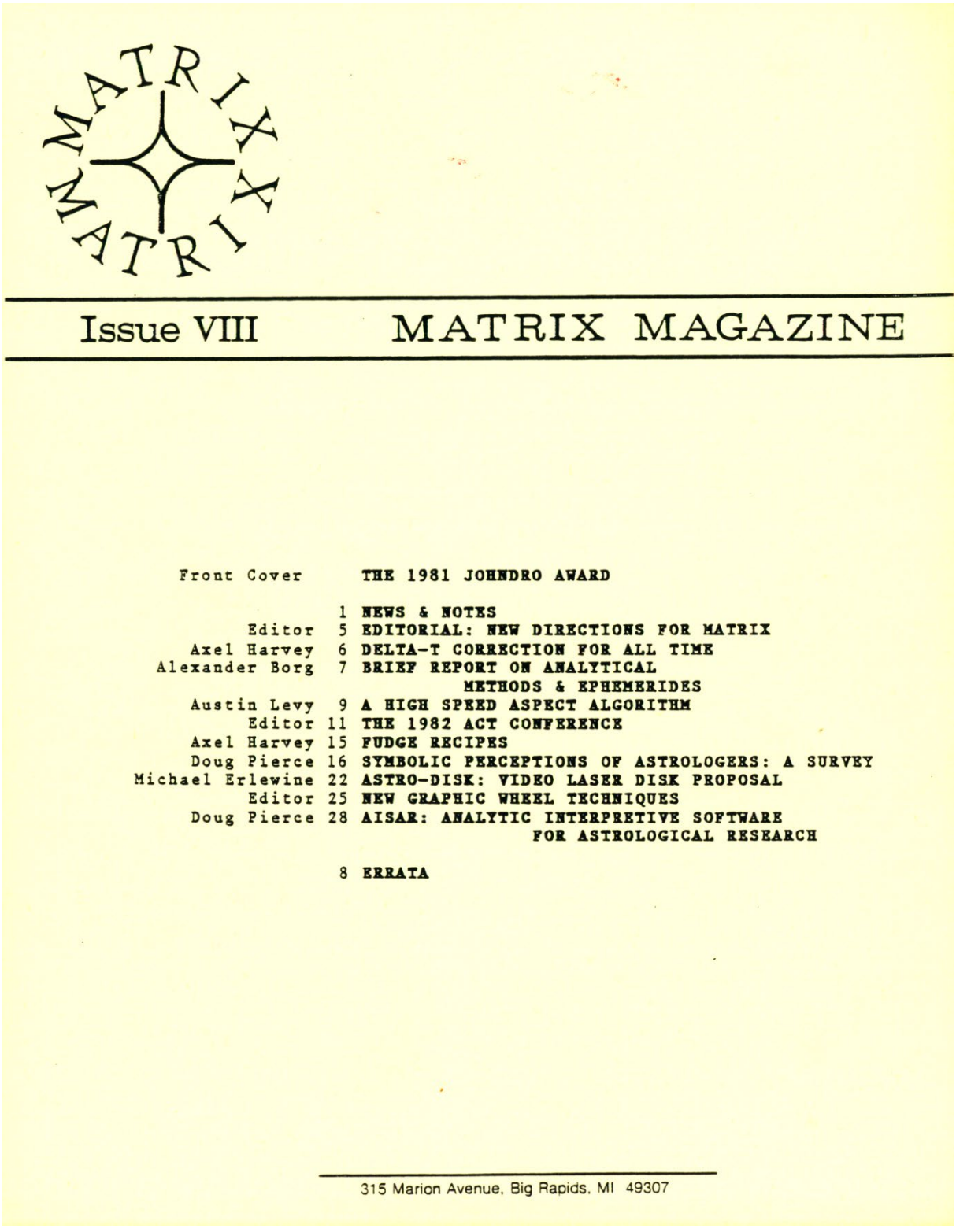
# MATRIX MAGAZINE ISSUE EIGHT – 1981



Issue VIII MATRIX MAGAZINE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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**

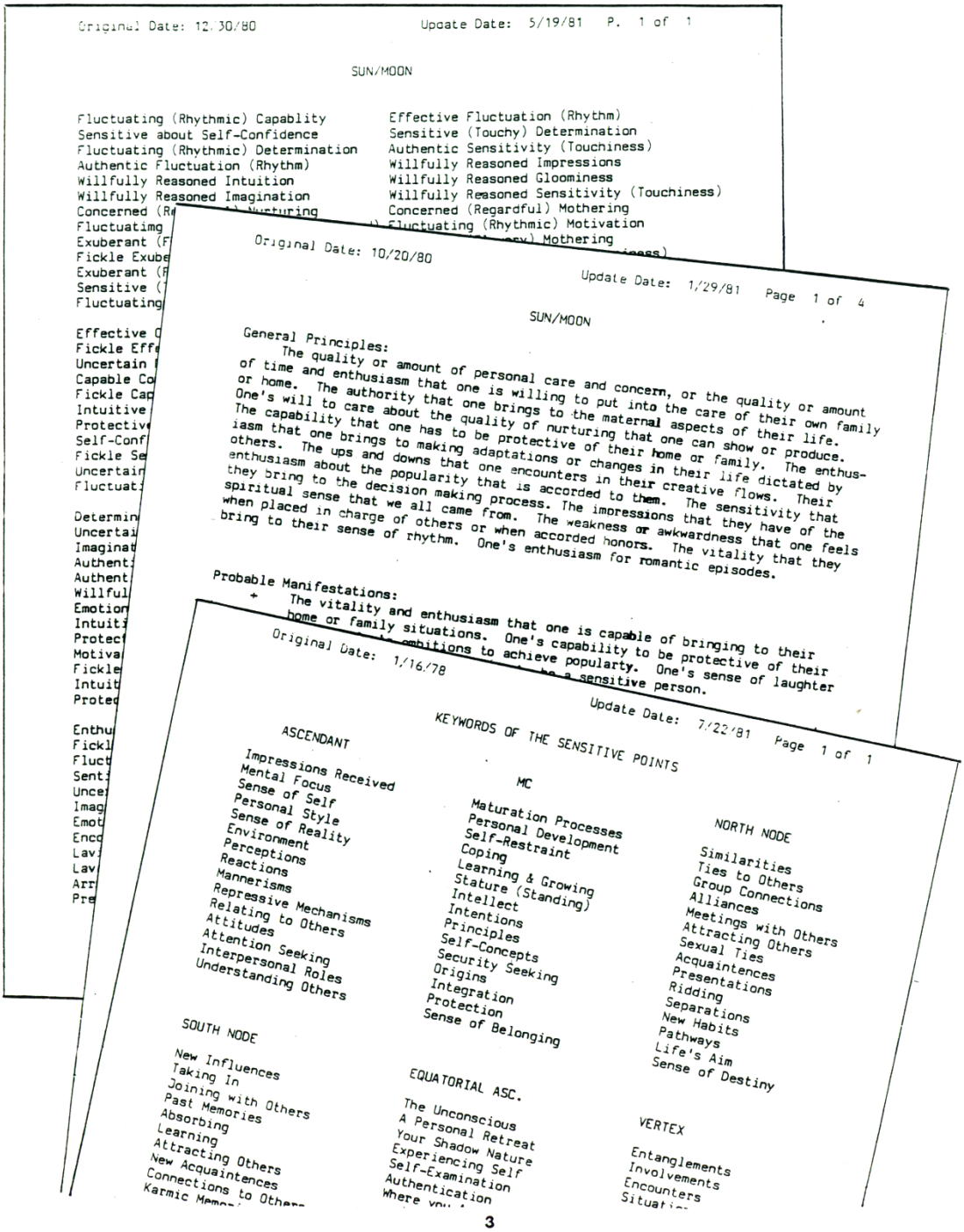
Michael and Nancy Munkasey spent a day here in Big Rapids recently. The chief purpose for the visit was to share with the MATRIX staff the results of many years of research into astrological keywords. The amount of this KEYWORD research and documentation really has to be seen to be believed. Thank God 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



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SUN/MOON

Fluctuating (Rhythmic) Capablity
Sensitive about Self-Confidence
Fluctuating (Rhythmic) Determination
Authentic Fluctuation (Rhythm)
Willfully Reasoned Intuition
Willfully Reasoned Imagination
Concerned (Re Nurturing
Fluctuatimg
Exuberant (F
Fickle Exube
Exuberant (F
Sensitive (
Fluctuating

Effective F
Fickle Effe
Uncertain
Capable Co
Fickle Cap
Intuitive
Protective
Self-Conf
Fickle Se
Uncertain
Fluctuati

Determin
Uncertai
Imaginat
Authenti
Authent
Willful
Emotion
Intuiti
Protect
Motiva
Fickle
Intuit
Proted

Enthu
Fickl
Fluct
Senti
Uncer
Imag
Emot
Enco
Lavi
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
) 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.

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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

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

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

SOUTH NODE

New Influences
Taking In
Joining with Others
Past Memories
Absorbing
Learning
Attracting Others
New Acquaintences
Connections to Others
Karmic Memo

EQUATORIAL ASC.

The Unconscious
A Personal Retreat
Your Shadow Nature
Experiencing Self
Self-Examination
Authentication
Where you

VERTEX

Entanglements
Involvements
Encounters
Situati

3

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 how 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
    000000006666666000000055555551
    000000000000003333333333333330
    000000000004444444444444444400
    000000000000000077700000000000
    000000000222222222"
```

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 understand 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 experession 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

$$20".496 + 0".345 \cos (281 - \text{longitude}).$$

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

$$A = d \text{ modulo } 360/a$$

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 <u>before</u> 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
1 2 3 4 5 6 7

assertive _____ 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.

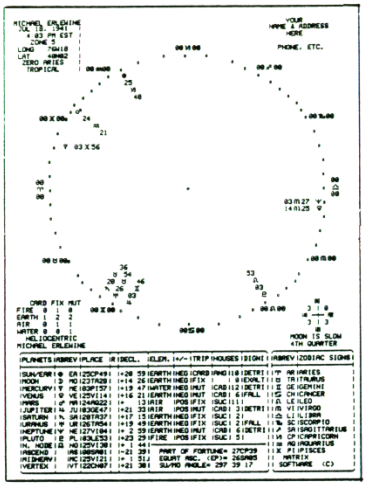
**ADVANCES IN CHART WHEEL GRAPHICS**

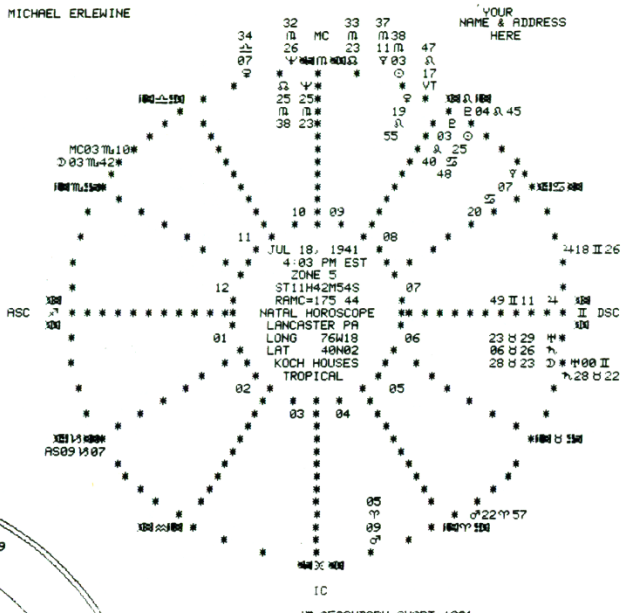
The representation of natal chart wheels via computer graphic techniques continue to be developed here at MATRIX. We thought you would enjoy a peek at our latest endeavors. We have a number of new chart representation techniques including astrological glyphs on the Commodore, Epson and IDS printers, 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.

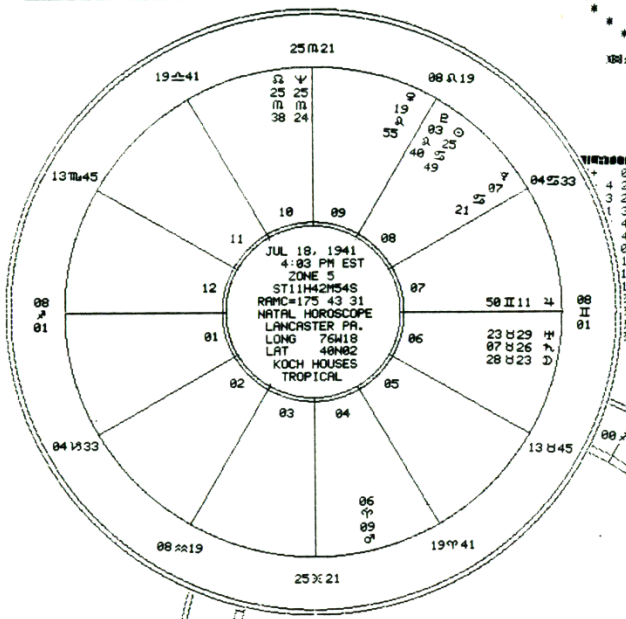
The techniques necessary to implement these Picture Wheels took a lot of work and research on our part. The majority of the interfacing and machine language work was done by Stephen Erlewine. Among other things we found that the companies that make these printers dont always know how to use their own 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 | 03 | V | 38 | 56 | + | 00 | 00 | 155 | 34 | +10 | 10 |
| - | 4 | 21 | 07 | 52 | 12 | +14 | 26 | MO | 03 | SC | 42 | 31 | + | 3 | 26 | 49 | 212 | 39 | - 9 | 31 |
| | 3 | 27 | 44 | 37 | 48 | +19 | 47 | ME | 11 | V | 37 | 15 | + | 1 | 25 | 33 | 163 | 36 | + 8 | 32 |
| | 1 | 35 | 32 | 142 | 52 | +16 | 21 | VE | 07 | L | 34 | 26 | + | | 34 | 19 | 187 | 11 | - 2 | 29 |
| | 41 | 19 | | 9 | 48 | + | 13 | MA | 22 | AR | 57 | 57 | - | 4 | 27 | 47 | 22 | 54 | + 4 | 47 |
| | 40 | 42 | 70 | 25 | +21 | 33 | JU | 18 | G | E | 26 | 14 | - | | 40 | 56 | 77 | 30 | +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 | G | E | 18 | 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 | L | E | 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 | 08 |
| | 30 | 00 | 175 | 44 | + | 1 | 51 | MC | 03 | SC | 10 | 53 | + | | 00 | 00 | 210 | 58 | -12 | 35 |
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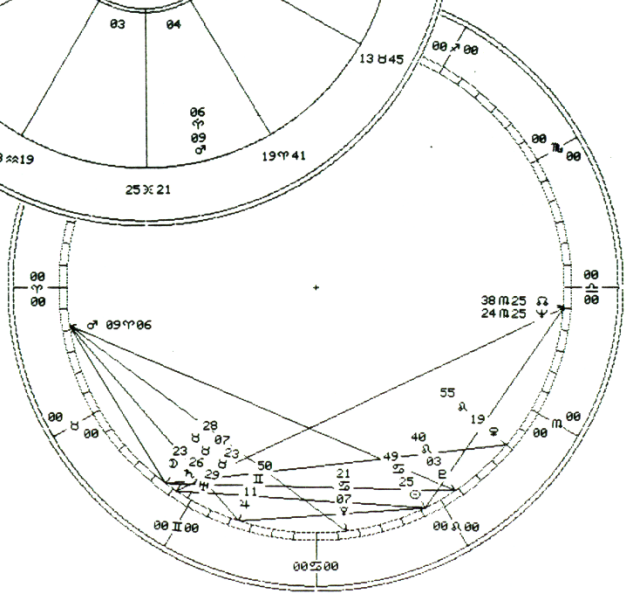
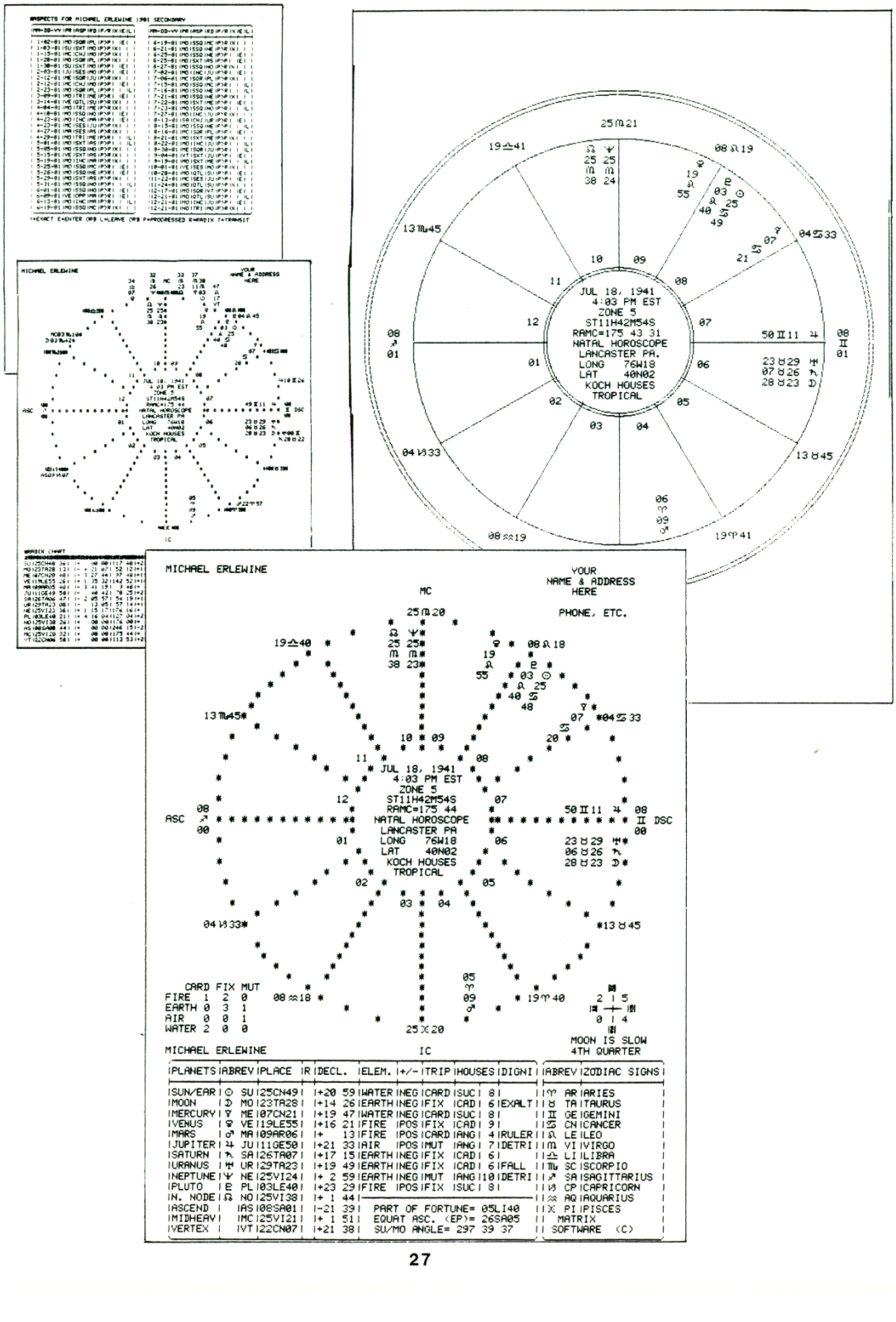





| PLANETS | ABREV | PLACE | R | DECL. | ELEM. | +/- | TRIP | HOUSES | DIGNI | ABREV | ZODIAC SIGNS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SUN/EAR | ☉ SU | 25CN49 | | +20 59 | WATER | NEG | CARD | SUC 8 | | ♈ AR | ARIES |
| MOON | ☽ MO | 23TA28 | | +14 26 | EARTH | NEG | FIX | CAD 6 | EXALT | ♉ TA | TAURUS |
| MERCURY | ☿ ME | 07CN21 | | +19 47 | WATER | NEG | CARD | SUC 8 | | ♊ GE | GEMINI |
| VENUS | ♀ VE | 19LE55 | | +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 able 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

Doug Pierce
4-B Terrell St.
Spartanburg, SC 29301

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

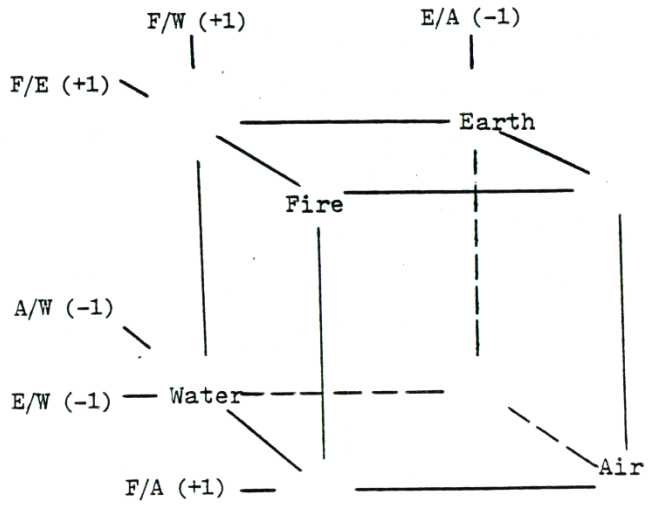


Figure 1 shows that the three polar dimensions intersect to form a cube. Each of the four elements is assigned a corner, by reference to its position within each of the three polar dimensions. There are exactly twelve edges on a cube. For each of the six possible matches of these polar dimensions with 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 |

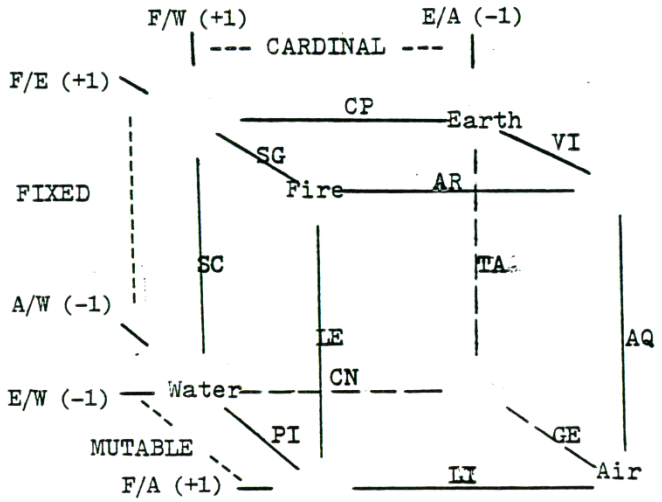
FIXED: Developmental context of identity

| 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/ Broadening 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.

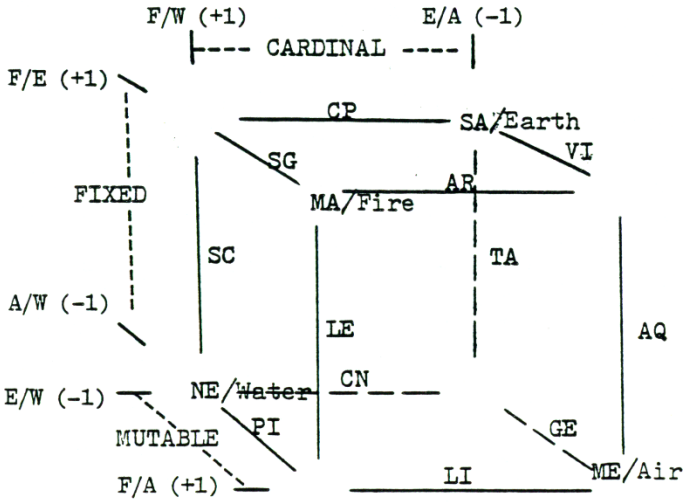
The discussion of the limits of the explicit model, at the end of Section I, anticipates some of the issues surrounding the representation of planets within this model. The points that need to be made have, I hope, been made in that discussion. Planets are represented here only to the extent that they 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.

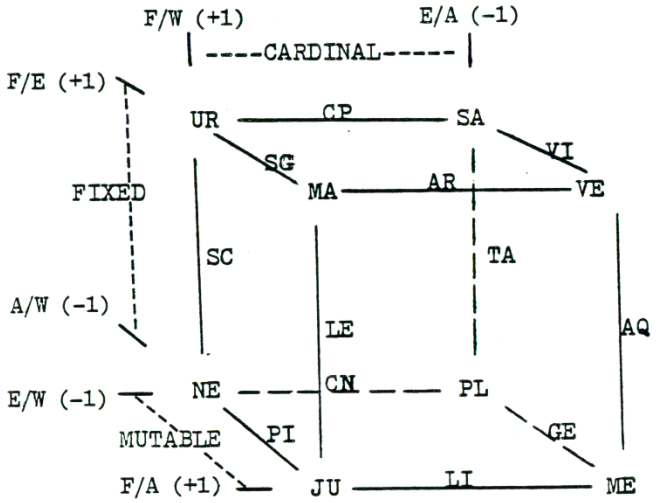
This leaves Uranus and Pluto, and now there are only two alternatives. Their positions within the Mutable dimension are already determined; they share the negative pole, associated with intensification of awareness within a private "adaptation" (or version) of reality. This model distinguishes between "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:

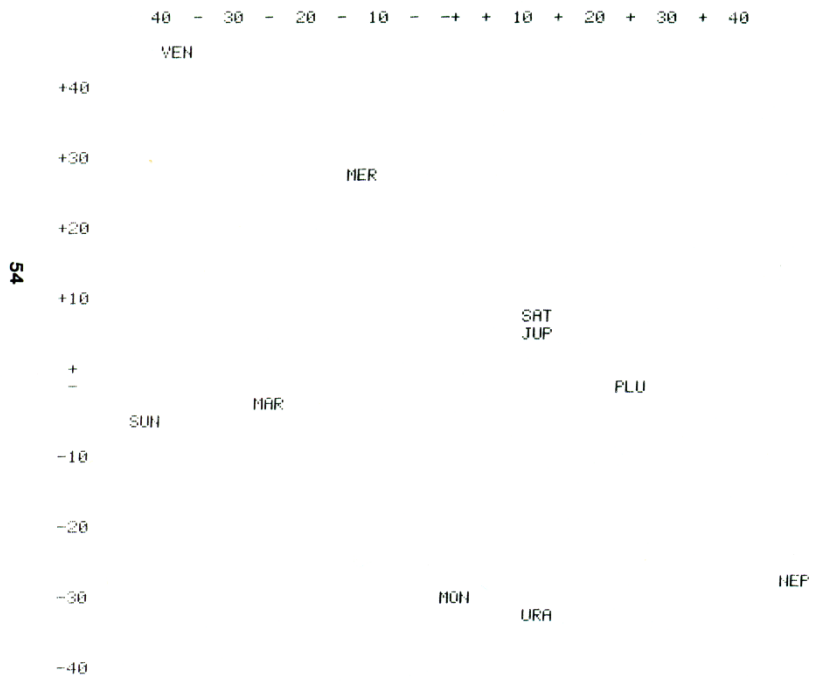
| | |
|---|---|
| SUN 05 TA 17 | JUP 29 AR 13 |
| MON 20 TA 34 | SAT 09 LI 51 |
| MER 10 AR 24 | URA 10 CA 33 |
| VEN 19 AR 09 | NEP 19 LI 56 |
| MAR 12 SC 36 | PLU 19 LE 06 |

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

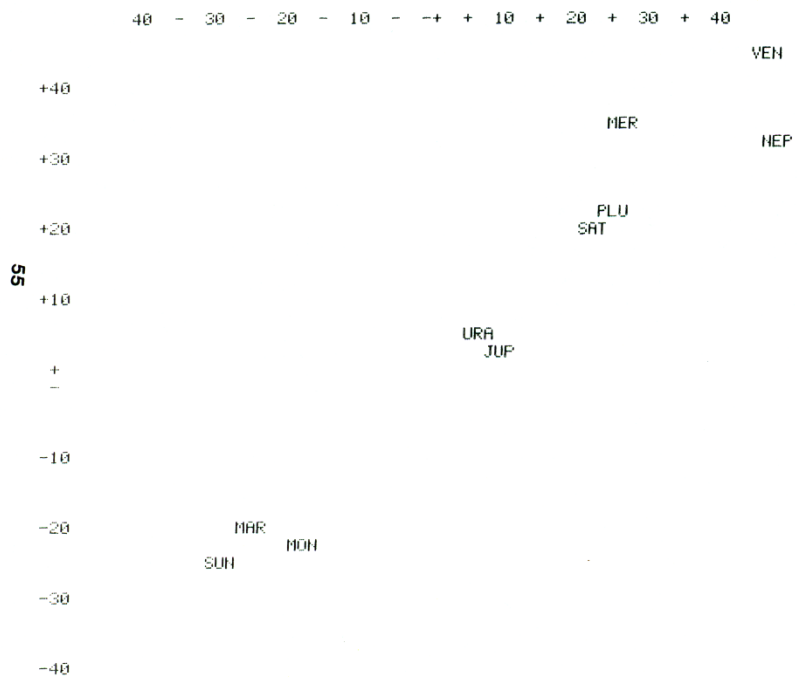



Figure 6 encompasses all of the encounters each planet has had with the rest of the planets. The dynamics of these encounters involve aspect prominence (exactness and "priority" in terms of harmonic number) and the quality of the planet and sign relationships. These qualitative relationships are of course 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 flexitility 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=I: 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.
```



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# 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
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## 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.

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# Matrix is the software source for computer astrology.

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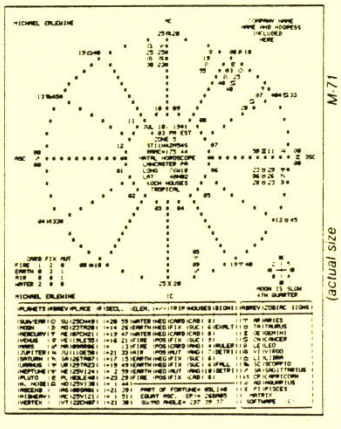
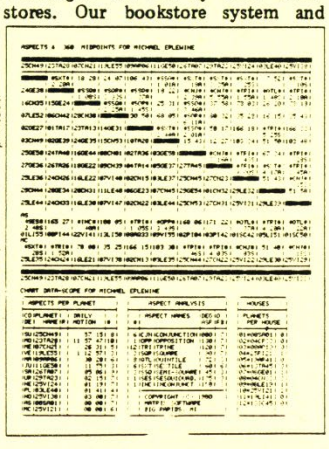
Home computers provide much more for astrologers than increased accuracy and time savings. They are a "window" into the great wealth of astrological tradition and techniques. Difficult techniques such as Primary Directions, Harmonic Analysis, Cosmobiology and Astro-Geography become instantly available 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.

## Chart Service From Your Home

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.

## MATRIX Bookkeeper System

We offer a total system for small businesses. This system is completely automated and menu-driven. Components of the MATRIX system include General Ledger, Accounts Payable & Receiveable, Payroll, Inventory Control, Depreciable Assets, Notes & Loans, Amortization Schedule, Invoicing, Financial reports and more, This program has been designed in cooperation with the American Federation of Astrologers for use by small bookstores. Our bookstore system and Chart Service provides a total package of the highest quality.

## MATRIX Full Catalog

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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