Occultation Newsletter

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FROM THE PUBLISHER

For subscription purposes, this is the fourth and final issue of 1983.

O.N.'s price is $1.40/issue, or $5.50/year (4 issues) including first class surface mailing. Back issues through *Vol. 2*, No. 13 still are priced at only $1.00/issue; later issues @$1.40. Please see the masthead for the ordering address. Air mail shipment of *O.N.* back issues and subscriptions is 45¢/issue ($1.80/year) extra, outside the U.S.A., Canada, and Mexico.

IOTA membership, subscription included, is $11.00/year for residents of North America (including Mexico) and $16.00/year for others, to cover costs of overseas air mail. European and U. K. observers should join IOTA/ES, sending DM 20.-- to Hans-J. Bode, Bartold-Knaust Str. 8, 3000 Hannover 91, German Federal Republic.

IOTA NEWS

David W. Dunham

The first IOTA annual meeting in Houston, TX, last November, was very successful, as reported by Charles Herold on p. 118. While in Texas, I also gave talks about last May's Pallas occultation at Rice University, Houston, and to a joint meeting of Ft. Worth and Dallas amateurs organized by George Ellis. George Ellis also attended the IOTA meeting, where he discussed possible cooperation of the Astronomical League with IOTA, especially for coordinating asteroid occultation observations. Don Archer already had sent me a listing of the addresses of all astronomical societies belonging to the Astronomical League, as well as of all (over 8000) individual A.L. members, conveniently arranged geographically by ZIP code. We noted how home computers might be used to disseminate last-minute predictions rapidly via mailgram-like services and computer bulletin boards.

Since IOTA must hold its annual meeting in Texas, Ellis suggested that we might hold the 1984 meeting in conjunction with the Texas Star Party in western Texas, the first weekend of June. This would result in a larger attendance and more publicity, as more amateur astronomers would be going there. However, observing the May 30th annular solar eclipse probably will make an early June meeting difficult, and it appears unlikely that three members of the IOTA board of directors, needed to conduct business, would be able to attend. So the second annual meeting probably will be held late in the year again, in eastern Texas, and the 1985 meeting likely will be held with the Texas Star Party. However, we should not make too many plans until we hear from the Internal Revenue Service about our application for tax-exempt status. In late October, the I.R.S. sent us a letter asking for more information, and we have not yet received a reply to our response. If they deny tax-exempt status, IOTA probably will disincorporate.

I thank Rice University's Department of Space Physics and Astronomy for paying the cost of my round-trip plane ticket to Houston last November. The General Dynamics Recreation Association in Ft. Worth, Don Stockbauer, John Cotton, Paul Maley, and Walter Morgan provided lodging, meals, and other transportation.

The analysis of lunar occultation observations was set back severely last month when Tom Van Flandern left the U.S. Naval Observatory. Little progress with the analysis had been made during the last year as disputes with Captain Roberts and other administrators, about working hours and other matters, took more of Van Flandern's time. Although Captain Roberts prevailed, Van Flandern is undertaking legal actions to reinstate his position. In the meantime, the most sophisticated software for analysis of lunar occultation data sits idle in disk files at U.S. N.O. Since H.M. Nautical Almanac Office discontinued its lunar occultation work in 1981 (except for a low-level effort, which lasted another year, to complete some publications about its final analyses), the only workers I know who are paid to analyze lunar occultation data are now at the International Lunar Occultation Centre in Japan. Unfortunately, their manpower is limited; their work of preparing prediction information for publication, and of key-punching the observations and computing and distributing residuals, leaves little time for analysis. At U.S.N.O., Marie Lukac continues to work part time to produce the total occultation predictions, obtaining advice from Van Flandern and me. But the future of even this vital work is not certain. So far, Lukac and Alan Fiala have argued successfully for continuing the work, but there are some in the Nautical Almanac Office who would just as soon see it ended. But with Van Flandern not on the scene, occultations have lost a powerful spokesman. The finding that G is essentially constant will not help; see p. 118.

The ILOC finally distributed residuals for 1981 occultation timings to observers a few months ago. Some have been confused by the format of the distributed lists. I have begun an independent calculation of the residuals for a small sample of observations at U.S.N.O. and plan to publish the results in the next *O.N.*

On rare occasions, an SAO number less than 17 will appear in the USNO total occultation predictions. Since such SAO stars are north of declination +80°, they are not true SAO numbers. They are actually error codes for AGK3-catalog stars which are not in the SAO catalog.

In spite of late-night breakdowns of our van, both coming and going, we felt that the meeting of the American Astronomical Society's Division of Planetary Science in Ithaca, NY, last October, was very successful. R. Millis and E. Bowell described possible 1984 occultations by (1) Ceres and by Halley's Comet; see p. 129. Observations of occultations by (375) Ursula on 1982 November 15 and by (93) Minerva seven days later were described in *O.N. 3* (3), 52. L. Wasserman reported in Ithaca that analyses of the observations at Lowell Observatory gave a diameter of 216 ±4 km for Ursula and 173 ±2 km for Minerva. The actual uncertainty is probably about ±10 km due to lack of coverage near the limits of both occultations. Since no ellipticity was evident, only circular fits were made. S. J. Ostro reported that a double peak in a radar reflection with the Arecibo radio telescope for the small asteroid (2201) Oljato indicates that it might be a contact binary. Speckle observations of (532) Herculina and my first solution from analysis of last September's occultation by (51) Nemausa were reported at Ithaca and described in *Sky and Telescope 67* (1), 60. I led a small meeting about publication of the results from the occultation of 1 Vulpeculae by (2) Pallas in May. We decided that the paper probably should be submitted to the *Astronomical Journal*. In addition to the occultation observations and analysis, we would list all miss observations to show the observational coverage in the vicinity of Pallas. We also would list everyone who travelled to observe the occultation, but were clouded out, to document the overall effort for this unique event. I hope to have a first draft of the paper ready in February. In the meantime, Paul Maley's account of the Texan effort for the event soon will be published in *Astronomy*, as well as translated versions in Italian, Latin American, and Swiss magazines. A first draft of the results from the occultation of 14 Piscium by (51) Nemausa should be ready in March or April.

Reports of lunar occultation timings made in the Soviet Union during 1980 and 1981 recently were received. Some grazing occultation observations were reported, including one of Aldebaran recorded at five stations on 1980 March 21 with the temperature -15°C! In a letter dated 1983 November 15, A. Osipov, Kiev, said that the Soviet report for 1982 was in press, and that a report for 1983 would follow in a few months. He reported that the occultation of 8.6-mag. SAO 104751 by (2) Pallas was observed from Engelhardt Observatory in Kazan on 1983 May 4, and that the occultation of 9.4-mag. SAO 41289 by (36) Atlante [Ed: misspelled Atalante in 1983 predictions] was seen in Khabarovsk last October 9th.

After the Soviet report for 1982 is received, and after the observations for 1982 are received on magnetic tape from ILOC, we will be able to make a final analysis of occultations timed during the total lunar eclipses which occurred that year. David Herald already has analyzed 105 timings during the July 6th eclipse and 141 timings during the December 30th eclipse made in Australia and New Zealand, and published the results in *Circular C83/9* of the Occultation Section of the Royal Astronomical Society of New Zealand (1983 October). In the same publication, Graham Blow reports that Peter Anderson timed a 6.7-second occultation of SAO 183401 by (10) Hygiea on October 8 at Bundaberg, Queensland. The disappearance was at $9^h\ 47^m\ 48\overset{s}{.}3$.

Hans-Joachim Bode recently sent me a report of the regional meeting held 1983 October 15 in Kiel, German Federal Republic. Asteroidal occultations were the main subject of discussion, and a cooperative network of observers of possible events in the G.F.R. and in Denmark was established. We hope that the network can be expanded to other European countries when the third European Symposium on Occultation Projects (ESOP III) will be held in June, probably on the 23rd, in either Czechoslovakia or Denmark. I will be attending an astrometry meeting near Munich earlier that week, so I plan to be at ESOP III.

The Astronomical League will be meeting in Milwaukee, WI, on 1984 August 1-4. I plan to be in the Los Angeles area at the time and will be unable to attend. Anyone who would be interested in speaking at a possible IOTA session or workshop during the meeting should contact Dan Koehler, W248 S7040, Sugar Maple Dr., Waukesha, WI 53186, phone 414,662-2987.

I apologize for my delays in preparing material for this issue; I know many of you are anxious to learn about this year's planetary and asteroidal occultations. Some information on early January events was distributed by Joseph Carroll in rough form along with the 1984 appulse predictions which he computes for all IOTA members. I again have not had time to publish organized accounts of grazes and asteroidal occultations and appulses, but plan to do so in the next issue, which will be targeted for late March.

THE TIMEKUBE/WEATHERADIO; WHETHER OR NOT

Don Stockbauer and Ken Thomson

[Ed: The following is an independent field evaluation, and solely represents the viewpoints of the authors.]

Many of us have waited eagerly for Radio Shack's newest Timekube/Weatheradio to appear in the stores, as a source of time signals. Stockbauer purchased one and was not pleased with the time signal reception at all! His old model Timekube almost always received WWV clearly on one or another of the three frequencies. Playing the two models simultaneously, he noticed that often the old one would receive a signal strongly while the new one would get only static on the same frequency. Sometimes the new one would receive a station other than WWV while the old unit picked up WWV quite well on that frequency. He asked another member of the Houston Astronomical Society, who is better versed in the mysteries of electronics, Thomson, to try to adjust the new unit for better reception. Thomson analyzed the whole design, and the results are quite discouraging!

He found that the new unit often receives an image frequency on top of WWV. For example, there often is a radioteletype signal transmitting at 15.910 MHz on the new unit; it is precisely at the predicted image frequency for a 455 KHz intermediate frequency (IF). It was found that both the old and new units have 455 KHz IF's by feeding a signal generator into the antenna. But the bad news is that while both receivers have two stages of IF amplification, the older Timekube has a stage of RF amplification, while the new one does not! As a result, we think the new Timekube will have much poorer RF selectivity, and nothing can be done about it, short of a redesign.

Stockbauer has kept his new toy to use as a 4th-level time backup on expeditions, and as an occasional weather source (the weather feature works fairly well).

We would appreciate feedback from other users of the new Timekube/Weatheradio, but would strongly advise having a backup for it, lest Murphy's law prevail. [Please route any replies via the editor, so that we may have the option of publishing them.]

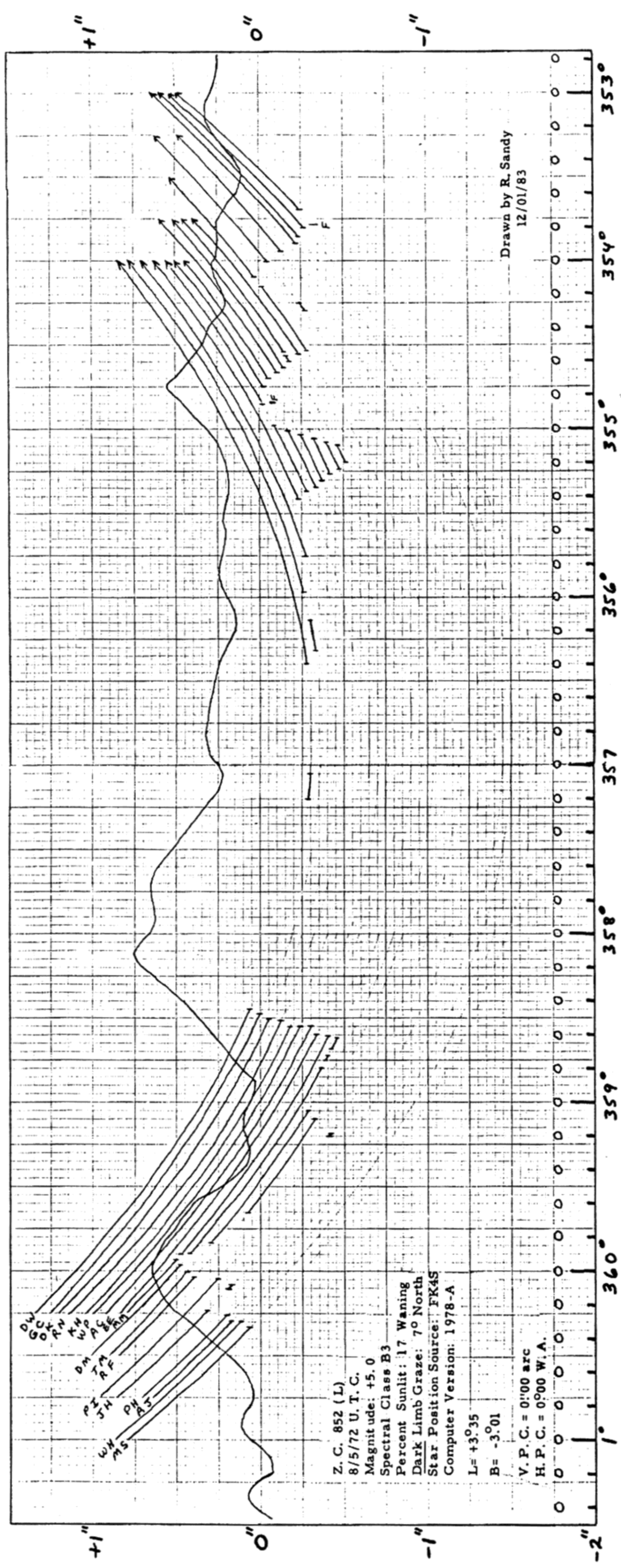
GRAZING OCCULTATIONS

David W. Dunham

The grazing occultation predictions for the first half of 1984 either have been, or are being, sent to IOTA members. A correction that should be applied to the profiles for northern-limit waning-phase northern-latitude-libration grazes was described on p. 100 of the last issue. Contrary to what is stated there, no changes have been made to the ACLPPP for the 1984 predictions, so the described correction still should be applied when appropriate. It seems that many of the discrepancies noticed between the 78A and 80F prediction versions are due to the use of Perth 70 catalog data for the latter, even for bright northern-declination stars, which could not be observed well from Perth. The best solution to the current problems probably would be a new analysis of all the occultation data, using the XZ catalog as it stands for the southern stars, but removing the Perth 70 data from the northern stars. Unfortunately, Van Flandern's absence from USNO (see p. 113. guarantees that no such analysis will be done soon.

The southern-limit Cassini-region grazes also seem to be causing problems. Observations of a few grazes in these areas have shown large south shifts. Until better advice can be given from studying more observations, I recommend that observers apply a 0".5 southward correction to southern-limit ACLPPP profiles if more than half the profile points (including all within 1° of central graze) are 3's and 4's.

G. M. Appleby and L. V. Morrison recently published their "Analysis of lunar occultations — V. Grazing occultations 1964-1977" in *Mon. Not. R. Astr. Soc. 205*, p. 57. Observations of 800 grazes were studied to find corrections to Watts' charts, to the analytical lunar ephemeris



j=2, and to the zero point of right ascension in the FK4 catalog. Computer-drawn observation reduction profiles of 228 of the best-observed grazes were published on microfiche.

Robert Sandy, now in Independence, MO, has prepared some more reduction profiles for some recent grazes and some well-observed earlier events. These will be published as time and space permit in *O.N.*; some others will be distributed to expedition leaders.

Graham Blow photoelectrically recorded 3 disappearances and 2 reappearances during a near-graze of 8.5-mag. SAO 186844 at Mt. John Observatory in New Zealand last Sept. 15. Since the rotating buffer contained space for only 3.84 seconds of data, the star may have reappeared briefly again after the last-recorded disappearance. The predicted position angle was 16° from central graze.

Joan and I have rewritten and updated the papers describing the use of graze predictions, as part of a long-delayed larger general IOTA manual on occultations. Some other parts of the manual also have been prepared. These soon will be sent to Mark Allman for duplication and distribution to all new and current IOTA members. Allman also is updating some parts of *Observing Grazing Occultations VIII*, especially the useful section telling where to send requests and reports.

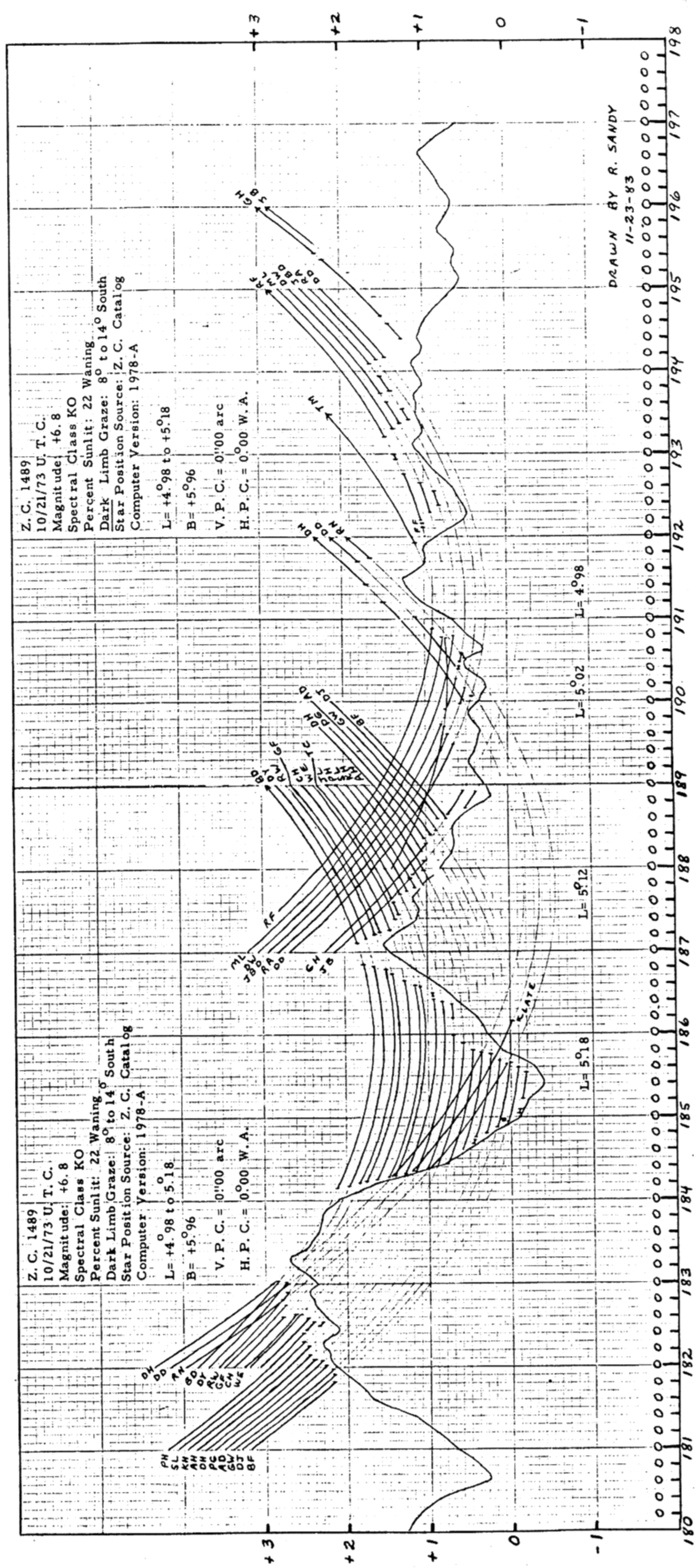
Again, time does not permit preparation of a list of observed grazes, but I am more determined than previously to include one in the next issue. After that, Don Stockbauer has agreed to collect reports of observations of grazes, make sure they are filled out properly, send blank forms when needed, and prepare the summaries for *O.N.* In the meantime, continue to send the reports to me, with, if possible, copies to ILOC.

LETTER

To the Editor:

Here are some notes relating to the article "Timing Occultations with a Digital Stop Watch," by Brian Loader (*O.N.* 3 (4), 85).

I have been using the described method for several years now, with only a slight difference; I have fixed the STOP key. In this way, I am sure of not losing the time base by accidentally stumbling or bumping, falling or grabbing the stop watch when I am late for a timing. In this way, I can use the time base for more than six months. I only un-fix the STOP key to reset the time base when it differs more than ten seconds from the correct time. For very



close events, I simply use a second stop watch (you can buy them for $7 these days).

Some care must be taken in choosing the digital stop watch you will use. Some four years ago, I used the CASIO computer quartz CQ-1 to do my timings. When using the LAP key of that stop watch, you do influence the time base in some way. I found that when I used the LAP key some 100 times, the time base drifted about 0.2 second or more. Especially when you test the stop watch against the time signal to get an accurate difference, you could wind up with accuracy poorer than 0.1 second.

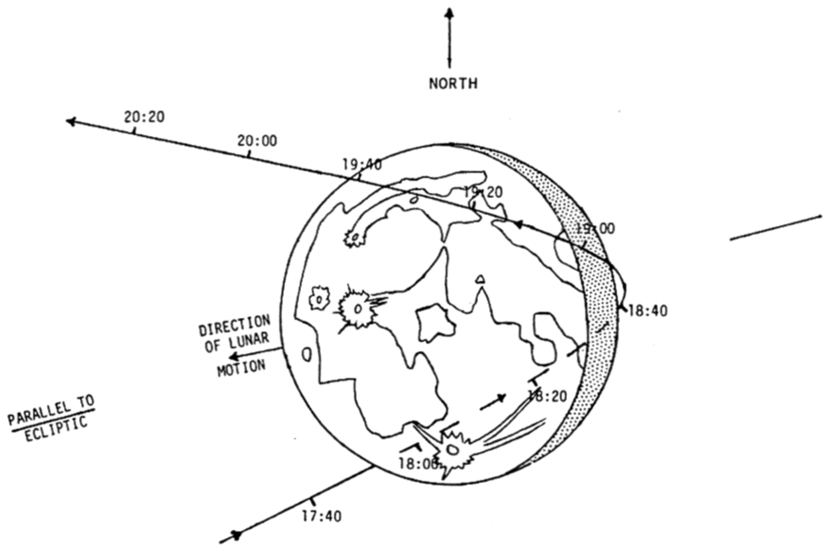
Henk Bulder
The Netherlands

LUNAR OCCULTATION OF ISEE-3

David W. Dunham

My orbital design work for the 3rd International Sun-Earth Explorer (ISEE-3) was mentioned briefly in *O.N. 3* (3), 45. The complex orbit planned for the spacecraft was shown on page 136 of last February's *Sky and Telescope*, and also in *Astronomy 11* (9), 20 (1983 September). Co-workers at Computer Sciences Corp. and at Goddard Space Flight Center successfully executed the propulsive maneuvers needed to target the five lunar swingbys. The last swingby, on December 22nd, provided an unusual opportunity to combine my occultation work with the main part of my job. We planned to send ISEE-3 only 118 km above the mean lunar surface, much closer than the other swingbys, and the only one where the spacecraft would be occulted by the moon as seen from the earth. We predicted the time of occultation as seen from Goddard and Jet Propulsion Laboratory tracking stations in Alaska, Guam, and Australia. By comparing the observed with the predicted times, we hoped to estimate the actual height above the moon at closest approach.

I modified an existing program, which computes a topocentric ephemeris of a spacecraft, to calculate the angular distance to the center of the moon. When this distance was within 10" of the subtended lunar radius, I printed position angles and other quantities so that Watts' charts could be used to include limb corrections. The program was not completed and partially tested until Friday, Dec. 16. In the meantime, ISEE-3 was being tracked by radio at both Goddard and J.P.L. stations, and improved trajectories, determined from the tracking data, were given to us every two days. We needed the latest information in order to decide whether we needed to perform another propulsive maneuver on Dec. 20 in order to achieve the precise lunar swingby parameters needed to get close to Comet Giacobini-Zinner in 1985. In the meantime, an independent occultation prediction (without limb corrections, which changed the times by only 1 or 2 seconds) was being made with an older "coverage" program as a check, although it had not been designed for such a calculation. Comparison with the same trajectories was not made until Dec. 19, and they disagreed by 20 seconds! But computer hardware problems prevented making any program modifications needed to trace down the discrepancy; the machine still had not been fixed on Dec. 23. We looked for another independent Calculation. At. J.P.L., the person who knew how to run their occultation program was on vacation. Marie Lukac, with some advice from Tom Van Flandern, finally overcame some computer problems at U.S.N.O. to compute a prediction only a few hours before the swingby. The U.S.N.O. times were closer to the "coverage" calculations, but disagreed with them by about ten seconds. However, the U.S.N.O. calculation neglected the spacecraft's motion, us-



TRAJECTORY OF
ISEE-3 AROUND THE MOON AS SEEN FROM THE EARTH. 1983 DECEMBER 22

ASTRONOMY DAY

MAY 5, 1984

ASTRONOMICAL LEAGUE

For more information, contact:

Gary Tomlinson, Astronomy Day Coordinator
Astronomical League
Chaffee Planetarium
54 Jefferson S.E.
Grand Rapids, MI 49503
616-456-3985

The Astronomical Association of Northern California will be hosting Astronomy Day on 1984 April 7.

ing fixed positions which I had supplied using the latest J.P.L. trajectory. The Goddard and J.P.L. trajectories obtained on Dec. 19 gave occultation times about seven seconds apart at a given station. At least, they indicated that the trajectory was accurate enough that the planned Dec. 20th correction maneuver could be cancelled.

As we waited for the swingby events in the control room at Goddard, we were confident that ISEE-3 would not crash into the moon, but wondered if it would survive a 29-minute passage through the moon's shadow. The spacecraft batteries had died a couple of years before, so sunlight was needed for the solar cells to provide all the spacecraft electrical power (in its originally designed "halo" orbit about the libration point 0.01 AU from the earth towards the sun, ISEE-3 was always in sunlight). Would hydrazine fuel which might still be in the lines freeze and expand, rupturing them and leaving ISEE-3 with no way to correct its orbit for the final targeting to the comet? Finally, over the intercom, we heard: "Alaska, LOS (loss of signal) at 17^h 50^m 46^s G.M.T." I checked my sheet — only two seconds later than my predicted time using the Goddard trajectory, and one of those seconds would be explained by neglected light-time delay! LOS at Guam was 17^h 52^m 24^s, four seconds late. The result for Orroral, Australia, was two seconds later than my time.

Emersion was at 18^h 38^m, but ISEE-3 was in eclipse then, and silent. Closest approach came six minutes later, over Mare Smythii. The eclipse ended at 18^h 48^m, after which we had to wait a few minutes for the spacecraft to power itself up. You could hear a pin drop as we waited and a command was sent to the spacecraft to report its condition. Then, "This is Guam — we have AOS (acquisition of signal)!" Robert Farquhar, who had conceived and led the effort to send ISEE-3 to Comet Giacobini-Zinner, blurted out, "Was there ever any doubt!" The readings from ISEE-3 showed that its temperature had dropped only 15° while in eclipse, and that all was well. A trajectory computed at J.P.L. using data both before and after the swingby showed that the closest approach was within 2 km of our target. The spacecraft, now leaving the earth-moon system, was rechristened the International Comet Explorer (ICE). We will be giving a series of papers about the trajectory design for this unique mission at the American Institute of Aeronautics and Astronautics' Astrodynamics Conference in Seattle, WA, this August. A 5-minute animation of ISEE-3's trajectory was videotaped at J.P.L.; I recently made a copy of it.

THE GRAVITATIONAL CONSTANT IS CONSTANT

David W. Dunham

In an article, "Experimental Test of the Variability of G Using Viking Lander Ranging Data," in *Physical Review Letters 51* (18), 1983 October 31st issue, Hellings, R. W.; Adams, P. J.; Anderson, J. D.; Keesey, M. S.; Lau, E. L.; and Standish, E. M., Jet Propulsion Laboratory; and Canuto, V. M. and Goldman, I., NASA Goddard Institute for Space Studies, NY, presented the result:

$$\dot{G}/G = (0.2 \pm 0.4) \times 10^{-11} \text{ per year.}$$

Using an interplanetary baseline for precise transponder range measurements gave these authors a big advantage over previous efforts to measure G, as they state: "This (our) sensitivity represents more than an order of magnitude improvement over previous limits set with radar ranging data or with lunar orbit data. The quoted error is much larger than the formal standard deviation and represents uncertainties stemming from our lack of knowledge of the masses of the asteroids." In fact, the ranging measurements were so accurate that it was possible to determine the masses of the three largest asteroids, (1) Ceres, (2) Pallas, and (4) Vesta, as well as the mean densities of the 200 largest asteroids, broken down into C- and S-type groups. The result is consistent with cosmological theories, such as Einstein's, which predict no change in the gravitational constant, and rules out others, such as Dirac's large numbers hypothesis, which predict $\dot{G}/G$ = the inverse of the Hubble time of galactic expansion, or about 5×10^{-11} per year.

The "lunar orbit data" are primarily photoelectric timings of total occultations. Although a major breakthrough like the above is always welcome, it does remove a major rationale for lunar occultation timings. Of course, observations of total and grazing lunar occultations are still valuable for dynamical and astrometric studies (including the determination of proper motions around the sky, which in turn are needed for deriving the Oort parameters of Galactic rotation), resolution of close binary stars (many of which can not be detected by other techniques), photoelectric measurement of stellar angular diameters, and improvement of knowledge of the lunar profile (which is needed for analysis of solar eclipse observations used to determine small variations of the solar radius). With the virtual cessation of lunar laser ranging observations, occultation data again may become more important for determining lunar orbital parameters and Ephemeris Time.

MINUTES OF IOTA MEETING 1983 NOVEMBER 11

The first meeting of IOTA as a non-profit organization incorporated in the State of Texas was called to order on the 11th of November, 1983, at 7:15 P.M. It was a joint meeting with the Johnson Space Center Astronomical Society, held at the Lunar and Planetary Institute, on NASA Rd 1, Houston, Texas.

After some preliminary discussions of JSC Astronomical Society, Paul Maley introduced Dr. D. W. Dunham.

Dr. Dunham discussed an occultation of a star by the asteroid Minerva, in Europe and North America. He then presented some preliminary findings on the Pallas occultation. Of 130 sites in Texas, only 68 were able to escape the cloud cover and time the event. With all the chords presented, including some photoelectric observations, the profile of Pallas appears circular. Formal analysis still is to be completed. He also showed a video recording of a grazing occultation by the moon, that he and his wife made on 1983 October 27.

Paul Maley then talked about, and showed some 35 mm film slides of, the Indonesian eclipse expedition. He also showed some data that were collected by other IOTA members. He also discussed upcoming grazing occultations and expeditions planned by him and some other members through 1988.

Dr. Dunham explained some reasons for grazing occul-

tations:
1. for better astrometry (and refinements thereof);
2. for detection of double stars (only method suitable for some very close pairs);
3. for improved knowledge of the lunar position;
4. to find the north-south diameter of the moon more accurately; and
5. for the most accurate resolution of the lunar profile.

At 11;01 P.M. Dr. Dunham opened the IOTA portion of the meeting. There were 12 IOTA members present.

I. David Dunham made a motion to elect all candidates as presented on the ballot which was mailed to all members, as the officers of the organization. The motion was seconded by P. Maley. All members present voted in favor of the motion.

Charles Herold distributed the unopened envelopes with ballots from members to members present, who in turn, opened and counted the ballots. They then were collected by C. Herold, who totalled the groups of ballots. 132 ballots gave their voting rights, by proxy, to C. Herold. One ballot gave its voting rights to Mark Allman. C. Herold cast all votes for which he was proxy for the above motion. Mark Allman was not present.

The tally was 144 ayes (for), and 2 nays (against). The motion carried, as 59% of the members were in favor (30% is required in the bylaws).

II. A motion was presented to change membership expirations from a monthly to a quarterly basis. The motion was seconded by C. Herold.

There were 142 ayes (for), and 2 nays (against). The motion carried.

Dave Dunham mentioned that because of budget cuts at the U.S. Naval Observatory, it may become difficult to obtain grazing occultation predictions in the future (alternative means of obtaining predictions are being studied, in case such a catastrophe occurs).

George Ellis, of the Astronomical League (which has 8500 members), offered its services to IOTA, to help organize occultation observation events. He said that they have a communication network that is in operation all year long. This network could alert the most people who would be interested in becoming part of a grazing occultation expedition in the least amount of time.

The meeting was adjourned at 12:01 A.M., 1983 November 12.

Respectfully submitted

Charles H. Herold
Executive Secretary

MORE TELEPHONE TIME DEVELOPMENTS

David W. Dunham

A caution about a possible 0.25-second delay caused by the routing of many North American long-distance telephone calls through geosynchronous communications satellites was published on p. 106 of the last issue. Derald Nye informed me that WWV time signals are available within the U.S.A. on a toll-free number, 800,957-9999. Use of this number would have the same drawback as use of the other accurate telephone time numbers mentioned in the last issue. But the Naval Observatory has introduced a new number, 900,410-8463, which uses only land lines, not satellites. Hence, the time available via this number to all residents of the U.S.A. would be accurate to, at worst, a couple of hundredths of a second, less than visual timing uncertainties, and is consequently preferred over the other long-distance numbers for occultation work. The 900 numbers are not free, but cost 50 cents for each call, regardless of location within the U.S.A. U.S.N.O.'s earlier master clock time number, 653-1800, is still in operation, and can be used to obtain accurate time within the Washington, DC, free-calling area; presumably, the same is true for WWV's regular number in the Ft. Collins, CO, area. But others for whom these calls are long-distance should use the 900 number to avoid the possible satellite delay.

REVISED SOLAR RADIUS RESULTS

Marion Schmitz, Joan B. Dunham, and David W. Dunham

We recently discovered and corrected an error in our computer program which computes solar radius and lunar — solar position corrections from reduced solar eclipse observations. Unfortunately, all of our previously published solar radius determinations must be revised, including those used in the article, "Solar Radius Change Between 1925 and 1979," published in *Nature* last August; see the end of IOTA News on p. 98 of the last issue of *O.N.* The new solar radius corrections for some eclipses are as follows:

Year	Correction
1715	+ 0".64 ± 0".2
1925	+ 0.08 ± 0.08
1979	- 0.11 ± 0.07
1980	- 0.03 ± 0.03

Hence, the change between 1925 and 1979 is - 0".19 or two times the standard error, not nearly as significant as the previous 4-σ result. The large decrease from 1715 to 1979 remains. Many other 19th- and 20th-century solar eclipse observations are in an advanced state of analysis.

PLANETARY OCCULTATIONS DURING 1984

David W. Dunham

Predictions of occultations of stars by major and minor planets during 1984 are given in two tables below. Reports of observations of these events should be sent to me at P. O. Box 7488, Silver Spring, Maryland 20907, U.S.A. (telephone 301, 585-0989), with (if possible; indicate on the form to whom copies are sent) a copy to Gordon Taylor, H. M. Nautical Almanac Office, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, Sussex BN27 1RP, England. Preferably, the report forms of the International Lunar Occultation Centre (ILOC), or the equivalent IOTA/ILOC graze report forms, should be used for reporting timed occultations or appulses (we want to know if you observed, and saw nothing, but do not need a report if weather prevented effective observation). The only difference from report-

(Text continues on page 121)

Table 1, Part A

U.T. DATE	UNIVERSAL TIME	PLANET NAME	PLANET m_v	PLANET Δ,AU	STAR SAO No	STAR m_v	STAR Sp	STAR R.A.(1950)	STAR Dec.	OCCULTATION Δm	OCCULTATION Dur	OCCULTATION df	OCCULTATION P	OCCULTATION Possible Area	El SUN	MOON El	MOON %Snl	MOON Up	Ephem. Source
1983 Dec 30	20^h29^m-33^m	Loreley	12.2	2.37		11.4		$6^h38^m.9$	29°47'	1.2	15^s	20	15	Mauritius, South Africa?n	173°	140°	11-	none	Herget78
1984																			
Jan 7	15 01-05	P/Halley	22.9	7.21		10.0	F8	6 24.9	10 18	12.9	3	16	42	Hawaii?s; Japan?s; southern USSR	180	119	17+	w 75°E	Yeomans7
Jan 7	22 23-38	Vesta	6.9	1.68	94222	9.1	K0	4 54.2	19 18	0.1	62	28	4	southern Africa, northeast Brazil	148	96	19+	w 5°W	APAENAXX
Jan 12	7 42-45	P/Halley	22.9	7.19		12.3		6 21.9	10 23	10.6	3	16	104	northern Canada, Alaska	160	64	59+	w 90°W	Yeomans7
Jan 12	17 53-68	Bertha	13.0	2.99		12.0		2 07.4	20 20	1.3	34	57	22	Europe, northern Siberia?s	105	10	63+	all	EMP 1983
Jan 14	10 57-65	Pales	11.7	1.88	97945	9.3	K5	8 33.0	17 26	2.5	15	22	16	Tahiti, Samoa, Queensland	167	68	79+	w130°W	Herget77
Jan 16	8 06-18	Bertha	13.0	3.04		12.7		2 08.3	20 30	0.9	27	46	22	north Pacific, western Canada	102	48	93+	all	EMP 1983
Jan 20	7 00-09	Prokne	12.3	2.26	117122	9.3	K0	8 44.6	3 45	3.1	12	19	17	Brazil?s; GA-WA; Alaska?n	161	21	96-	all	EMP 1983
Jan 20	12 56-69	Loreley	12.4	2.43	78310	9.2	A2	6 20.4	29 01	3.3	18	24	15	Hawaii; Taiwan?n; Indochina	155	52	94-	e100°E	Herget78
Jan 20	14 55-69	Loreley	12.4	2.43		10.2	G0	6 20.3	29 01	2.4	18	24	15	HI?s; Japan?s; n. China, s.w.Asia	155	53	94-	e 65°E	Herget78
Jan 20	19 09-20	Ursula	12.4	2.45		10.2		8 38.3	31 35	2.3	14	20	17	Indonesia, Sri Lanka, cen. Africa	167	27	93-	all	EMP 1981
Jan 23	17 41-45	Hermione	12.8	2.84		10.5		2 34.5	12 46	2.4	15	25	21	northern Europe?s	98	153	66-	none	EMP 1983
Jan 24	16 01-13	Ursula	12.4	2.44		11.5		8 34.4	31 37	1.3	14	20	17	Hawaii, southern USSR, Mideast	168	83	56-	e120°E	EMP 1981
Jan 26	18 09-31	Daphne	12.6	2.46	112434A	8.8	A0	5 04.8	2 23	3.9	23	35	18	s.w. Australia, n. Africa, Spain	127	153	34-	e 95°E	Herget78
Jan 26	18 19-34	Daphne	12.6	2.46	112434B	11.8		5 04.8	2 23	1.3	23	35	18	Mauritius, e. cen. & n.w. Africa	127	153	34-	e 90°E	Herget78
Jan 27	2 01-06	P/Halley	22.9	7.19		14.2		6 13.1	10 40	8.7	3	17	104	Europe?s; Canada?s	145	144	30-	e 0°	Yeomans7
Jan 29	4 24-37	Hestia	13.0	2.09	118733	9.1	F5	11 11.3	3 42	3.9	17	36	23	s. Europe, U. K., n. Canada	141	98	13-	e 10°E	Herget77
Jan 29	4 56-60	Bertha	13.1	3.22		11.9		2 13.4	21 14	1.5	15	27	23	Alaska, Canada?s	90	132	13-	none	Herget78
Jan 30	22 20-26	Prokne	12.2	2.24		11.7		8 35.5	4 55	1.1	12	18	17	southern Africa?n; eastern Brazil	167	152	4-	none	EMP 1983
Jan 31	8 12-16	Bertha	13.2	3.26		10.9		2 14.6	21 23	2.4	14	25	23	e. Siberia, Alaska, w. Canada?s	88	107	3-	none	EMP 1983
Feb 3	21 27-40	Bamberga	10.9	1.93		11.6		9 14.2	20 09	0.4	17	18	11	w. Indonesia, India, n. Africa	176	160	3+	none	Herget77
Feb 6	20 37-54	Dembowska	10.7	2.21		10.8	K	11 16.1	15 21	0.7	13	27	22	n.w. Australia, northern Africa	151	154	20+	w 10°E	EMP 1975
Feb 10	2 03-06	Bertha	13.2	3.39		13.2		2 20.7	22 05	0.8	11	20	24	U. S. A.	80	13	49+	all	EMP 1983
Feb 13	16 06-08	Prokne	12.3	2.28		11.7		8 24.1	6 39	1.1	12	19	17	Japan?s; eastern Siberia	159	33	84+	all	EMP 1983
Feb 14	7 08-14	Bamberga	11.1	1.97		11.5		9 03.1	20 21	0.6	18	19	11	U. S. A.	168	26	89+	all	Herget77
Feb 15	0 41-58	Victoria	11.5	1.96		11.8		7 37.4	9 58	0.6	12	25	21	central Africa, southeast U.S.A.	148	15	94+	all	Herget77
Feb 17	12 28-29	Interamnia	12.3	3.65	186422	8.0	G5	18 08.1	-29 39	4.3	10	12	16	Mexico	56	117	99-	all	EMP 1977
Feb 17	16 35-48	Victoria	11.6	1.98		11.9		7 35.6	10 08	0.6	13	27	21	China, southwest U. S. S. R.	145	46	99-	all	Herget77
Feb 19	1 10-27	Metis	9.9	1.52	119464	9.3	F8	12 30.7	6 03	1.1	26	37	13	s.w.Asia,w.U.S.S.R.,s.Scandinavia	144	8	94-	all	Branham
Feb 19	16 55-57	Prokne	12.4	2.31		10.6		8 19.7	7 28	2.0	13	20	17	sothern Africa	153	64	89-	e 55°E	EMP 1983
Feb 20	16 34-37	Prokne	12.4	2.31		12.1		8 19.0	7 35	0.9	13	20	17	Mauritius, Kenya?n	152	78	81-	e 70°E	EMP 1983
Feb 21	14 16-33	Victoria	11.7	2.01		11.9		7 33.2	10 21	0.6	15	31	22	New Zealand, Australia, India?n	140	102	72-	e120°E	Herget77
Feb 22	11 05-11	Adorea	12.1	1.81		11.0	K0	9 30.6	16 19	1.4	8	24	31	NewZealand,Australia (poor orbit)	167	87	64-	e160°E	EMP 1983
Feb 23	3 18-27	Vesta	7.8	2.17		11.4		4 52.6	21 33	0.0	54	28	6	northern South America	101	162	56-	e 60°W	APAENAXX
Feb 23	4 15-18	Siegena	13.1	3.28	141366	9.0	G0	16 45.7	-3 26	4.2	9	17	23	Greenland; northwestern Europe?s	83	22	56-	all	EMP 1981
Feb 24	1 52-57	Vesta	7.8	2.18		11.9		4 53.2	21 36	0.0	52	27	6	central South America	100	174	46-	none	APAENAXX
Feb 25	0 05-06	Euphrosyne	11.8	2.80	75140A	8.6	A0	2 03.4	24 52	3.2	9	11	15	southern South America?n	63	136	37-	none	EMP 1980
Feb 25	0 05-06	Euphrosyne	11.8	2.80	75140B	9.1		2 03.4	24 52	2.8	9	11	15	northern South America	63	136	37-	none	EMP 1980
Feb 25	16 25-39	Prokne	12.5	2.35		11.3		8 15.9	8 15	1.5	14	22	17	Australia, India, Mideast	147	142	30-	e125°E	EMP 1983
Feb 25	20 27-36	Metis	9.8	1.48		11.8		12 27.0	6 40	0.2	20	29	13	Japan, Siberia?s	151	88	29-	e120°E	Branham
Feb 26	11 18-27	Andromache	13.9	2.89	80634	7.7	G0	9 03.9	20 43	6.2	6	24	52	Samoa, southern Indonesia	156	146	24-	none	EMP 1983
Feb 28	15 18-24	Metis	9.7	1.47		11.8		12 25.1	6 56	0.1	19	27	13	Japan, China	154	122	9-	none	Branham
Mar 1	1 54-61	Prokne	12.5	2.39		11.3		8 13.6	8 49	1.5	15	24	18	northwestern Africa, Europe	142	156	3-	none	EMP 1983
Mar 2	18 42-45	Vesta	7.9	2.28		11.8		4 58.9	22 02	0.0	40	22	6	northern Europe, Siberia?s	94	94	0+	none	APAENAXX
Mar 4	21 10-15	Germania	13.0	2.89	184336A	3.0	B2	16 18.1	-25 28	10.0	15	26	22	Tadzhik SSR; s.China, Philippines	97	119	4+	none	EMP 1981
Mar 4	21 08-13	Germania	13.0	2.89	1843362	5.2		16 18.1	-25 28	7.8	15	26	22	Kazak SSR, China, Taiwan?n	97	119	4+	none	EMP 1981
Mar 5	14 14-26	Elektra	12.8	2.99		12.2		13 54.1	11 49	1.1	16	24	18	New Zealand, Japan?s; e. Siberia	138	161	7+	none	EMP 1983
Mar 5	15 20-33	Bamberga	11.6	2.15		9.4		8 46.0	20 19	2.3	27	31	12	Manchuria, Mongolia, Kazakstan	144	112	7+	w 75°E	Herget77
Mar 5	20 08-09	Euphrosyne	11.8	2.89		12.2		2 17.7	26 31	0.6	8	10	16	northwestern Africa	57	28	8+	w 5°E	Herget78

ing lunar events is that the name of the occulting body should be written prominently at the top of the form, and the report should not be sent to the ILOC in Japan. Copies of the report forms can be obtained either from the ILOC, from IOTA (address given in the *O.N.* masthead), or from me. Your request will be acted upon more quickly if you send either IOTA or me a S.A.S.E.

The stellar and ephemeris data for the events listed in the tables below are discussed following the sources for the occultations. The two tables below

(Text continues on page 123)

Table 2, Part A

U.T. DATE	MINOR PLANET No.	Name	km-diam.	"	RSOI	Type	MOTION °/Day	PA	STAR SAO No	DM No.	D	STELLAR DIAMETER m"	m	Time	df	S	COMPARISON DATA AGK3 No	Shift	Time	APPARENT R.A.	Dec.
1983																					
Dec 30	165	Loreley	228	0.13	1483	C	0.211	263°								C				6h41m.1	29°45'
1984																					
Jan 7		P/Halley	100	0.02	1051		0.156	275		+10°1142						A	N10° 752			6 26.8	10 17
Jan 7	4	Vesta	555	0.46	4323	U	0.177	282	94222	+19 818	X	0.25	305	34	1.2	XA	N19 410	0".18	-0m.7	4 56.2	19 22
Jan 12		P/Halley	100	0.02	1046		0.154	276								C				6 23.8	10 22
Jan 12	154	Bertha	201	0.09	1243		0.066	47								C				2 09.3	20 29
Jan 14	49	Pales	175	0.13	850	C	0.212	279	97945	+17 1880		0.45	610	51	2.3	XA	N17 918	0.19	-0.2	8 35.0	17 19
Jan 16	154	Bertha	201	0.09	1243		0.082	53								C				2 10.2	20 39
Jan 20	194	Prokne	195	0.12	1124	C	0.230	295	117122	+04 2042		0.29	473	30	1.6	AS	N 3 1203	0.42	-1.4	8 46.4	3 38
Jan 20	165	Loreley	228	0.13	1485	C	0.174	254	78310	+29 1208		0.05	95	7	0.3	XA	N29 711	0.17	0.0	6 22.5	29 00
Jan 20	165	Loreley	228	0.13	1485	C	0.174	254		+29 1206		0.08	136	11	0.4	A	N29 710			6 22.5	29 00
Jan 20	375	Ursula	214	0.12	1375	C	0.210	274								C				8 40.4	31 28
Jan 23	121	Hermione	201	0.10	1150	C	0.153	58								C				2 36.4	12 55
Jan 24	375	Ursula	214	0.12	1376	C	0.213	272								C				8 36.6	31 30
Jan 26	41	Daphne	204	0.11	1184	C	0.117	313	112434	+02 865	A	0.05	96	11	0.3	AS	N 2 536	-0.54	2.2	5 06.5	2 26
Jan 26	41	Daphne	204	0.11	1184	C	0.117	313	112434	+02 865	B					AS	N 2 536	-0.54	2.2	5 06.5	2 26
Jan 27		P/Halley	100	0.02	1033		0.141	279								C				6 15.0	10 40
Jan 29	46	Hestia	133	0.09	576	F	0.125	294	118733	+04 2439		0.10	156	20	0.5	PA	N 3 1471	-0.84	0.9	11 13.0	3 31
Jan 29	154	Bertha	201	0.09	1239		0.137	62								C				2 15.3	21 24
Jan 30	194	Prokne	195	0.12	1126	C	0.247	299								C				8 37.3	4 47
Jan 31	154	Bertha	201	0.09	1239		0.145	62								C				2 16.5	21 32
Feb 3	324	Bamberga	256	0.18	1535	C	0.259	276								C				9 16.1	20 00
Feb 6	349	Dembowska	145	0.09	699	R	0.163	297		+15 2320		0.11	183	17	0.6	A	N15 1228			11 17.9	15 09
Feb 10	154	Bertha	201	0.08	1236		0.181	65								C				2 22.6	22 14
Feb 13	194	Prokne	195	0.12	1129	C	0.232	305								C				8 25.9	6 33
Feb 14	324	Bamberga	256	0.18	1552	C	0.240	273								C				9 05.0	20 13
Feb 15	12	Victoria	135	0.09	575	S	0.185	288								C				7 39.3	9 54
Feb 17	704	Interamnia	339	0.13	2579	C	0.296	85	186422	-2914610		0.32	854	26	2.3	PX		-0.57	1.0	18 10.2	-29 39
Feb 17	12	Victoria	135	0.09	575	S	0.170	290								C				7 37.4	10 03
Feb 19	9	Metis	168	0.15	670	S	0.141	307	119464	+06 2628		0.11	120	18	0.5	AS	N 6 1540	-0.83	-0.7	12 32.5	5 52
Feb 19	194	Prokne	195	0.12	1130	C	0.215	308								C				8 21.5	7 21
Feb 20	194	Prokne	195	0.12	1130	C	0.211	309								C				8 20.9	7 29
Feb 21	12	Victoria	135	0.09	575	S	0.148	293								C				7 35.1	10 17
Feb 22	268	Adorea	85	0.06	279	U	0.200	292		+16 1989		0.10	137	13	0.5	A	N16 1020			9 32.5	16 10
Feb 23	4	Vesta	555	0.35	4299	U	0.157	69								C				4 54.6	21 36
Feb 23	386	Siegena	203	0.09	1233	C	0.217	69	141366	-03 3996		0.13	318	15	0.9	S				16 47.5	-3 29
Feb 24	4	Vesta	555	0.35	4299	U	0.162	69								C				4 55.2	21 39
Feb 25	31	Euphrosyne	270	0.13	1433	C	0.356	62	75140	+24 302	A	0.07	143	5	0.4	AG	N24 187	-0.87	-2.7	2 05.3	25 02
Feb 25	31	Euphrosyne	270	0.13	1433	C	0.356	62	75140	+24 302	B					AG	N24 187	-0.87	-2.7	2 05.3	25 02
Feb 25	194	Prokne	195	0.11	1131	C	0.193	313								C				8 17.8	8 08
Feb 25	9	Metis	168	0.16	672	S	0.186	301								C				12 28.7	6 29
Feb 26	175	Andromache	80	0.04	352	U	0.160	282	80634	+21 1969		0.26	554	40	1.7	ZA	N20 1068	-0.18	0.1	9 05.8	20 35
Feb 28	9	Metis	168	0.16	673	S	0.202	299								C				12 26.8	6 45
Mar 1	194	Prokne	195	0.11	1132	C	0.175	317								C				8 15.4	8 43
Mar 2	4	Vesta	555	0.34	4294	U	0.200	74								C				5 01.0	22 05
Mar 4	241	Germania	187	0.09	1042	C	0.147	102	184336	-2511485	U	0.95	1994	156	5.9	FP		-0.01	-0.2	16 20.2	-25 33
Mar 4	241	Germania	187	0.09	1042	C	0.147	102	184336	-2511485	2					FZ		-0.00	-0.3	16 20.2	-25 33
Mar 5	130	Elektra	235	0.11	1757	C	0.159	334								C				13 55.7	11 39
Mar 5	324	Bamberga	256	0.16	1585	C	0.145	263								C				8 47.9	20 11
Mar 5	31	Euphrosyne	270	0.13	1426	C	0.380	64								C				2 19.7	26 40

Table 1, Part B

1984 DATE	UNIVERSAL TIME	PLANET NAME	PLANET m_v	PLANET Δ,AU	STAR SAO No	STAR m_v	STAR Sp	STAR R.A.(1950)	STAR Dec.	OCCULTATION Δm	OCCULTATION Dur	OCCULTATION df	OCCULTATION P	OCCULTATION Possible Area	El SUN	MOON El	MOON %Snl	MOON Up	Ephem. Source
Mar 10	$10^{h}41^{m}-57^{m}$	Thisbe	12.3	2.47		12.6		$8^{h}11^{m}.3$	15°41'	0.6	41^{s}	55	15	New Zealand?s; Australia	132°	46°	47+	all	Herget78
Mar 10	21 50-80	Victoria	12.0	2.20		12.1		7 27.6	11 21	0.7	40	86	24	South Africa?n; Brazil?s	121	32	52+	w 10°E	Herget77
Mar 13	5 53-66	Euterpe	9.8	1.21	118750	9.6	G5	11 13.0	8 03	0.8	12	23	15	Morocco, Labrador, northern Canada	173	52	76+	w 30°W	Herget77
Mar 14	3 48-57	P/Halley	23.0	7.52		13.8		5 55.2	12 00	9.2	9	48	109	Peru; Mexico?n	95	42	85+	all	Yeomans7
Mar 15	4 22-26	Metis	9.5	1.44		10.1		12 11.8	8 29	0.5	15	21	12	western Europe?s	170	37	92+	w 10°E	Branham
Mar 16	0 47-48	Juno	9.6	2.24		11.6		4 00.3	8 39	0.2	8	9	12	northeastern Canada	65	97	97+	all	APAENAXX
Mar 16	22 50-59	Prokne	12.8	2.55		12.3		8 08.6	10 42	1.0	22	36	19	Brazil?e	125	49	99+	all	EMP 1983
Mar 23	4 11-29	Kassandra	12.6	1.96	159989	8.5	A0	16 32.5	-16 10	4.1	21	44	22	Bermuda?n; n.w. Africa, Italy	113	12	62-	e 60°W	Herget78
Mar 25	7 41-54	Saturn	1.0	9.08	158913	8.6	A5	14 53.9	-13 56	0.0	146^{m}	46	0	Americas, Pacific	139	61	40-	e125°W	NA0001
Mar 26	11 18-19	Juno	9.7	2.35		11.0		4 21.0	10 13	0.3	7^{s}	8	13	western and central Australia	60	124	30-	none	APAENAXX
Mar 26	23 18-20	Hygiea	10.8	3.13	163443	9.3	G0	20 16.4	-19 44	1.8	15	11	10	southern India	64	6	25-	all	Schmadel
Mar 27	9 21-23	Penelope	12.8	2.42	162170	8.1	B9	19 02.4	-16 57	4.7	4	13	38	northern Mexico, Cuba	81	27	22-	e 90°W	EMP 1981
Mar 31	19 18-21	Parthenope	10.2	1.63		11.5	G5	12 10.9	5 47	0.3	13	21	15	n.e. Siberia; Japan, China?s	168	177	1-	none	Herget77
Apr 2	17 41-57	Metis	9.7	1.48		12.3		11 54.2	9 53	0.1	17	24	13	southern Asia, eastern Europe	160	148	2+	none	Branham
Apr 3	10 08-18	Bamberga	12.3	2.55		11.0		8 38.9	19 19	1.6	59	73	14	Australia	114	92	4+	w130°E	Herget77
Apr 9	23 06-10	Victoria	12.4	2.58		13.2		7 36.9	12 24	0.4	11	26	28	Newfoundland?s; Scandinavia	94	14	59+	all	Herget77
Apr 10	4 51-55	Ursula	13.2	3.16		13.5		8 03.1	27 17	0.6	18	29	21	California, Mexico	97	6	61+	all	EMP 1981
Apr 10	6 49-61	Meliboea	12.9	2.36	138680	8.3	G5	12 13.3	-5 53	4.6	10	21	22	Argentina, Chile, Hawaii	165	62	62+	w 95°W	EMP 1982
Apr 10	6 49-60	Meliboea	12.9	2.36	138680	10.3		12 13.3	-5 53	2.6	10	21	22	Patagonia; Hawaii?n	165	62	62+	w 95°W	EMP 1982
Apr 13	1 23-28	Prokne	13.1	2.92		12.6		8 12.9	13 00	1.1	18	31	22	South America?n	100	44	89+	all	EMP 1983
Apr 14	5 00-02	Loreley	13.4	3.49		13.6		6 34.2	24 47	0.7	10	16	22	western North America?s	74	84	96+	all	Herget78
Apr 19	1 01-03	Tamara	11.5	1.08	207516	8.8		16 14.2	-34 42	2.8	8	17	17	Seychelles, Madagascar; sAfrica?w	139	13	86-	all	EMP 1983
Apr 19	10 19-22	Prokne	13.2	3.01		9.7	F5	8 16.0	13 21	3.6	15	27	22	Japan; Alaska?n	94	133	83-	e140°W	EMP 1983
Apr 21	23 25-26	Daphne	13.3	3.38		12.1		5 51.3	10 14	1.5	7	12	24	northeastern South America	57	152	60-	none	Herget78
Apr 24	8 37-38	Vesta	8.3	2.92		11.0		6 05.7	24 15	0.1	17	10	8	Queensland	57	133	37-	none	APAENAXX
Apr 24	21 37-38	Daphne	13.3	3.40		12.5		5 54.8	10 24	1.2	6	11	24	Brazil?s	55	121	32-	none	Herget78
Apr 27	14 56	Daphne	13.3	3.42		12.2		5 58.2	10 34	1.4	6	11	24	Kazakstan	54	91	12-	none	Herget78
Apr 30	21 22-23	Ursula	13.4	3.46		12.6		8 14.9	25 19	1.3	11	18	23	eastern Brazil	80	83	0-	none	EMP 1981
May 2	1 27-40	Nemesis	12.0	2.13	139402	7.9	K0	13 30.4	-2 10	4.2	9	23	27	South Africa, Brazil, Peru	159	149	1+	none	Herget78
May 5	11 19-22	Siegena	12.3	2.39		12.0		16 59.0	4 48	0.9	16	25	17	New Zealand?n	142	143	19+	none	EMP 1981
May 8	2 29-31	Victoria	12.7	2.95		13.8		8 01.1	12 23	0.3	6	15	32	eastern U. S. A.	73	18	46+	all	Herget77
May 11	10 23-32	Athamantis	10.9	1.55	158162	8.5	K0	13 44.6	-16 50	2.5	11	23	19	NewZealand, Queensland?s; NewGuinea	159	32	82+	all	EMP 1980
May 11	12 25-32	Tamara	11.0	0.96	226309	9.5	A0	15 48.7	-42 12	1.8	7	16	15	Indonesia	154	67	82+	all	EMP 1983
May 12	15 18-52	Mars	-1.9	0.54	159094	7.0	G5	15 09.6	-17 54	0.0	$19^{m}.2$	25	1	Hawaii, n. Australia, Asia	178	32	91+	w170°W	NA0001
May 12	21 01-02	Hektor	15.5	5.92		10.9		0 10.9	5 49	4.6	7^{s}	15	37	South China Sea; Australia?s	47	162	93+	w105°E	EMP 1975
May 13	1 52-53	Loreley	13.6	3.86		13.1		7 05.2	23 17	1.0	7	12	25	southeastern North America?n	53	99	94+	all	Herget78
May 15	23 37-55	Tamara	11.0	0.95	226130	9.5	A0	15 41.0	-43 27	1.7	7	16	15	e. & s. Africa, Tierra de Fuego	155	23	99-	all	EMP 1983
May 16	9 43-52	Lutetia	10.8	1.47	158714	9.4	G5	14 37.3	-12 22	1.7	11	23	19	Guatemala; Mexico, Hawaii?n	165	30	98-	all	EMP 1977
May 16	18 26-28	Pallas	10.4	3.55		12.1		22 46.8	7 59	0.2	24	17	10	China, Japan	70	90	97-	all	Sitarski
May 18	4 46-68	Metis	10.7	1.91		11.0		11 38.8	8 52	0.6	28	45	16	s.w. U. S. A., Mexico, n. Chile	115	104	89-	e113°W	Branham
May 19	15 31-37	Athamantis	11.0	1.59	158099	9.2	F8	13 39.3	-15 40	2.0	13	28	20	Okinawa, n.e.China, cen. Siberia	150	85	78-	s 40°N	EMP 1980
May 22	12 46-49	Fortuna	12.0	2.36		10.6		10 59.5	5 34	1.6	25	33	15	southeastern Siberia	103	164	52-	none	EMP 1981
May 25	8 09-14	Fortuna	12.0	2.40		10.8		11 01.0	5 27	1.5	22	30	15	Fiji; Queensland, New Zealand?s	101	161	26-	none	EMP 1981
May 28	3 35-36	Thisbe	13.2	3.51		11.4		8 48.0	14 02	2.0	9	14	22	Mexico?n	64	94	7-	none	Herget78
May 29	17 48-49	Diotima	13.1	3.44		14.0		9 08.8	26 55	0.4	7	13	24	Caucasus Mountains to N.W. India	64	75	1-	none	EMP 1980
May 30	11 00-14	Klymene	13.6	2.64	186140	8.8	F8	17 59.3	-26 01	4.8	10	25	29	cen. Chile; N. Z., s. Australia?n	159	156	0-	none	EMP 1983
May 31	10 04-05	Pallas	10.3	3.34		11.5		22 57.4	8 52	0.3	32	21	9	northern Chile, Bolivia	81	89	1+	none	Sitarski
Jun 1	12 06-07	Io	13.5	3.39	117560	8.6	F8	9 14.5	7 27	4.9	6	14	33	southern Australia?n	68	47	4+	none	Herget78
Jun 2	0 18-19	Aglaja	12.6	2.35	146574	9.1	K0	23 11.1	-9 04	3.6	8	15	22	South Africa?n	86	115	6+	none	Herget78
Jun 2	12 21-30	Tamara	11.1	0.96	225520	9.8		15 08.3	-46 55	1.6	10	20	15	Indonesia, Singapore	149	127	9+	w120°E	EMP 1983
Jun 2	17 36-49	Marianna	13.1	2.29	227909	8.5	F8	17 20.5	-44 05	4.6	11	23	24	Australia, southern Africa	157	148	11+	w 35°E	Herget78

are presented in the same format as those for last year's events. Due to the large number of events, the tables are given on alternating pages, so that all the data for a given event (and for others which occur either just before and/or just after it) are available on facing pages. Explanations of the data given in the tables, and of the finder charts, and regional and world maps appearing in *O.N.*, as well as information about local circumstances (appulse predictions) sent to IOTA members were given in the article about 1983 events in *O.N. 3* (1), 9. Joseph E. Carroll, 4261 Queen's Way, Minnetonka, MN 55345,

(Text continues on page 125)

Table 2, Part B

1984	M I N O R	P L A N E T				MOTION		S T A R			STELLAR DIAMETER					COMPARISON DATA			A P P A R E N T	
DATE	No.	Name	km-diam.	-"	RSOI Type	°/Day	PA	SAO No	DM No.	D	m"	m	Time	df	S	AGK3 No	Shift	Time	R.A.	Dec.
Mar 10	88	Thisbe	232	0.13	1465 C	0.076	285°								C				$8^h13^m.2$	15°35'
Mar 10	12	Victoria	135	0.08	575 S	0.051	344								C				7 29.5	11 17
Mar 13	27	Euterpe	116	0.13	355 S	0.253	293	118750	+08°2478		0.15	136	15	0.6	AX	N 8°1465	0".14	$0^m.9$	11 14.8	7 52
Mar 14		P/Halley	100	0.02	988	0.050	307								C				5 57.1	12 00
Mar 15	9	Metis	168	0.16	679 S	0.254	292								C				12 13.6	8 17
Mar 16	3	Juno	267	0.16	1144 S	0.507	72								C				4 02.2	8 45
Mar 16	194	Prokne	195	0.11	1134 C	0.113	343								C				8 10.5	10 36
Mar 23	114	Kassandra	131	0.09	488 C	0.105	72	159989	-15 4346		0.07	106	17	0.4	PX		-0.00	0.9	16 34.4	-16 14
Mar 25		Saturn	115644	8.78		0.047	290	158913	-13 4022		0.08	538	41	0.9	X				14 55.8	-14 05
Mar 26	3	Juno	267	0.16	1153 S	0.516	74								C				4 22.9	10 18
Mar 26	10	Hygiea	443	0.20	3414 C	0.322	75	163443	-20 5887		0.09	198	6	0.6	X				20 18.4	-19 38
Mar 27	201	Penelope	92	0.05	281 M	0.329	80	162170	-17 5459		0.08	135	6	0.4	X				19 04.3	-16 54
Mar 31	11	Parthenope	155	0.13	649 S	0.240	295		+ 6 2571		0.06	76	6	0.3	A	N 5 1701			12 12.6	5 36
Apr 2	9	Metis	168	0.16	686 S	0.220	283								C				11 56.0	9 41
Apr 3	324	Bamberga	256	0.14	1629 C	0.056	152								C				8 40.9	19 11
Apr 9	12	Victoria	135	0.07	572 S	0.156	83								C				7 38.7	12 19
Apr 10	375	Ursula	214	0.09	1385 C	0.128	136								C				8 05.2	27 11
Apr 10	137	Meliboea	153	0.09	814 C	0.206	309	138680	-05 3463	A	0.28	481	33	1.6	X				12 15.1	-6 04
Apr 10	137	Meliboea	153	0.09	814 C	0.206	309	138680	-05 3463	B					X				12 15.1	-6 04
Apr 13	194	Prokne	195	0.09	1136 C	0.122	60								C				8 14.8	12 53
Apr 14	165	Loreley	228	0.09	1486 C	0.217	103								C				6 36.2	24 46
Apr 19	326	Tamara	90	0.12	215 C	0.365	198	207516	-3410911	B					G				16 16.4	-34 47
Apr 19	194	Prokne	195	0.09	1136 C	0.141	69		+13 1887		0.08	170	13	0.5	A	N13 828			8 17.9	13 15
Apr 21	41	Daphne	204	0.08	1109 C	0.303	78								C				5 53.1	10 14
Apr 24	4	Vesta	555	0.26	4248 U	0.365	87								C				6 07.7	24 15
Apr 24	41	Daphne	204	0.08	1106 C	0.309	79								C				5 56.7	10 25
Apr 27	41	Daphne	204	0.08	1104 C	0.315	79								C				6 00.1	10 34
Apr 30	375	Ursula	214	0.09	1386 C	0.191	121								C				8 16.9	25 12
May 2	128	Nemesis	116	0.08	498 CEU	0.194	282	139402	-01 2834	A	0.55	849	68	3.0	AG	S 2 809	0.66	1.4	13 32.1	-2 21
May 5	386	Siegena	203	0.12	1207 C	0.172	310								C				17 00.7	4 45
May 8	12	Victoria	135	0.06	569 S	0.258	94								C				8 03.0	12 17
May 11	230	Athamantis	116	0.10	406 S	0.226	310	158162	-16 3744		0.41	461	43	1.9	X				13 46.4	-17 00
May 11	326	Tamara	90	0.13	212 C	0.426	226	226309	-41 7369		0.04	27	2	0.1	S				15 51.1	-42 18
May 12		Mars	6782	17.46	*****	0.364	278	159094	-17 4273		0.51	199	34	1.4	YG		1.05	-0.5	15 11.6	-18 02
May 12	624	Hektor	234	0.05	2437 D	0.184	57								C				0 12.6	6 00
May 13	165	Loreley	228	0.08	1485 C	0.279	102								C				7 07.2	23 13
May 15	326	Tamara	90	0.13	212 C	0.421	231	226130	-43 7243		0.04	27	2	0.1	S				15 43.3	-43 34
May 16	21	Lutetia	114	0.11	386 M	0.235	282	158714	-11 3783		0.17	183	18	0.8	X				14 39.1	-12 31
May 16	2	Pallas	538	0.21	5374 U	0.209	71								C				22 48.6	8 10
May 18	9	Metis	168	0.12	702 S	0.104	145								C				11 40.6	8 41
May 19	230	Athamantis	116	0.10	405 S	0.187	316	158099	-15 3723		0.11	127	14	0.5	X				13 41.2	-15 51
May 22	19	Fortuna	226	0.13	1211 C	0.129	108								C				11 01.3	5 23
May 25	19	Fortuna	226	0.13	1212 C	0.143	109								C				11 02.8	5 16
May 28	88	Thisbe	232	0.09	1456 C	0.255	104								C				8 49.9	13 54
May 29	423	Diotima	209	0.08	1219 C	0.277	114								C				9 10.8	26 47
May 30	104	Klymene	134	0.07	721 C	0.161	266	186140	-2612698		0.13	246	19	0.8	X				18 01.4	-26 01
May 31	2	Pallas	538	0.22	5351 U	0.166	72								C				22 59.1	9 03
Jun 1	85	Io	149	0.06	739 C	0.249	95	117560	+07 2102		0.15	357	14	1.0	AS	N 7 1315	-1.01	-1.3	9 16.3	7 19
Jun 2	47	Aglaja	156	0.09	627 C	0.288	67	146574	-09 6147		0.31	538	26	1.8	X				23 12.9	-8 53
Jun 2	326	Tamara	90	0.13	210 C	0.326	247	225520	-46 7250						S				15 10.7	-47 03
Jun 2	602	Marianna	139	0.08	685 C	0.189	270	227909	-4411668		0.18	295	23	1.0	YG		-1.77	9.2	17 23.0	-44 07

Table 1, Part C

1984 DATE	UNIVERSAL TIME	PLANET NAME	PLANET m_v	PLANET Δ,AU	STAR SAO No	STAR m_v	STAR Sp	STAR R.A.(1950)	STAR Dec.	OCCULTATION Δm	OCCULTATION Dur	OCCULTATION df	OCCULTATION P	OCCULTATION Possible Area	El SUN	MOON El	MOON %Snl	MOON Up	Ephem. Source
Jun 2	19 22^m-24^m	Hektor	15.4	5.65		10.7	G5	$0^h22^m.6$	7°49'	4.7	9^s	18	35	Australia	64°	102°	11+	none	EMP 1975
Jun 4	0 56	Panopaea	10.9	1.28	211413	10.5	A0	19 33.7	-36 04	1.0	24	35	12	Mauritius?w	141	159	21+	none	Herget77
Jun 4	5 48-57	Tamara	11.1	0.96	225478	9.3	A0	15 05.3	-47 08	2.0	10	21	15	s.w.U.S.A., n.w.Mexico, Hawaii?s	148	107	23+	all	EMP 1983
Jun 4	18 29-30	Eugenia	12.9	3.32		11.2		1 17.2	4 37	1.9	7	11	19	eastern Australia; New Zealand?s	54	119	29+	none	Herget77
Jun 8	18 23-24	Egeria	11.8	2.70	80995	9.2	G0	9 41.8	27 31	2.7	7	10	16	central Africa, Kenya	62	57	73+	all	Herget77
Jun 14	16 31-51	Dido	12.8	2.12	189495	9.1		20 34.4	-28 27	3.7	26	54	22	Australia, Mauritius	139	28	99-	all	EMP 1983
Jun 20	16 58-60	Hektor	15.3	5.39		12.8		0 30.2	9 21	2.6	12	24	33	eastern Australia; New Zealand?s	78	23	57-	all	EMP 1975
Jun 23	20 14-15	Iris	10.0	2.26		12.9		2 04.3	17 18	0.1	6	8	15	Australia	57	10	28-	all	Branham
Jun 23	22 30-31	Thisbe	13.2	3.80		12.2		9 17.8	11 59	1.4	7	11	24	Chile, Argentina	46	108	27-	none	Herget78
Jun 24	4 25-32	Adeona	12.6	2.00	159236	9.0	G5	15 21.5	-14 31	3.6	19	38	21	northern South America	139	161	25-	none	ITA 1977
Jun 24	13 08-12	Fortuna	12.4	2.83	118864	6.4	K0	11 24.2	3 17	6.0	10	15	18	Sri Lanka, Indonesia, Papua	78	134	22-	none	EMP 1981
Jun 27	13 21	Iris	9.9	2.22		13.3		2 12.4	18 01	0.0	6	8	15	Hawaii?n	59	39	3-	none	Branham
Jun 29	1 13-15	Hektor	15.3	5.26		11.3		0 32.8	9 59	4.0	15	29	33	South Africa?n	86	84	0-	none	EMP 1975
Jun 30	6 14-23	Dido	12.6	2.02	189347	8.9	K0	20 26.7	-29 12	3.7	15	30	21	Azores?n; northern South America	154	169	2+	none	EMP 1983
Jul 6	5 54	Ceres	9.2	3.21		12.5		2 43.5	7 19	0.0	35	12	5	Canary Islands	63	158	54+	none	APAENAXX
Jul 6	9 18-19	Hebe	10.1	2.45		11.2		3 43.7	8 13	0.3	5	8	19	central South America	49	145	56+	none	Branham
Jul 7	18 38-44	Elektra	13.4	3.71		12.0		13 13.3	14 52	1.7	15	24	23	Libya, Sudan, Kenya	86	34	71+	all	EMP 1983
Jul 7	18 42	Hebe	10.1	2.44	111439	8.1	G5	3 46.8	8 19	2.1	5	8	19	Japan?s	50	161	71+	none	Branham
Jul 13	19 41-45	Cybele	12.8	3.26		12.7		1 14.9	6 06	0.8	22	25	15	Western Australia?s; Timor, Papua	91	80	99-	all	Herget78
Jul 14	1 01-04	Juewa	12.0	1.93	209985	8.3	G5	18 15.9	-39 42	3.7	15	25	17	Iberia, Canary Islands?s	156	31	99-	all	Herget78
Jul 15	9 20	Iris	9.8	2.05		11.2		2 51.9	21 09	0.3	7	8	13	northern Chile, Bolivia	66	88	95-	all	Branham
Jul 16	0 34-53	Siegena	12.4	2.48		11.4	K0	16 13.6	5 19	1.4	23	36	18	nw Africa, e Brazil; Argentina?n	123	89	91-	all	EMP 1981
Jul 16	21 02-17	Isolda	12.7	2.33	164173	9.1	F5	21 06.3	-12 31	3.7	14	26	20	Indonesia, southern Africa	158	24	86-	all	Herget81
Jul 18	7 37-57	Lydia	11.3	1.58	211065	9.2	K0	19 10.5	-30 17	2.2	10	25	22	nBrazil, Peru, N.Z.?s; Queensland	167	69	76-	e150°W	Herget74
Jul 22	6 48-56	Neptune	7.9	29.38	186001	8.7	K5	17 54.7	-22 14	0.4	42^m	54	1	America, Hawaii, New Zealand	150	133	39-	e 90°W	JPL DE96
Jul 28	10 45	Aurora	12.3	2.26	211730	9.6		19 57.7	-31 19	2.7	15^s	23	17	northwest Argentina,central Chile	166	169	0+	none	EMP 1981
Jul 30	10 13	Winchester	11.8	2.22		11.4		4 23.9	5 16	1.0	6	8	15	western North America?s	63	90	6+	none	EMP 1982
Aug 2	6 32-33	Iris	9.7	1.88		10.0		3 31.6	23 40	0.6	8	9	12	Midwest, southeast Canada	73	138	30+	none	Branham
Aug 2	16 46-55	Pallas	9.3	2.43		11.7		23 07.1	7 54	0.1	49	28	7	China, Burma	138	146	34+	none	Sitarski
Aug 4	10 06-09	Tamara	12.2	1.35	225490	9.4	G5	15 05.6	-48 28	2.9	8	21	22	New Guinea	104	34	54+	all	EMP 1983
Aug 5	23 52-53	Iris	9.6	1.84		11.4		3 39.8	24 07	0.2	8	9	12	western Europe	75	170	70+	none	Branham
Aug 7	9 24-26	Iris	9.6	1.83		11.7		3 42.8	24 16	0.2	8	9	12	Mexico, Florida	76	154	83+	w105°W	Branham
Aug 8	17 43-59	Sylvia	11.7	2.29	211985	10.0	G2	20 15.3	-32 15	1.9	24	26	12	Papua, n.w.Australia; S. Africa?n	159	18	92+	all	Herget78
Aug 17	3 48-52	Ceres	8.8	2.64		11.8		3 25.1	9 36	0.1	70	22	4	northwest Africa	93	27	75-	all	APAENAXX
Aug 19	13 40	Winchester	11.6	2.05		11.5		5 05.9	5 23	0.8	7	9	14	Hawaii?s	71	28	53-	all	EMP 1982
Aug 19	20 49-50	Hebe	9.9	2.13		10.1		5 16.0	9 12	0.7	6	10	17	southeast Asia, Philippines	68	25	50-	all	Branham
Aug 19	21 16-20	Pallas	9.0	2.28		12.0		22 57.7	5 27	0.1	33	18	6	Java; Western Australia?s	156	70	49-	all	Sitarski
Aug 20	9 39-40	P/Halley	22.5	7.07		14.0		6 39.6	13 41	8.5	6	31	102	Caribbean Sea	48	37	44-	all	Yeomans7
Aug 21	22 36-37	Winchester	11.6	2.03		11.9		5 10.6	5 21	0.6	7	9	14	south central U.S.S.R., Sinkiang	72	20	29-	all	EMP 1982
Aug 23	5 06-08	Ceres	8.7	2.56		11.7		3 29.3	9 44	0.1	83	26	4	northeast U.S.A., s.e. Canada?s	97	50	17-	e 70°W	APAENAXX
Aug 25	9 00-19	Klymene	14.1	3.10	185260	9.2	K0	17 16.0	-25 40	4.9	27	69	34	Micronesia, Hawaii	108	129	3-	none	EMP 1983
Aug 28	5 48-78	Eugenia	12.2	2.30		12.7		2 28.5	7 45	0.5	62	74	13	Central America, Colombia, Brazil	117	138	3+	none	Herget77
Aug 28	17 08-09	Winchester	11.6	1.97		12.6		5 23.8	5 11	0.4	7	10	14	s.e. Australia, New Zealand?n	75	102	6+	none	EMP 1982
Aug 30	15 57	Winchester	11.6	1.95		11.7		5 27.5	5 08	0.7	8	10	14	New Zealand?n	76	128	21+	none	Herget78
Sep 1	0 09-18	Doris	12.0	2.42		12.2		2 45.0	12 49	0.6	41	64	18	northern Europe?n	115	172	35+	none	Herget77
Sep 1	1 19-32	Hektor	14.8	4.41		13.6		0 27.5	12 38	1.5	17	30	27	Arabia, northern Africa, Antilles	146	139	35+	w 50°W	EMP 1975
Sep 2	10 12-13	Winchester	11.5	1.93		10.3	A0	5 32.6	5 02	1.5	8	10	13	Oregon to New York	78	157	50+	none	EMP 1982
Sep 4	0 45-90	Dido	13.0	2.24	188498	9.3	K	19 41.1	-29 16	3.7	33	71	24	S.Africa?n; Brazil,cen.America,TX	130	22	67+	w 25°E	EMP 1983
Sep 5	21 09-12	P/Halley	22.4	6.70		10.2		6 44.0	13 23	12.2	9	47	97	southwest Australia?n	63	161	83+	none	Yeomans7
Sep 14	4 10-12	Hebe	9.8	1.91		10.7		5 59.7	8 03	0.4	8	12	15	northwest Africa	81	57	87-	all	Branham
Sep 14	21 22-24	Hebe	9.8	1.91		12.0		6 00.8	8 01	0.1	8	12	15	India, southeast Asia	82	50	82-	all	Branham

computes the appulse predictions. Special requests for the appulse predictions should be sent to his address, which was given incorrectly in the *O.N.* article about 1983 events, and also in the article about 1984 planetary occultations in this month's issue of *Sky and Telescope*. Specific information about some of the events is given at the end of this article.

Sources of Planetary Occultations. The total of 230 events given in the list is the largest number ever published for a given year (actually, one event not

(Text continues on page 127)

Table 2, Part C

1984 DATE	MINOR PLANET No.	Name	km-diam.	"	RSOI	Type	MOTION °/Day	PA	STAR SAO No	DM No.	D	STELLAR DIAMETER m"	m	Time	df	S	COMPARISON DATA AGK3 No	Shift	Time	APPARENT R.A.	Dec.
Jun 2	624	Hektor	234	0.06	2436	D	0.152	53°		+ 7° 46		0.09	381	15	0.8	A	N 7° 45			$0^h24^m.4$	8°00'
Jun 4	70	Panopaea	153	0.16	529	C	0.166	191	211413	-3613626		0.02	23	4	0.1	S				19 36.0	-35 59
Jun 4	326	Tamara	90	0.13	210	C	0.311	248	225478	-46 7222		0.04	30	3	0.2	S				15 07.7	-47 16
Jun 4	45	Eugenia	250	0.10	1452	U	0.333	73								C				1 18.9	4 48
Jun 8	13	Egeria	245	0.13	1180	C	0.413	121	80995	+27 1804		0.12	238	7	0.7	AS	n27 1026	-1".16	$0^m.5$	9 43.8	27 22
Jun 14	209	Dido	137	0.09	611	C	0.082	237	189495	-2816800						S				20 36.5	-28 20
Jun 20	624	Hektor	234	0.06	2436	D	0.118	47								C				0 32.0	9 32
Jun 23	7	Iris	222	0.14	813	S	0.559	70								C				2 06.1	17 28
Jun 23	88	Thisbe	232	0.08	1449	C	0.304	107								C				9 19.6	11 51
Jun 24	145	Adeona	137	0.09	589	C	0.122	245	159236	-14 4194		0.20	296	40	1.1	X				15 23.4	-14 38
Jun 24	19	Fortuna	226	0.11	1222	C	0.257	111	118864	+03 2502	A	0.65	1331	61	4.0	ZA	N 3 1496	0.28	0.2	11 25.9	3 06
Jun 27	7	Iris	222	0.14	811	S	0.557	70								C				2 14.3	18 11
Jun 29	624	Hektor	234	0.06	2436	D	0.100	42								C				0 34.6	10 10
Jun 30	209	Dido	137	0.09	613	C	0.154	252	189347	-2917110		0.25	367	39	1.3	S				20 28.8	-29 05
Jul 6	1	Ceres	1025	0.44	12255	C	0.305	75								C				2 45.3	7 28
Jul 6	6	Hebe	186	0.10	637	S	0.549	83								C				3 45.6	8 20
Jul 7	130	Elektra	235	0.09	1754	C	0.143	138								C				13 15.0	14 41
Jul 7	6	Hebe	186	0.11	637	S	0.548	83	111439	+08 573		0.30	538	13	1.7	AS	N 8 398	-0.95	0.2	3 48.6	8 25
Jul 13	65	Cybele	311	0.13	2428	C	0.142	74								C				1 16.7	6 16
Jul 14	139	Juewa	165	0.12	788	C	0.188	283	209985	-3912452		0.15	211	19	0.8	PS		-1.26	-0.1	18 18.3	-39 41
Jul 15	7	Iris	222	0.15	801	S	0.543	73								C				2 53.9	21 17
Jul 16	386	Siegena	203	0.11	1174	C	0.115	211		+ 5 3174		0.09	156	18	0.5	A	N 5 2112			16 15.3	5 14
Jul 16	211	Isolda	168	0.10	925	C	0.166	260	164173	-12 5915		0.10	173	15	0.6	X				21 08.2	-12 23
Jul 18	110	Lydia	102	0.09	342	U	0.209	259	211065	-3016780		0.24	273	27	1.1	S				19 12.7	-30 14
Jul 22		Neptune	50184	2.36	*****		0.022	269	186001	-2212373		0.59	12547	633	11.7	HX		0.35	12.5	17 56.8	-22 14
Jul 28	94	Aurora	191	0.12	1106	C	0.189	266	211730	-3117238						S				19 59.9	-31 14
Jul 30	747	Winchester	208	0.13	764	C	0.536	87								C				4 25.7	5 21
Aug 2	7	Iris	222	0.16	793	S	0.519	76								C				3 33.6	23 47
Aug 2	2	Pallas	538	0.31	5229	U	0.150	222								C				23 08.9	8 05
Aug 4	326	Tamara	90	0.09	208	C	0.267	92	225490	-48 7147		0.07	64	6	0.3	S				15 08.0	-48 36
Aug 5	7	Iris	222	0.17	791	S	0.512	77								C				3 41.8	24 13
Aug 7	7	Iris	222	0.17	791	S	0.510	77								C				3 44.9	24 23
Aug 8	87	Sylvia	275	0.17	1913	P	0.163	254	211985	-3215863		0.09	150	13	0.5	S				20 17.5	-32 08
Aug 17	1	Ceres	1025	0.53	12140	C	0.184	81								C				3 27.0	9 43
Aug 19	747	Winchester	208	0.14	762	C	0.499	92								C				5 07.7	5 26
Aug 19	6	Hebe	186	0.12	650	S	0.467	93								C				5 17.9	9 14
Aug 19	2	Pallas	538	0.33	5190	U	0.239	224								C				22 59.5	5 38
Aug 20		P/Halley	100	0.02	829		0.078	101								C				6 41.5	13 39
Aug 21	747	Winchester	208	0.14	762	C	0.493	92								C				5 12.5	5 24
Aug 23	1	Ceres	1025	0.55	12122	C	0.159	83								C				3 31.2	9 51
Aug 25	104	Klymene	134	0.06	710	C	0.053	87	185260	-2512079		0.30	683	136	2.0	X				17 18.1	-25 42
Aug 28	45	Eugenia	250	0.15	1478	U	0.058	134								C				2 30.4	7 54
Aug 28	747	Winchester	208	0.15	762	C	0.475	94								C				5 25.6	5 13
Aug 30	747	Winchester	208	0.15	762	C	0.470	94								C				5 29.3	5 10
Sep 1	48	Doris	200	0.11	1092	C	0.066	110								C				2 46.9	12 58
Sep 1	624	Hektor	234	0.07	2434	D	0.105	271								C				0 29.3	12 50
Sep 2	747	Winchester	208	0.15	763	C	0.461	95		+ 4 978		0.03	37	1	0.1	A	N 5 640			5 34.5	5 03
Sep 4	209	Dido	137	0.08	619	C	0.062	325	188498	-2916476		0.29	469	112	1.6	S				19 43.3	-29 11
Sep 5		P/Halley	100	0.02	811		0.054	111								C				6 45.9	13 21
Sep 14	6	Hebe	186	0.13	662	S	0.386	100								C				6 01.6	8 04
Sep 14	6	Hebe	186	0.13	662	S	0.383	100								C				6 02.7	8 01

Table 1, Part D

1984 DATE	UNIVERSAL TIME	PLANET NAME	PLANET m_v	PLANET Δ,AU	STAR SAO No	STAR m_v	STAR Sp	STAR R.A.(1950)	STAR Dec.	OCCULTATION Δm	OCCULTATION Dur	OCCULTATION df	OCCULTATION P	OCCULTATION Possible Area	El SUN	MOON El	MOON %Snl	MOON Up	Ephem. Source
Sep 14	21 55ᵐ-56ᵐ	Hebe	9.8	1.91		11.7		6ʰ00ᵐ.9	8°01'	0.2	8ˢ	12	15	northwest Siberia	82°	49°	82-	all	Branham
Sep 15	11 01-03	Hebe	9.8	1.90		10.9		6 01.7	7 58	0.3	8	12	15	southwest Canada	82	44	78-	all	Branham
Sep 15	18 21-22	Hebe	9.8	1.90		12.3		6 02.2	7 57	0.1	9	12	15	China, Japan	82	40	75-	all	Branham
Sep 16	2 18-26	Aglaja	11.3	1.54	146599	8.9	K0	23 13.4	-7 10	2.5	16	25	14	Iceland, southern Canada	173	70	72-	e 90°W	Herget78
Sep 17	14 26-29	Iris	9.1	1.43		12.2		5 05.2	26 53	0.1	14	14	9	eastern Siberia	97	4	58-	all	Branham
Sep 17	18 53-85	Flora	8.4	0.96		10.2	G0	1 51.1	-0 47	0.2	43	52	9	e. Siberia, e. China, s.e. Asia	147	53	56-	e 70°E	Branham
Sep 21	2 54-57	Winchester	11.4	1.77		13.0		6 04.6	4 06	0.2	10	12	12	central Africa	87	39	22-	e 10°W	EMP 1982
Sep 23	8 52-56	Winchester	11.3	1.75		11.0		6 08.1	3 58	0.9	10	13	12	Central America, n. South America	88	66	5-	e 70°W	EMP 1982
Sep 23	17 30-32	Winchester	11.3	1.75		11.9		6 08.6	3 56	0.5	10	13	12	eastern China, Japan	88	71	3-	none	EMP 1982
Sep 23	19 40-50	Faina	12.4	1.72		11.1		5 02.4	12 49	1.6	11	26	22	Sri Lanka, southeast Asia, Taiwan	104	87	3-	e130°E	EMP 1982
Sep 25	6 38-42	Iris	9.0	1.36	77119	9.4	A0	5 17.7	26 58	0.6	16	16	9	central South America	101	103	0+	none	Branham
Oct 2	1 02-24	Chicago	13.2	3.01	164723	9.0	K2	21 51.1	-15 40	4.2	34	58	22	nw Africa, CanaryIs., n.S.America	136	44	52+	w 25°W	EMP 1983
Oct 6	3 04-15	Corduba	13.1	1.78	145486	8.6	K0	21 31.0	-6 36	4.6	17	42	24	western NorthAmerica (poor ephem)	130	15	87+	all	EMP 1982
Oct 6	8 25-27	Hebe	9.6	1.72		11.0		6 29.1	6 23	0.3	13	18	13	Canada	95	121	88+	w105°W	Branham
Oct 6	15 13-14	Penelope	12.0	1.83	162800	9.2	K2	19 33.0	-19 30	2.9	6	18	29	West and South Australia	99	45	90+	all	EMP 1981
Oct 9	0 04-06	Iris	8.7	1.24		12.1		5 36.0	26 50	0.0	23	23	8	South Africa?n	111	80	99+	all	Branham
Oct 9	3 45-58	Iris	8.7	1.24		11.0		5 36.2	26 50	0.1	24	23	8	Amazon, northwest Africa	111	78	99+	all	Branham
Oct 9	15 16-19	Hebe	9.5	1.69		9.7		6 32.5	6 07	0.7	14	19	13	cen. & e.Australia, n. New Zealand	97	85	100+	all	Branham
Oct 9	23 50-69	Doris	11.3	2.04		11.1		2 38.3	10 32	0.9	20	28	15	Virginia, Bermuda, central Africa	155	24	100-	all	Herget77
Oct 12	11 20-30	Hispania	11.3	1.66	74936	8.7	G5	1 44.9	28 14	2.7	15	22	14	Hawaii?n; eastern Indonesia	158	21	94-	e120°E	Herget
Oct 13	22 59-62	Winchester	11.1	1.57		10.9		6 34.8	2 36	0.9	16	19	11	northern Europe?n; n.w. Siberia	100	40	86-	all	EMP 1982
Oct 14	13 01-16	Aemilia	12.7	2.14	128970	9.0	G5	0 47.1	-3 18	3.7	11	23	22	Hawaii?s; eastern Indonesia	166	62	82-	e120°E	EMP 1982
Oct 14	20 26-35	Winchester	11.1	1.57		11.2		6 35.7	2 32	0.7	17	20	11	Mauritius?n; southwest Australia	101	33	79-	all	EMP 1982
Oct 15	15 24-29	Winchester	11.1	1.56		9.5	B8	6 36.5	2 29	1.8	17	20	11	northern Australia; New Zealand?s	101	27	73-	all	EMP 1982
Oct 16	0 29-51	Marghanna	11.7	1.04		11.4		3 07.0	13 03	0.9	8	23	20	M'ritius,Africa,Canaries;B'muda?n	154	42	69-	e 50°W	EMP 1983
Oct 17	14 47-50	Penelope	12.2	1.95	163019	9.2	K2	19 46.9	-19 29	3.0	5	14	31	south central U. S. S. R.	91	173	53-	none	EMP 1981
Oct 17	16 17-23	Winchester	11.1	1.54		11.7		6 38.5	2 21	0.5	18	21	11	eastern Siberia, Alaska	103	27	52-	all	EMP 1982
Oct 19	12 00-10	Winchester	11.0	1.53		12.6		6 40.2	2 14	0.2	19	23	11	Hawaii?n; western Mexico?n	104	44	32-	all	EMP 1982
Oct 20	12 24-29	Winchester	11.0	1.52		10.5		6 41.1	2 10	1.1	20	23	11	Alaska, western Canada	105	56	22-	all	EMP 1982
Oct 21	4 02-26	Messalina	14.4	2.84	57899	8.5	K2	5 16.3	36 53	5.9	17	53	39	Libya,Sicily,France,U.K.,n.Canada	125	79	16-	e 55°W	EMP 1982
Oct 21	9 35-60	Iris	8.4	1.14		12.0		5 47.3	26 28	0.0	42	39	7	Hawaii, Mexico, Jamaica	121	77	14-	e105°W	Branham
Oct 21	14 53-57	Pretoria	12.9	2.34	73865	9.5	A5	0 14.2	27 16	3.5	13	22	19	western U. S. S. R.	153	141	12-	none	EMP 1981
Oct 23	2 15-21	Winchester	11.0	1.50		13.1		6 43.3	2 01	0.1	22	26	10	United Kingdom, Europe	107	89	3-	e 35°E	EMP 1982
Oct 24	21 05-23	Boliviana	11.3	1.30	108591	8.8	M0	23 21.5	10 53	2.6	17	30	15	Newfoundland?w;Azores?e;e. Brazil	142	137	0+	none	EMP 1982
Oct 25	23 52-58	Hebe	9.3	1.55		11.4		6 45.2	4 47	0.1	26	34	12	South Africa	109	129	3+	none	Branham
Oct 31	6 58-62	Eugenia	11.5	1.95		12.0		1 58.0	2 32	0.5	19	21	11	northern Canada, Alaska	167	83	48+	w125°W	Herget77
Nov 2	7 26-50	Winchester	10.9	1.42		9.8		6 49.9	1 30	1.4	38	43	10	Mexico?n; northern South America	114	127	67+	w 90°W	EMP 1982
Nov 2	20 31-44	Doris	11.1	1.98		11.5		2 21.6	8 18	0.6	16	22	14	cen. & sw USSR, Turkey, nw Africa	173	60	72+	w 60°E	Herget77
Nov 4	0 04-27	Winchester	10.8	1.41		10.7		6 50.6	1 26	0.8	43	49	10	U. K., s. Europe, Mideast, India	116	110	81+	w 30°E	EMP 1982
Nov 4	12 46-57	Hermione	13.2	3.19		10.6		8 19.9	24 01	2.7	22	38	23	Hawaii?s; northwest U. S. A.	100	126	85+	w150°W	EMP 1983
Nov 6	7 05-18	Eugenia	11.6	1.97		12.4		1 53.2	2 06	0.4	21	23	11	northwest South America; Tahiti?s	161	12	95+	all	Herget77
Nov 6	12 01-27	Winchester	10.8	1.39		11.3		6 51.6	1 21	0.5	54	61	10	Hawaii; western Mexico?n	118	84	95+	w115°W	EMP 1982
Nov 8	5 22-30	Pretoria	13.1	2.46		10.8	F5	0 07.3	24 26	2.4	14	25	20	e. U.S.A.?n; Hispaniola, Panama	141	36	100+	all	EMP 1981
Nov 12	0 04-25	Hypatia	11.9	1.79	112399	7.6	G0	5 02.4	6 04	4.3	16	26	17	Mideast,central Africa, s. Brazil	150	22	90-	e 45°W	EMP 1983
Nov 12	12 58-71	Themis	11.6	2.19		13.2		2 31.1	15 02	0.2	17	22	14	Hawaii?n; Indonesia	170	53	86-	e120°E	Herget78
Nov 13	4 35-51	Ceres	7.3	1.83		10.3		3 08.7	8 39	0.1	79	21	3	nwAfrica, Caribbean,Mexico,Hawaii	171	56	81-	e120°W	APAENAXX
Nov 15	11 46-48	Euphrosyne	11.7	2.64		10.1		11 31.1	29 54	1.8	10	12	14	Mexico?n	74	33	59-	all	Herget78
Nov 19	1 34-36	Venus	-4.6	1.14	186841	2.8	K0	18 24.9	-25 27	0.0	296	5	1	southern Alaska, British Columbia	39	92	20-	none	NA0001
Nov 22	9 34-36	Euphrosyne	11.7	2.58		11.9		11 41.2	29 27	0.6	11	13	14	northern Canada, Greenland	78	71	0-	none	Herget78
Nov 23	7 00-05	P/Halley	21.3	4.81		12.9		6 24.9	11 59	8.5	3	15	70	Canary Islands, Florida, Mexico	143	147	0+	none	Yeomans7
Nov 24	9 23-40	Faina	11.4	1.28		11.1	G5	4 48.8	17 22	0.9	10	20	16	Venezuela, Mexico, Japan	168	169	3+	none	EMP 1982

previously published occurs at the end of 1983). Of the total, 130 (54%) are occultations of Astrographic Catalog (A.C., source catalog "C") stars which I found during computer comparisons with ephemerides at the U. S. Naval Observatory (USNO); these are documented in a separate section following this section. The occultations by all major planets except Neptune were found by Gordon Taylor at the Royal Greenwich Observatory and published in his Bulletin 30 of the International Astronomical Union's Commission 20 Working Group on Predictions of Occultations by Satellites and Minor Planets. The occultation by

(Text continues overleaf)

Table 2, Part D

1984 DATE	MINOR PLANET No.	Name	km-diam.	-"	RSOI	Type	MOTION °/Day	PA	STAR SAO No	DM No.	D	STELLAR DIAMETER m"	m	Time	df	S	COMPARISON DATA AGK3 No	Shift	Time	APPARENT R.A.	Dec.
Sep 14	6	Hebe	186	0.13	662	S	0.383	100°								C				6^{h}02.7	8°01'
Sep 15	6	Hebe	186	0.13	662	S	0.381	100								C				6 03.6	7 58
Sep 15	6	Hebe	186	0.14	662	S	0.380	100								C				6 04.0	7 57
Sep 16	47	Aglaja	156	0.14	639	C	0.212	257	146599	-07°5973		0.35	386	39	1.6	X				23 15.2	-6 58
Sep 17	7	Iris	222	0.21	784	S	0.380	87								C				5 07.4	26 56
Sep 17	8	Flora	160	0.23	491	S	0.129	212		-01 257		0.08	53	14	0.3	A	S 0° 197			1 52.9	-0 37
Sep 21	747	Winchester	208	0.16	767	C	0.393	99								C				6 06.4	4 06
Sep 23	747	Winchester	208	0.16	768	C	0.383	99								C				6 09.9	3 57
Sep 23	747	Winchester	208	0.16	768	C	0.382	99								C				6 10.4	3 56
Sep 23	751	Faina	113	0.09	339	C	0.191	74		+12 720						A	N12 512			5 04.4	12 52
Sep 25	7	Iris	222	0.23	784	S	0.340	90	77119	+26 807		0.72	713	51	3.1	XA	N26 486	0".48	-0^m.0	5 19.8	27 00
Oct 2	334	Chicago	199	0.09	1374	C	0.065	247	164723	-16 5967		0.33	721	123	2.1	PX		-0.09	-0.1	21 53.0	-15 30
Oct 6	365	Corduba	107	0.08	363	C	0.117	174	145486	-07 5584		0.40	515	82	2.0	PG		-0.59	1.7	21 32.9	-6 27
Oct 6	6	Hebe	186	0.15	673	S	0.281	107								C				6 30.9	6 22
Oct 6	201	Penelope	92	0.07	251	M	0.274	92	162800	-19 5515		0.36	477	32	1.8	X				19 35.0	-19 26
Oct 9	7	Iris	222	0.25	786	S	0.253	95								C				5 38.2	26 52
Oct 9	7	Iris	222	0.25	786	S	0.252	95								C				5 38.4	26 51
Oct 9	6	Hebe	186	0.15	675	S	0.262	108								C				6 34.3	6 06
Oct 9	48	Doris	200	0.14	1084	C	0.166	238								C				2 40.2	10 41
Oct 12	804	Hispania	175	0.15	777	C	0.232	274	74936	+27 282		0.23	281	24	1.1	AG	N28 199	0.72	4.1	1 46.8	28 25
Oct 13	747	Winchester	208	0.18	776	C	0.272	104								C				6 36.6	2 34
Oct 14	159	Aemilia	141	0.09	673	C	0.195	246	128970	-03 105		0.20	316	25	1.1	S				0 48.8	-3 07
Oct 14	747	Winchester	208	0.18	777	C	0.266	104								C				6 37.5	2 31
Oct 15	747	Winchester	208	0.18	777	C	0.261	104		+02 1330		0.04	42	3	0.2	A	N 2 768			6 38.3	2 27
Oct 16	735	Marghanna	75	0.10	165	C	0.281	300		+12 447						A	N13 253			3 08.9	13 11
Oct 17	201	Penelope	92	0.07	251	M	0.323	88	163019	-19 5616		0.86	1219	64	4.4	X				19 48.9	-19 24
Oct 17	747	Winchester	208	0.19	778	C	0.247	105								C				6 40.3	2 19
Oct 19	747	Winchester	208	0.19	779	C	0.234	105								C				6 42.0	2 12
Oct 20	747	Winchester	208	0.19	780	C	0.227	106								C				6 42.9	2 08
Oct 21	545	Messalina	105	0.05	487	C	0.072	313	57899	+36 1082		0.41	846	136	2.5	AS	N36 536	1.22	12.8	5 18.7	36 55
Oct 21	7	Iris	222	0.27	789	S	0.155	104								C				5 49.5	26 29
Oct 21	790	Pretoria	178	0.10	997	P	0.198	218	73865	+26 26		0.06	98	7	0.3	AS	N27 26	0.55	-2.8	0 16.0	27 28
Oct 23	747	Winchester	208	0.19	782	C	0.208	106								C				6 45.1	1 59
Oct 24	712	Boliviana	128	0.14	405	C	0.192	189	108591	+10 4931		0.82	777	103	3.5	AS	N10 3214	1.24	1.0	23 23.3	11 05
Oct 26	6	Hebe	186	0.17	685	S	0.154	120								C				6 47.1	4 45
Oct 31	45	Eugenia	250	0.18	1491	U	0.218	249								C				1 59.8	2 42
Nov 2	747	Winchester	208	0.20	788	C	0.127	109								C				6 51.7	1 28
Nov 2	48	Doris	200	0.14	1080	C	0.208	244								C				2 23.4	8 28
Nov 4	747	Winchester	208	0.20	789	C	0.113	109								C				6 52.4	1 24
Nov 4	121	Hermione	201	0.09	1285	C	0.097	80								C				8 21.9	23 54
Nov 6	45	Eugenia	250	0.17	1492	U	0.202	251								C				1 55.0	2 16
Nov 6	747	Winchester	208	0.21	791	C	0.091	110								C				6 53.4	1 19
Nov 8	790	Pretoria	178	0.10	1005	P	0.167	197		+23 6		0.05	84	7	0.3	A	N24 11			0 09.1	24 38
Nov 12	238	Hypatia	155	0.12	668	C	0.185	237	112399	+05 803		0.27	352	35	1.3	AS	N 6 528	0.49	0.1	5 04.3	6 07
Nov 12	24	Themis	228	0.14	1407	C	0.200	253								C				2 33.1	15 11
Nov 13	1	Ceres	1025	0.77	11864	C	0.236	267		+08 471		0.04	49	4	0.2	H				3 10.5	8 47
Nov 15	31	Euphrosyne	270	0.14	1456	C	0.333	102								C				11 33.0	29 43
Nov 19		Venus	12220	14.81	*****		1.200	89	186841	-25 13149		4.82	3980	96	18.9	FZ		0.05	-0.0	18 27.0	-25 26
Nov 22	31	Euphrosyne	270	0.14	1462	C	0.310	101								C				11 43.0	29 16
Nov 23		P/Halley	100	0.03	725		0.198	268								C				6 26.8	11 57
Nov 24	751	Faina	113	0.12	349	C	0.288	291		+17 796		0.08	72	6	0.3	A	N17 426			4 50.8	17 26

Table 1, Part E

1984 DATE	UNIVERSAL TIME	PLANET NAME	PLANET m_v	PLANET Δ,AU	STAR SAO No	STAR m_v	STAR Sp	STAR R.A.(1950)	STAR Dec.	OCCULTATION Δm	OCCULTATION Dur	OCCULTATION df	OCCULTATION P	OCCULTATION Possible Area	El SUN	MOON El	MOON %Snl	MOON Up	Ephem. Source
Nov 24	12 45-47	P/Halley	21.3	4.78		13.0		$6^h23^m.9$	11°58'	8.3	3^s	15	69	New Zealand?s; Papua	144°	161°	3+	none	Yeomans7
Nov 24	23 57-62	P/Halley	21.3	4.77		12.9		6 23.5	11 58	8.4	3	15	69	India?n; central Africa	145	164	5+	none	Yeomans7
Nov 28	5 52-87	Winchester	10.5	1.26	114569	9.0	A3	6 50.9	1 27	1.7	49	52	9	Brazil, Ecuador, see note	137	141	30+	none	EMP 1982
Dec 1	15 24-50	Iris	7.3	0.93		11.5		5 39.1	23 50	0.0	34	29	6	Alaska?n; e.Siberia, China, India	164	92	62+	w135°E	Branham
Dec 3	22 26-39	Harmonia	10.0	1.36	78926	9.2	G5	6 55.5	22 19	1.3	17	33	17	central Africa	149	82	82+	all	Herget78
Dec 7	13 48-75	Iris	7.2	0.93		11.1		5 33.2	23 18	0.0	31	27	6	w. U.S.A., Japan, China, e. India	171	19	99+	all	Branham
Dec 9	4 40-58	Winchester	10.3	1.22		12.3		6 44.8	2 16	0.2	28	29	9	northern South America; Mexico?n	148	28	99-	all	Herget78
Dec 10	23 15-18	Berbericia	13.5	3.40	100286	9.3	F8	12 46.8	14 03	4.3	8	15	27	Arabia, India, south central China	74	75	93-	all	Herget78
Dec 11	23 16-35	Winchester	10.3	1.21		12.3		6 42.8	2 34	0.2	25	27	8	South Africa, eastern Brazil	150	33	87-	e 45°W	Herget78
Dec 12	8 46-52	Winchester	10.3	1.21		12.6		6 42.5	2 37	0.1	25	26	8	eastern Canada?s	151	36	83-	all	EMP 1982
Dec 12	9 53-69	Hermione	12.8	2.75		12.9		8 21.0	25 32	0.7	23	37	20	Colombia, Mexico; Hawaii?s	138	7	83-	all	EMP 1983
Dec 13	7 51-70	Iris	7.0	0.93		11.4		5 27.1	22 46	0.0	30	26	6	northern U. S. A.; Hawaii?s	179	59	75-	e155°W	Branham
Dec 14	11 18-45	Iris	7.0	0.93		9.9		5 25.9	22 40	0.1	30	26	6	Mexico,Hawaii?n;Papua,w.Australia	179	75	63-	e175°E	Branham
Dec 15	16 05-18	Tercidina	12.5	1.72	109396	8.9	F8	0 40.1	3 31	3.6	11	27	23	Kenya; Sri Lanka?n; Maylaysia	107	163	50-	e115°E	EMP 1981
Dec 16	4 12-29	Hebe	8.5	1.26		11.7		6 29.9	4 02	0.1	19	22	10	nw Africa, ne U. S. A., sw Canada	156	85	44-	e 60°W	Branham
Dec 16	22 29-44	Dejopeja	13.1	2.22		10.0	C44	5 31.4	24 49	3.1	10	21	24	S'mtra,sIndia,sArabia,nAfr,Am'znR	178	108	35-	e 40°E	EMP 1983
Dec 17	0 48-60	Athor	12.5	1.65	59154	8.9	G0	6 27.0	37 05	3.6	8	20	24	Sinkiang, Kazak SSR, Urals, northern and western Canada, northwest USA	163	97	34-	e 15°E	EMP 1981
Dec 20	4 50-74	Iris	7.2	0.95		11.1		5 20.0	22 08	0.0	31	27	6	northwest Africa, Florida, Mexico	173	158	7-	e 2°W	Branham
Dec 22	3 41-59	Winchester	10.2	1.21		11.5		6 34.1	3 59	0.3	20	21	8	w. cen. Africa, ne USA, sw Canada	159	155	0-	none	EMP 1982
Dec 23	2 21-28	Winchester	10.2	1.21		12.9		6 33.2	4 09	0.1	20	21	8	northern South America; Mexico?n	159	157	1+	none	EMP 1982
Dec 23	4 12-26	Winchester	10.2	1.21		11.3		6 33.2	4 10	0.3	20	21	8	northern South America; Mexico?n	160	157	1+	none	Herget78
Dec 25	23 51-68	Winchester	10.2	1.21		9.3	A0	6 30.5	4 39	1.3	20	20	8	s and w Africa, Georgia (U.S.A.)	161	135	14+	w 55°W	EMP 1982
Dec 27	1 10-18	Winchester	10.2	1.21		11.3		6 29.6	4 50	0.3	19	20	8	Iran, western U. S. S. R.	161	123	22+	none	EMP 1982
Dec 27	14 30-35	P/Halley	20.9	4.36		12.4		5 50.4	12 00	8.5	3	11	63	Hawaii, China, India	166	109	26+	w110°E	Yeomans7
Dec 29	4 56-59	Eugenia	12.4	2.51		10.3		1 39.1	2 16	2.2	33	41	15	northwest South America	106	28	40+	w 83°W	Herget77
Dec 30	19 00-19	Ate	10.8	1.36	78743	9.5	F8	6 44.3	26 48	1.5	16	23	13	Indonesia, Sri Lanka, cen. Africa	176	85	55+	w 80°E	EMP 1979
Dec 30	20 08-13	Winchester	10.2	1.22		10.6		6 26.1	5 33	0.6	19	20	9	South Africa?n	162	81	56+	all	Herget78
Dec 31	5 00-01	Nuwa	12.5	2.04	96300	9.3	A5	6 54.0	19 43	3.2	10	21	22	Patagonia	175	83	59+	w 69°W	EMP 1980

Neptune is from "Predicted Occultations by Neptune, 1981-1984" by D. Mink, A. Klemola, and J. Elliot, *Astronomical Journal 86* (12), 135. That article and another one by the same authors in the same issue of *Astron. J.* list some occultations of fainter stars by Uranus and by Neptune, which probably will be detectable only with photoelectric equipment used with large telescopes at

(Text continues on next page)

Table 3.

Ephemeris Differences for 1984

Date	MP#	Shift	Δt	Ephemeris Source
Jan 12	154	1".24S	$10^m.2$	Herget 78
Jan 14	49	0.30S	1.1	EMP 1983
Jan 16	154	1.38S	7.5	Herget 78
Jan 20	165(both)	0.06S	0.2	EMP 1980
Jan 26	41	0.45N	3.5	EMP 1976
Jan 29	46	0.02S	-0.7	EMP 1980
Jan 31	154	1.51S	3.3	Herget 78
Feb 10	154	1.49S	2.5	Herget 78
Feb 22	268	42.75S	-63.0	Herget 78
Feb 23	386	0.93S	-1.7	Herget 77
Feb 25	31	2.87S	8.7	Herget 78
Mar 4	241	0.59N	-11.2	Bardwell 67
Mar 23	114	0.24N	1.7	EMP 1982
Mar 26	10	0.09S	-4.8	Klepczynski
Mar 31	11	1.23S	5.0	EMP 1980
May 2	128	0.44S	3.2	EMP 1977
May 11	230	1.87N	5.1	Herget 78
May 19	230	2.03N	5.7	Herget 78
May 30	104	0.02N	68.8	EMP 1980
Jun 1	85	0.06S	-1.4	ITA 1977
Jun 2	47	0.06N	1.0	EMP 1983
Jun 2	602	1.25S	-21.0	EMP 1981
Jun 2	624	0.68N	-56.4	Herget 78
Jun 4	70	0.60E	0.5	EMP 1980
Jun 8	13	0.07N	-0.9	EMP 1980
Jun 24	145	0.61N	1.3	Herget 78
Jul 14	139	0.36S	6.9	ITA 1974
Jul 16	386	1.78S	-0.1	Herget 77
Jul 16	211	0.25S	-0.1	EMP 1983
Aug 8	87	0.12N	-1.8	EMP 1983
Aug 19	747	1.70N	-3.3	Herget 78
Aug 21	747	1.74N	-3.4	Herget 78
Aug 25	104	1.62S	-167.3	EMP 1980
Aug 28	747	1.89N	-3.5	Herget 78
Sep 2	747	2.00N	-3.6	Herget 78
Sep 16	47	0.06S	-2.3	EMP 1983
Sep 21	747	2.46N	-4.4	Herget 78
Sep 23	747	2.53N	-4.5	Herget 78
Sep 23	747	2.54N	-4.5	Herget 78
Oct 2	334	0.94S	39.2	Herget 78
Oct 12	804	0.56S	-13.2	EMP 1982
Oct 14	747	3.17N	-6.7	Herget 78
Oct 15	747	3.20N	-6.9	Herget 78
Oct 21	790	0.55N	-3.0	Herget 78
Oct 24	712	0.16W	-0.7	Herget 78
Nov 2	747	3.84N	-14.7	Herget 78
Nov 6	747	4.00N	-20.8	Herget 78
Nov 8	790	1.01N	-2.6	Herget 78
Nov 28	747	4.85N	18.3	Herget 78
Dec 3	40	0.91N	6.5	EMP 1975
Dec 10	776	4.13S	-17.5	EMP 1980
Dec 11	747	5.43S	-9.0	EMP 1982
Dec 16	184	0.50N	2.6	Herget 78
Dec 23	747	5.83N	6.8	Herget 78
Dec 25	747	5.90N	6.3	Herget 78

major observatories. In addition, Philip Nicholson (Center for Radiophysics and Space Research, Cornell University) and Keith Matthews (Caltech) have provided me with a list of 39 additional occultations by Neptune during 1984 which probably can be recorded with infrared detectors; 20 of these events will be observable under good conditions from large observatories at either Palomar Mountain, Mauna Kea, Cerro Tololo, Siding Spring, or Sutherland. Copies of this list can be obtained either from Nicholson or from me.

Table 2, Part E

1984 DATE	No.	MINOR PLANET Name	km-diam.-"	RSOI	Type	MOTION °/Day	PA	STAR SAO No	DM No.	D	STELLAR DIAMETER m"	m	Time	df	S	COMPARISON DATA AGK3 No	Shift	Time	APPARENT R.A.	Dec.
Nov 24		P/Halley	100 0.03	723		0.203	268°								C				$6^h25^m.8$	11°57'
Nov 25		P/Halley	100 0.03	723		0.204	268								C				6 25.4	11 57
Nov 28	747	Winchester	208 0.23	809	C	0.111	296	114569	+01°1573		0.06	57	14	0.3	AS	N 1° 783	-0".19	$-1^m.1$	6 52.8	1 25
Dec 1	7	Iris	222 0.33	808	S	0.234	248								C				5 41.2	23 51
Dec 3	40	Harmonia	118 0.12	373	S	0.171	287	78926	+22 1533		0.18	179	26	0.8	XA	N22 798	-0.25	0.4	6 57.6	22 16
Dec 7	7	Iris	222 0.33	812	S	0.256	249								C				5 35.3	23 20
Dec 9	747	Winchester	208 0.24	819	C	0.204	300								C				6 46.6	2 14
Dec 10	776	Berbericia	183 0.07	1045	C	0.231	96	100286	+14 2550		0.11	263	11	0.7	AS	N14 1322	-0.55	0.5	12 48.5	13 51
Dec 11	747	Winchester	208 0.24	821	C	0.224	301								C				6 44.6	2 32
Dec 12	747	Winchester	208 0.24	822	C	0.226	301								C				6 44.3	2 35
Dec 12	121	Hermione	201 0.10	1302	C	0.105	306								C				8 23.1	25 25
Dec 13	7	Iris	222 0.33	815	S	0.261	249								C				5 29.2	22 48
Dec 14	7	Iris	222 0.33	816	S	0.260	249								C				5 28.0	22 42
Dec 15	345	Tercidina	109 0.09	326	C	0.183	86	109396	+03 94		0.13	158	17	0.6	PA	N 3 83	-0.30	-0.8	0 41.9	3 42
Dec 16	6	Hebe	186 0.20	720	S	0.262	287								C				6 31.8	4 01
Dec 16	184	Dejopeja	132 0.08	626	EMP	0.205	267		+24 862		1.05	1690	123	5.7	A	N24 505			5 33.5	24 51
Dec 17	161	Athor	100 0.08	336	CMEU	0.252	280	59154	+37 1521		0.75	900	71	3.6	AS	N37 733	0.07	0.2	6 29.4	37 04
Dec 20	7	Iris	222 0.32	820	S	0.247	248								C				5 22.1	22 10
Dec 22	747	Winchester	208 0.24	832	C	0.279	306								C				6 35.9	3 58
Dec 23	747	Winchester	208 0.24	833	C	0.283	306								C				6 35.1	4 07
Dec 23	747	Winchester	208 0.24	833	C	0.283	306								C				6 35.0	4 08
Dec 25	747	Winchester	208 0.24	836	C	0.291	308		+4 1312		0.04	37	3	0.2	A	N 4 801			6 32.4	4 37
Dec 27	747	Winchester	208 0.24	837	C	0.294	308								C				6 31.4	4 48
Dec 27		P/Halley	100 0.03	685		0.275	272								C				5 52.3	12 00
Dec 29	45	Eugenia	250 0.14	1499	U	0.101	49								C				1 40.9	2 27
Dec 30	111	Ate	156 0.16	587	C	0.245	266	78743	+26 1353		0.09	92	9	0.4	XA	N26 711	0.29	0.6	6 46.4	26 46
Dec 30	747	Winchester	208 0.24	841	C	0.299	310								C				6 28.0	5 31
Dec 31	150	Nuwa	137 0.09	623	CEU	0.217	274	96300			0.06	94	7	0.3	XA	N19 654	0.01	0.0	6 56.1	19 40

Most of the asteroidal occultations of AGK3 and SAO stars originally were found by Gordon Taylor and published either in his IAU Working Group Bulletin 29 or in "Occultations of Stars by the Four Largest Minor Planets, 1981-1989," in *Astron. J. 86* (6), 903. The following occultations not found by Taylor were published by L. Wasserman, E. Bowell, and R. Millis in "Occultations of Stars by Solar System Objects. IV. Occultations of Catalog Stars by Asteroids in 1984 and 1985" in *Astron. J. 88* (11), 1670 (1983 Nov.): by (704), Feb. 17; (386), Feb. 23; (31), Feb 25; (114), Mar. 23; (201), Mar. 27 & Oct. 6 & 17; (326) on Apr. 19, May 11 & 15, June 2 & 4, and Aug. 4; (230) on May 19; (47), June 2; (70), June 4; (13), June 8; (209), Sept. 4; (735), Oct. 16; (790), Oct. 21; (345), Dec. 15; (184), Dec. 16; and (161), Dec. 17. The possible occultation by Halley's Comet on Jan. 7 was given by Bowell, Wasserman, and Millis in *Bull. Amer. Astron. Soc. 15* (3), 804. The occultation by (1) Ceres on Nov. 13 was reported by Millis, Wasserman, Bowell, Franz, and Klemola in "Asteroid Occultations — Progress and Prospects" in *B.A.A.S. 15* (3), 882.

Andrew Lowe has undertaken some manual searches of the SAO Catalog in an attempt to find some additional events, as he has done successfully during the past couple of years. However, he was not able to find any useful events not already found by Taylor or by Wasserman *et al.* Lowe used the same reasonable rejection criteria used by Wasserman *et al.*: The asteroid must have reasonably good orbital elements, agreeing with recent observations to within 4"; the asteroid must subtend at least 0".08 (except for some asteroids of special interest, including 44, 170, 171, 433, 617, 624, and 2060); the predicted central occultation duration must be at least 5 seconds; and the elongation from the sun must be at least 45°. However, while Wasserman *et al.* used only diameters from the TRIAD file, Lowe used the diameters published in *O.N. 3* (2), 24, where TRIAD values had been augmented with more observations and revised classifications reported by Edward Tedesco at I.A.U. Colloquium 75 at Toulouse, France, in 1982. Even so, Lowe found no new events.

The astronomers at Lowell have scanned Lick Observatory plates to find more occultations by some asteroids during 1984. The results just recently have been submitted to *Astron. J.* for publication, but have become available too late for inclusion in the lists below. Some of these events probably have been found independently in my A.C. searches discussed below. If there are any other useful events which will occur before the next issue of *O.N.* is distributed, I will try to distribute advance predictions to regional coordinators.

History of Astrographic Catalog Searches. IOTA obtained magnetic tape copies of several of the northern Astrographic Catalog zones from the Stellar Data Center in Strasbourg, France, in 1977, as described in *O.N. 1* (9), 97. They were obtained to include fainter stars in predictions for both lunar and asteroidal occultations. The data were a little difficult to use, being ordered by the astrographic plates, rather than in right ascension order. I wrote a computer program to extract data for selected small regions and sort the stars within the region in order of increasing right ascension. This was used mainly for star clusters to form the main basis for the USNO "J" and later "C" catalogs for extended lunar occultation predictions, first distributed in late 1977, as described in *O.N. 1* (12), 123. Occultations of A.C. stars by asteroids were first computed at the same time and published in *O. N. 1* (12), 127. But the latter work was haphazard, depending on manual searches by D. Wallentinsen and others to identify when an asteroid would cross an open cluster, so relatively few events were published. The relatively high frequency of A.C. events for a given asteroid was demonstrated with my articles, "Occultations of A.C. Stars by (24) Themis," in *O.N. 2* (5), 43 and "Occultations of A.C. Stars by (27) Euterpe" in *O.N. 2* (7), 73. In spite of the early 1900's epoch of most of the A.C. plates, modern astrometry by Klemola and Penhallow has demonstrated that the A.C. positions are within 1" of the current positions for the large majority of faint A.C. stars, an accuracy which rivals that of most asteroid ephemerides. Most of these faint stars are very distant and have negligible proper motions. However, when possible, new astrometric observations are recommended to improve the A.C. position and identify stars whose positions now differ from the predicted positions due to significant proper motion.

For a long time, I had planned to compare asteroid ephemerides with A.C. data automatically to find occultations of many stars not in the AGK3 and SAO catalogs. But other commitments prevented my making the important first step of sorting all of the A.C. data from France into right ascension order and eliminating duplicates (most A.C. stars appear on at least two plates). Alain Fresneau finally accomplished this job at the Space Telescope Science Institute in Baltimore last year, to help set up the Guide Star Selection System for the Space Telescope. He published his procedures in an article, "Survey of the Astrographic Catalog from 1 to 31 Degrees of Northern Declination," in *Astron. J. 88* (9), 1378 and gave a formatted magnetic tape with 1,025,208 A.C. stars to Wayne Warren at the Astronomical Data Center at Goddard Space Flight Center for distribution to the astronomical community (A few of the stars on Fresneau's tape were out of order; Warren corrected this). I obtained a copy and produced a binary version at USNO for more efficient use with the IBM 4341 computer there. During the course of this work, I found 27,897 duplicate entries, less than 30 of which I felt were possible true double stars. I deleted all of the duplicates from my binary copy, but sent a tape containing only the duplicates to Fresneau, so that he could trace their origin. I modified my occultation search computer program to read the binary tape for comparison with both retrograde and prograde parts of an ephemeris. The program would not find occultations which occur within a couple of days of a stationary point or near the $24^h - 0^h$ discontinuity in right ascension, but stars near these troublesome points were printed so that any events missed in the automatic part of the search could be found manually.

Occultation of Astrographic Catalog Stars during 1984. Since some manual work still was involved and time was short for including the A.C. events with the others for 1984 in this issue of *O.N.* (the work was begun in mid-November, 1983, it was not practical to consider the hundreds of asteroids involved in the searches performed at the Royal Greenwich and Lowell Observatories. I limited my search to those asteroids with diameters of at least 200 km (according to Tedesco, see above) which have oppositions between declinations of -2° and +33° during 1984 or late 1983, as well as a few smaller asteroids of special interest. Unfortunately, (532) Herculina, (171) Ophelia, and several other interesting asteroids are in the Southern Hemisphere, entirely south of the area covered by the French A.C. The asteroids which I included in my searches for 1984 have the following numbers: 1-4, 6, 7, 9 (occultation binary suspect), 12 (speckle binary suspect), 19, 24, 31, 41, 45, 48, 49, 65, 88, 121, 130, 154, 165, 194, 324, 375, 386, 423, 624, 747, and 2060. Halley's Comet (P/Halley) was also included; its ephemeris was generated from the latest orbital elements supplied by Don Yeomans at J.P.L. and used a numerical integration program which includes non-gravitational forces. The ephemerides which I generated for the searches were restricted to the declinations noted above and to elongations greater than 45° from the sun. The faint A.C. stars would be difficult to observe closer to the sun (favorable closer-elongation events of brighter SAO and AGK3 stars presumably would have been found by Taylor). Occultations also were rejected if the asteroid angular diameter was less than 0".08, when even last-minute astrometry likely would give a poor prediction of the path relative to its width. This restriction was waived in the case of asteroids of special interest, such as (9) Metis, (12) Victoria, (624) Hektor, and (2060) Chiron. No Chiron events were found. Both Cincinnati (Herget) and Leningrad ephemerides were used for the searches for (154) Bertha and (747) Winchester, since these differed by two or more arc seconds and recent observations could not distinguish which is the better ephemeris (in each case, the Leningrad orbit seems to be favored slightly). For the others, I have used what I consider to be the best orbit, the source being given in Table 1 for individual events.

Observational Considerations for the Astrographic Catalog Occultations. Many of the asteroids considered in my A.C. searches are considerably brighter than the faint A.C. stars, so that their occultations can be recorded only photoelectrically. This is especially the case for (1) Ceres and (4) Vesta; no prediction is given if the blue-magnitude Δm is less than 0.05. However, the Δm's in the table are computed from asteroid V magnitudes, while only photographic (blue) magnitudes are available for the A. C. stars. This is for conformance with other catalogs, where V or photovisual magnitudes are available, and a visual Δm is desired. But most faint A. C. stars are brighter visually (because most have later spectral types than A0) than their A.C. magnitude, sometimes by more than a magnitude. Hence, the actual Δm's often will be a few to several tenths larger than given in Table 1 for the A.C. stars. So visual observers should check the relative magnitudes of the star and asteroid if the predicted Δm is about 0.4 or larger.

Finder charts have been prepared with an expanded scale from the A.C. data for a square 1 degree on a side centered near the target star. This square is shown in the AGK3-based plot drawn at the same scale as finder charts appearing in previous issues of *O. N.*, which, however, are now only 3° on a side to conserve space. In some cases, small-scale Atlas-Coeli-based charts are not included due to lack of time. A.C.-based charts also are included for AGK3 stars fainter than about mag. 8.5, since the fainter stars help to identify the proper target star. Since Ceres and Vesta are brighter than 8th magnitude, they can be located reliably with the AGK3-based charts. Therefore, A.C.-based charts usually are not produced for them. In general, only the A. C.-based charts in *O.N.* have been checked against the True Visual Star Atlas for Northern Hemisphere stars. I do not do this manual checking for unpublished finder charts which I distribute directly to regional coordinators in other countries.

When Fresneau produced his tape, none of the A.C. designations were saved. Hence, no numbers are given for these stars; they can be identified only by their coordinates and magnitudes. Fresneau may save the original designations on a future version of his tape. In the meantime, we will use the current tape as well as we can. When Lowell and the Royal Greenwich observatories obtain copies of Fresneau's tape, they probably will use their more efficient (at least, more automatic) computer-search programs to extend the A.C. searches to smaller asteroids. My programs also might be used on other computers by one or two other IOTA members to extend the searches, or I will do it if I can find time to automate some of the manual procedures currently used. I also would like to add more catalog data, especially Yale Catalog stars which are in neither the AGK3, SAO, or Perth 70 catalogs, and IOTA's Southern Astrographic Catalog Project stars. Extension to all asteroids larger than 0."08 will result in many hundreds, even thousands, of events per year, and current publication methods will not be practical. An automatic method of geographically sorting the predictions will be needed, so that observers would be sent computer-produced data only for events in their regions, as we do now for lunar occultations. Then, only the very best events would be included in *O.N.*, mainly for the benefit of those who might travel to other regions for outstanding occultations. I have plans for how this might be accomplished, but it will take time to implement them.

Ephemerides and Stellar Data. General guidelines for the ephemerides used for my predictions were given in my article about 1983 events referenced above. Table 3, listing ephemeris differences for several 1984 events, is in the same format as last year's table. My comparisons with recent astrometric observations, aided by Brian Marsden and Conrad Bardwell at the Minor Planet Center in Cambridge, MA, showed that the Leningrad (Ephemerides of Minor Planets, or EMP) orbits were slightly better than Herget's orbits for (31) Euphrosyne, (241) Germania, (624) Hektor, and (747) Winchester. However, the differences were not very significant except for (624) Hektor. (194) Prokne's orbit was rated poor by Millis *et al.*, so they excluded it from their searches (Herget did not compute an orbit for Prokne). However, I found that two of the four pairs of observations made since 1976 agreed within about 1" with the positions computed from the EMP 1983 orbit. On closer examination, it was found that the other two pairs would also be in good agreement if the observers had made a 1-hour error in the time of their exposures. An observation in November by Klemola confirms the good accuracy of the Leningrad orbital elements. On the other hand, the orbits for (268) Adorea disagree with recent data by tens of arc seconds for Leningrad and by several arc seconds for Herget. Herget's orbit, apparently the better one, predicts a wide miss, so the February 22nd occultation probably will not happen. The orbit for (365) Corduba is also poor, so the occultation predicted by it on October 6 probably will not occur.

I have used AGK3 positions and proper motions for many of my nominal predictions, rather than SAO data. This agrees with Taylor's and Lowell Observatory's practice, but it is the opposite of my practice in previous years. Good-quality astrometric observations usually favor the AGK3 data, but not always. Wayne Warren supplied me with Yale Catalog data for several stars, as well as some useful double star data. The individual components of four close double stars are listed separately in Tables 1 and 2.

Prediction Updates. The predictions for asteroidal occultations can be improved by astrometric observations to update the ephemeris and the star's position a few months in advance. The improvement can be quite good if the asteroid happens to pass near the star, perhaps during its retrograde loop, so that both objects can be photographed on the same plate. Sometimes these preliminary prediction improvements are published in *O.N.* or in *Sky and Telescope*, or distributed by mail by Gordon Taylor, by Lowell Observatory astronomers, or by me. But a very accurate prediction generally can not be made until the objects are close enough together to photograph on the same astrometric plate during their final approach, only a few days before the event. In these cases, those of us involved with computing the final predictions must concentrate on notifying those near the path; this is facilitated if those we contact telephone other observers in their areas. You can find out the latest predicted shift and time correction for upcoming asteroidal occultations by telephoning Astro-Alert in Chicago, IL, area 312, 259-2376, or Gordon Taylor at the Royal Greenwich Observatory, England, city code 0323, 833171, ext. 3252. Information also usually can be obtained from Paul Maley in Houston, TX, 713,488-6871 and, at least for events in the western U.S.A., from Lowell Observatory, Flagstaff, AZ, 602,774-3358.

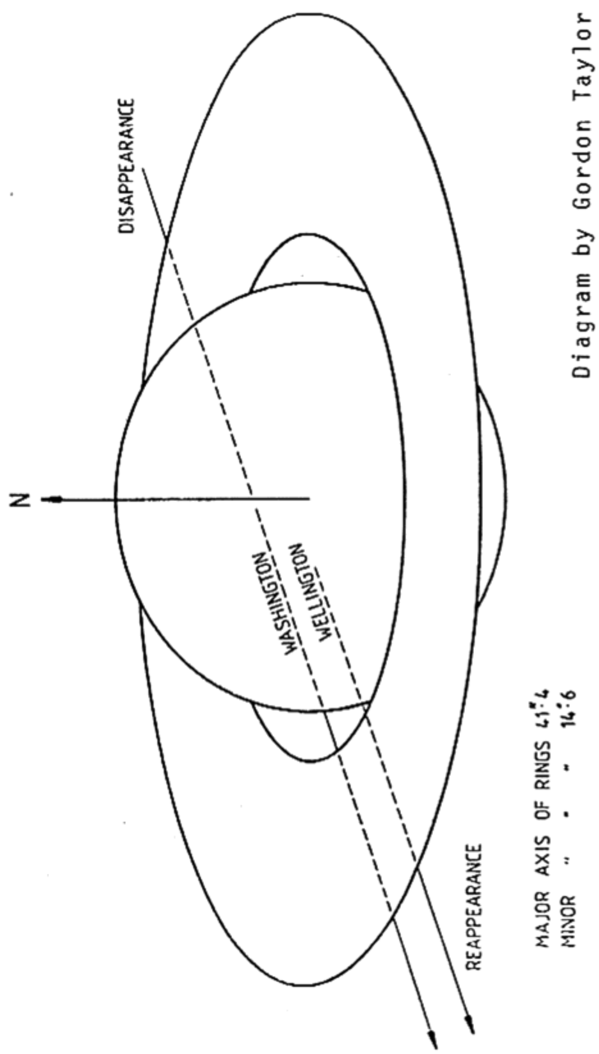
Notes about Individual Events. There will be considerable moonlight interference for many of the 1984 events, especially for some of the faint A.C. stars, so pay attention to the lunar elongation and percent sunlit given in Table 1. For these cases, it would be useful to try to locate the star about a month before the occultation, when moonlight conditions might approximate those for the actual event. Any prior experience in locating the star, even in a dark sky, will help on the night of the occultation. Notes about some of the events are given below:

Jan. 7, Halley's Comet: The nucleus is less than 100 km in diameter, but there may be some material in orbit 50 km or more from the nucleus.

Jan. 12, Halley's Comet: Klemola has measured a recent Lick Observatory plate to improve the star's position. His position is south of the A.C. position, which means that the occultation path is expected to shift north, off the earth's surface. But the ephemeris could be in error by at least 1", larger than the shift.

Jan. 20, Prokne: In early November, Prokne passed close to the star. Klemola obtained a plate, measurements of which indicate a 0".26 south shift and a correction to the time of 2.4 minutes early. The shift puts the path across Oregon, Louisiana, and southern Florida. Although the path is very likely to cross the U.S.A., the seeing was not good when the Lick plate was taken. This, combined with ephemeris drift, could cause the path to shift 0".5 from the above value.

Jan. 26: The star is Aitken Double Star (ADS) 3707. The 11.8-mag. B-component is 1".3 away, in position angle 344°. Good seeing will be needed in order to resolve the star and detect its occultation.



OCCULTATION OF SAO 158913 BY SATURN ON 1984 MARCH 25

Diagram by Gordon Taylor

Jan. 27: The note for Jan. 12 is also true for this event.

Feb. 25: The star is ADS 1654. The 8.6-mag. primary is 2".0 away in p.a. 344°; its occultation path misses the earth above Antarctica.

Mar. 4: The star is σ Scorpii (Al Niyat or Zodiacal Catalog No. 2349 or ADS 10009), the brightest known to be occulted by an asteroid this year. A star brighter than Sigma is occulted by an asteroid larger than Germania about once every 35 years, on the average. The 3.0-mag. primary is probably a spectroscopic binary (hence, the double star code U) which might be resolved during this spectacular occultation. Lunar occultation observations show a 5.2-mag. component (component"2") which is probably now about 0".7 away, according to an analysis by Ed Nather and P. Wild given in *Publications of the Astronomical Society of the Pacific, Vol. 86*, p. 116. Hence, the Δm that actually will be seen when the primary is occulted will be 2.2, not 10.0, since the 5.2-mag. star will remain visible. It will be occulted along a separate path two minutes earlier and probably north of the primary, but the Δm will be only 0.1, detectible only photoelectrically, since the primary will remain visible. The 8.3-mag. visual B component, 20" away in p.a. 273°, will not be occulted from the earth, missing it by 2". I have made tentative plans to observe the occultation of the primary star. NOAA satellite data for early March during the last 3 years indicate relatively clear skies over southern China, Indochina, and the northern Philippines, but poor weather prospects for northern China and Japan.

Mar. 25: This occultation will be difficult to see due to the faintness of the star relative to Saturn, and even photoelectric attempts may fail. The star will be visible for several minutes after it reappears from behind the ball of the planet and before it merges into the inner edge of Ring C.

Apr. 10: The 10.3-mag. B component is 0".48 away in p.a. 63°.

Apr. 19, Tamara: SAO 207516 is the secondary of a double star. The 8.6-mag. primary, SAO 207517, is 4".9 away in p.a. 118°, according to the Lick Index Catalog of Double Stars. But the difference in the current SAO positions is about 8" and implies that the occultation path for the primary misses the earth by 2" above South America. The SAO used relatively poor G.C. data.

Apr. 24: The star is in M35. Fred Schaaf, Millville, NJ, informed me that this M35 passage had been predicted by Steve Albers.

May 2: The star is ADS 8938. Two 12th-magnitude companions 16" and 140" away will not be occulted.

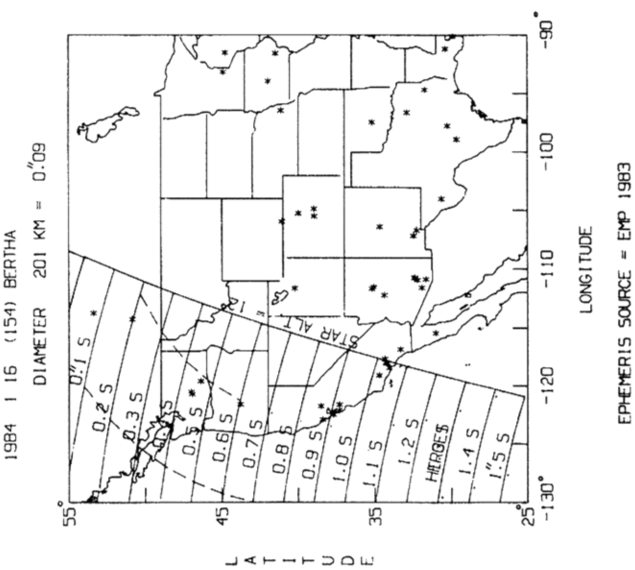
May 12, Mars: The star is Z.C. 2173. This event will be very difficult, since Mars will be at opposition, with essentially no defect of illumination (dark crescent). Taylor predicts immersion at 15:23.0 at Tokyo, with emersion 17.0 minutes later in p.a. 78°. At Naini Tal, India, the corresponding times are 15:36.2 and 15:54.4 in p.a. 103°.

June 24: The star is 83 Leonis (Z.C. 1660 or ADS 8162). The 7.6-mag. B component (SAO 118865) is 28" away in p.a. 149°, while a 10th-mag. companion is 90" away. Neither will be occulted by Fortuna.

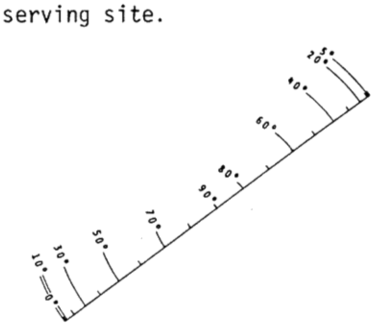
July 22: This occultation might be seen by using high power to spread out Neptune's image, so that a higher effective Δm can be achieved. The occultation may last less than 10 minutes for most Northern Hemisphere observers. The nominal northern limit passes just above the earth's north polar regions. The position I used combined SAO proper motion with Klemola's position. If Klemola's position alone were used, the northern limit of the occultation would cross North America.

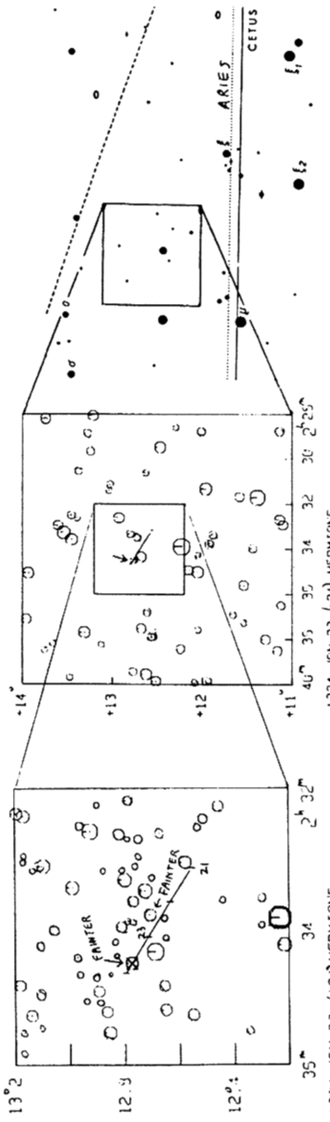
Nov. 13: A possible north shift could bring more observatories in the southern U.S.A. into the path of this important event. A.C. data predict a path across the northern U.S.A., but the Klemola position for the star, used for the nominal prediction, is certainly better.

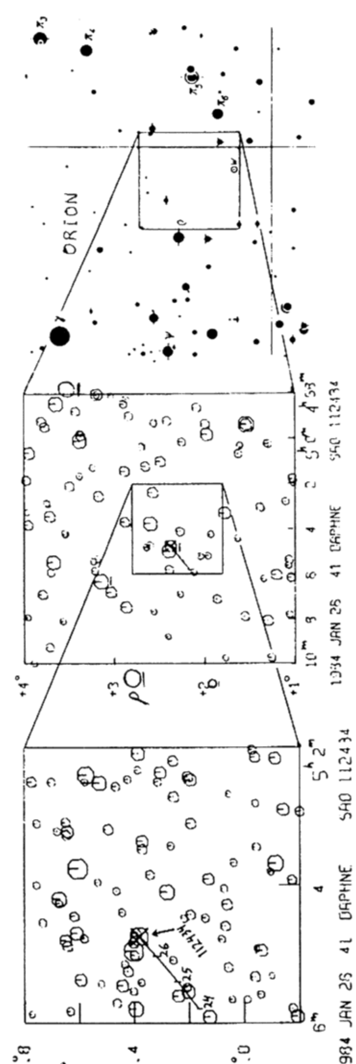
Nov. 19: The star is λ Sagittarii (Kaus Borealis or Z.C. 2672). Lunar occultations show that the star is single, with a diameter of 0".005. Venus will be 75% sunlit with a 3".6 defect of illumination. The location of the southern limit could be in error by 100 km or more. Central graze will be only 2° from the south cusp on the dark side as seen from the southern limit.

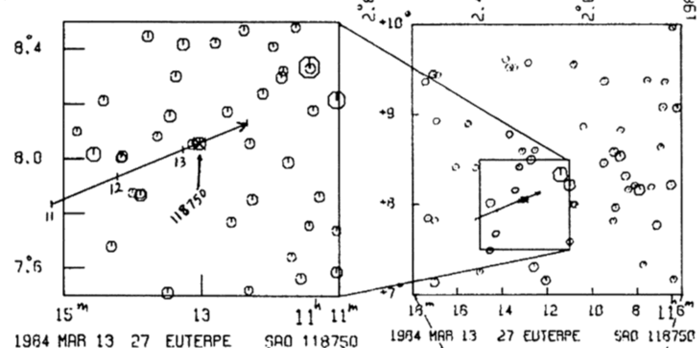


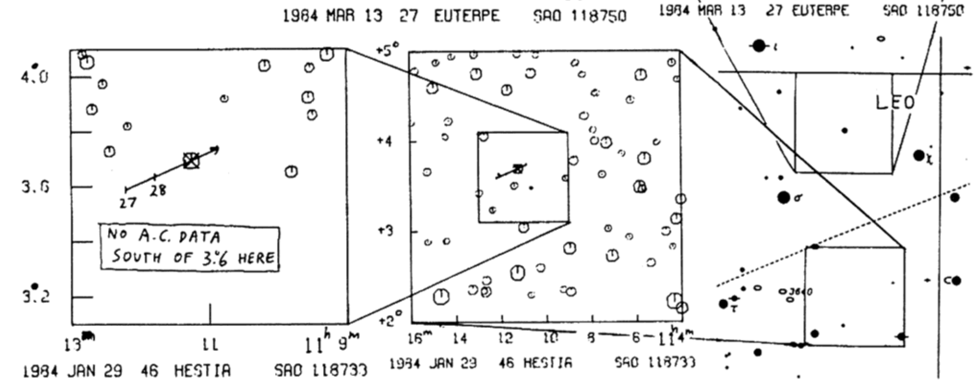
Use a tracing of this cosine scale to estimate star altitude from the Sôma world maps; place the 90° mark at the center of the circle, and read the star altitude at the observing site.

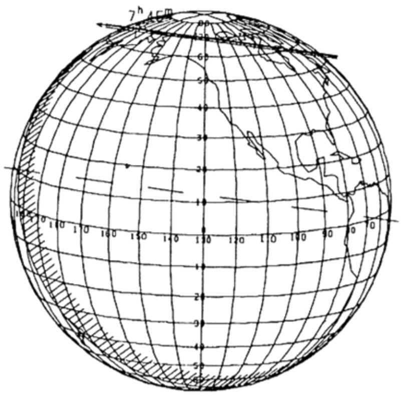




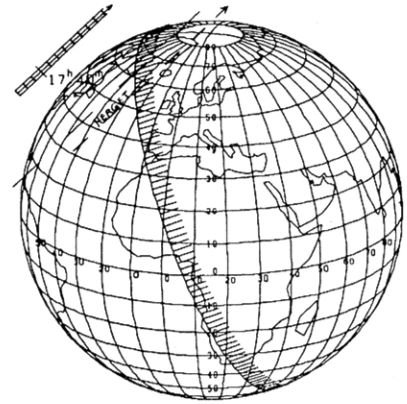




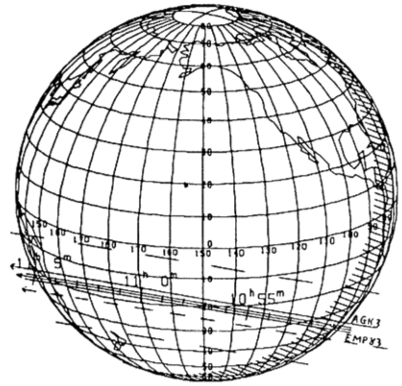




Anonymous by P/Halley 1984 Jan 12

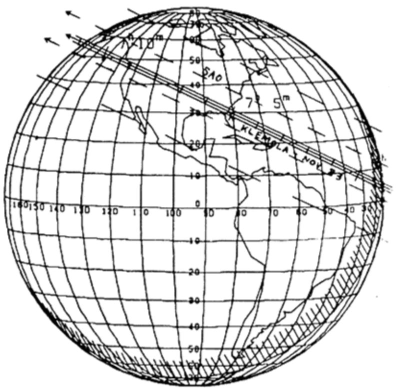


Anonymous by Bertha 1984 Jan 12

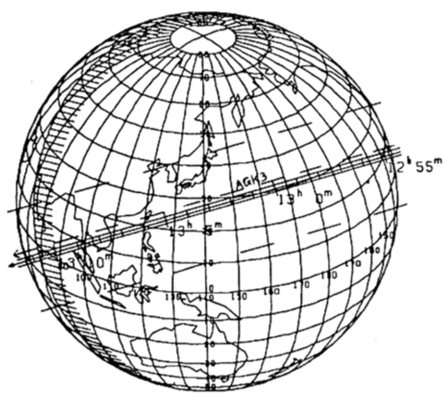


SAO 97945 by Pales 1984 Jan 14

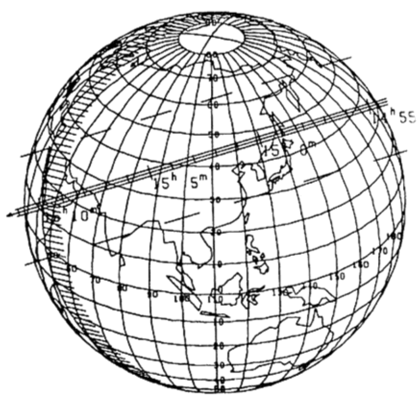
Anonymous by Bertha 1984 Jan 16



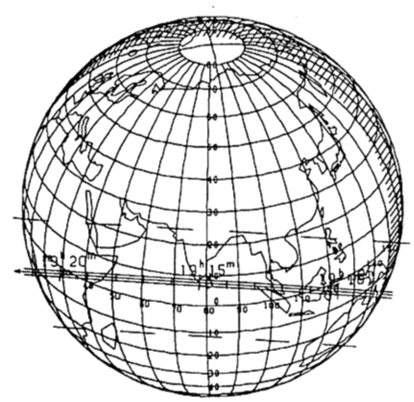
SAO 117122 by Prokne 1984 Jan 20



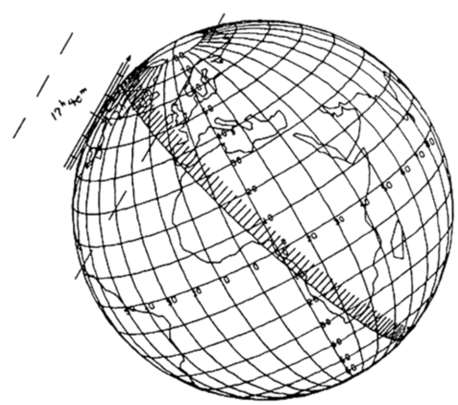
SAO 78310 by Loreley 1984 Jan 20



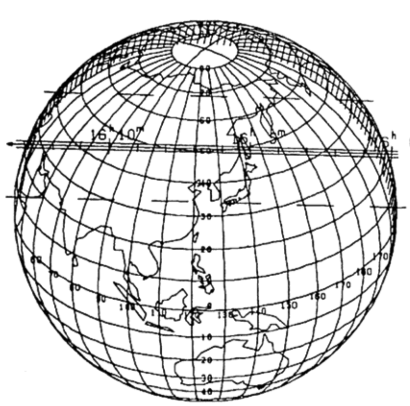
+29°1206 by Loreley 1984 Jan 20



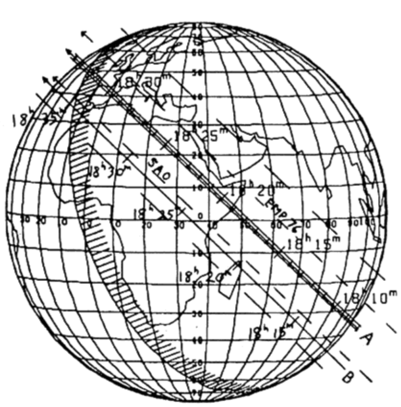
Anonymous by Ursula 1984 Jan 20



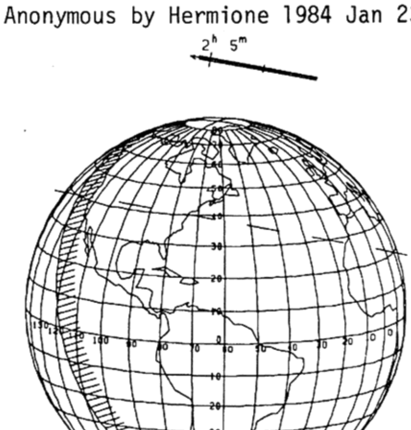
Anonymous by Hermione 1984 Jan 23



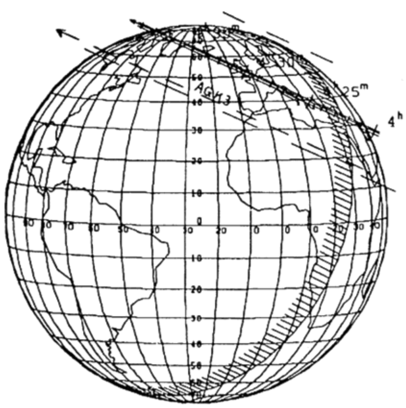
Anonymous by Ursula 1984 Jan 24



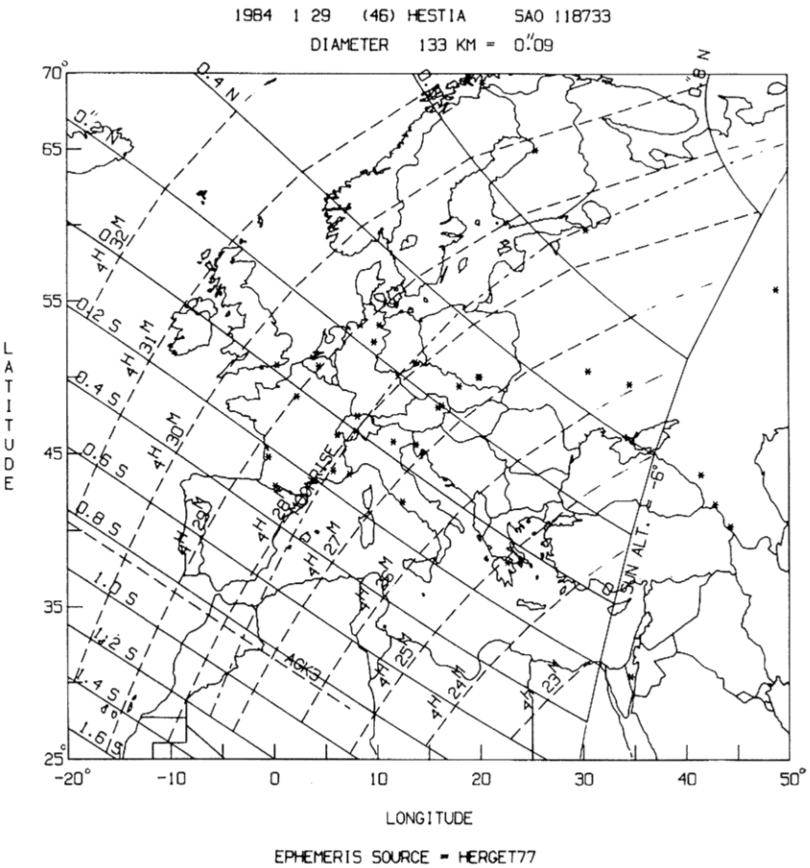
SAO 112434 by Daphne 1984 Jan 26

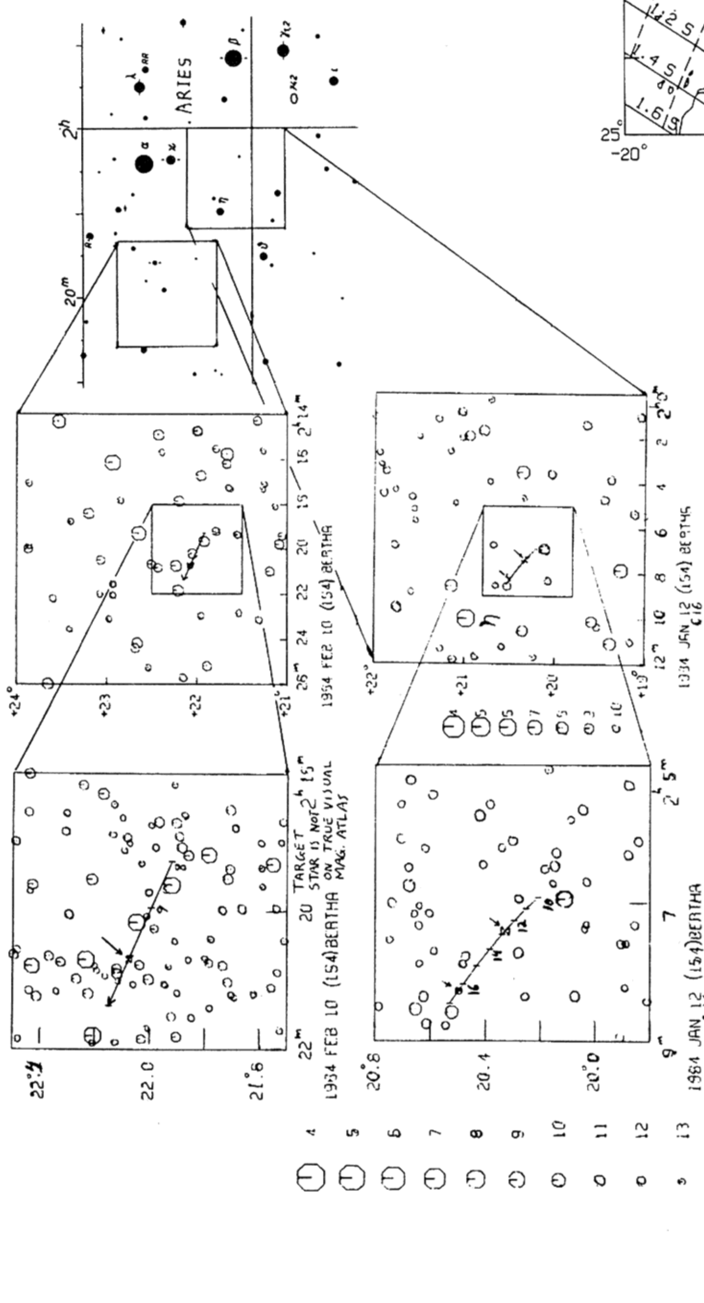


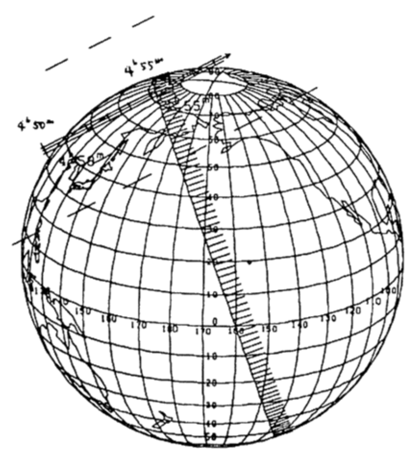
Anonymous by P/Halley 1984 Jan 27



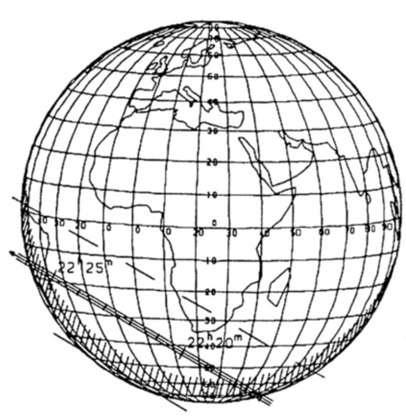
SAO 118733 by Hestia 1984 Jan 29



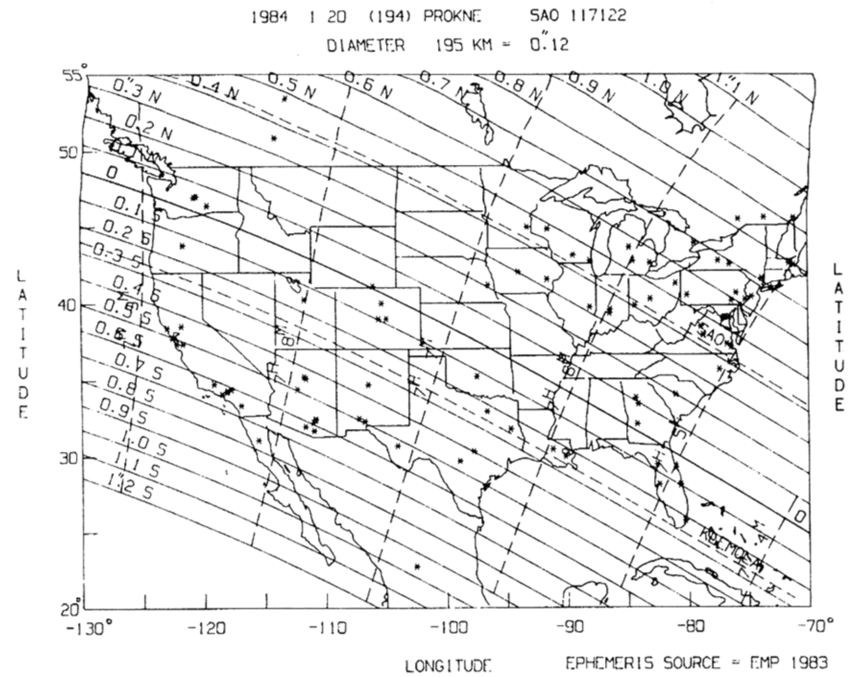


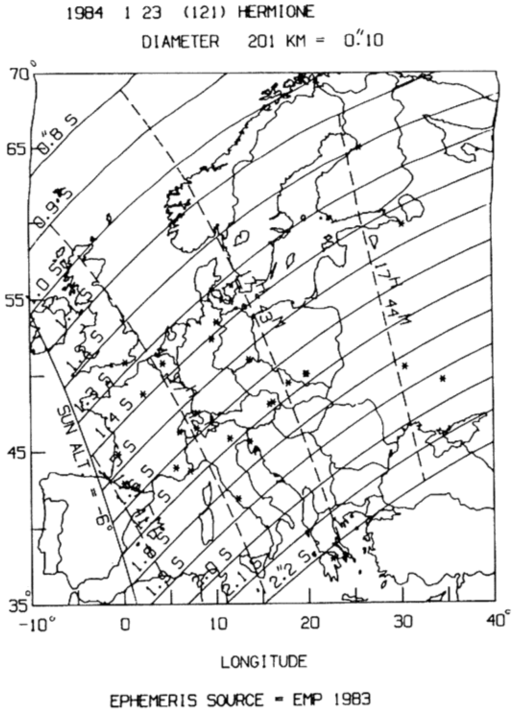


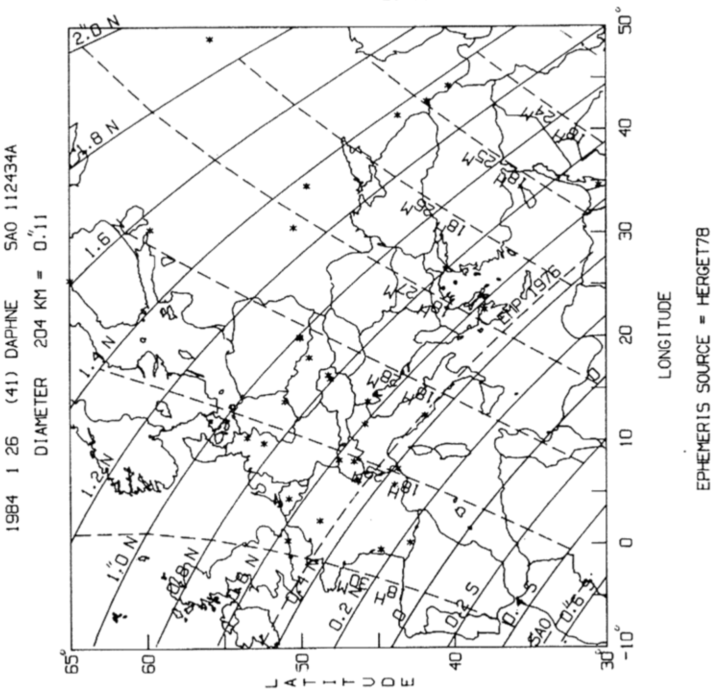
Anonymous by Bertha 1984 Jan 29

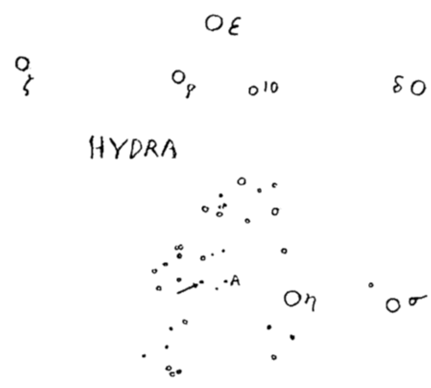


Anonymous by Prokne 1984 Jan 30

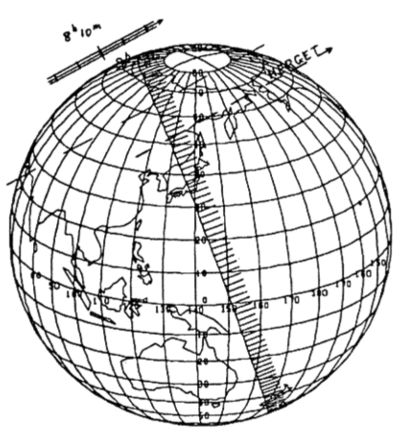




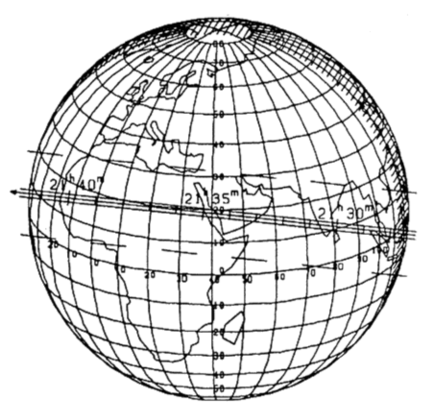




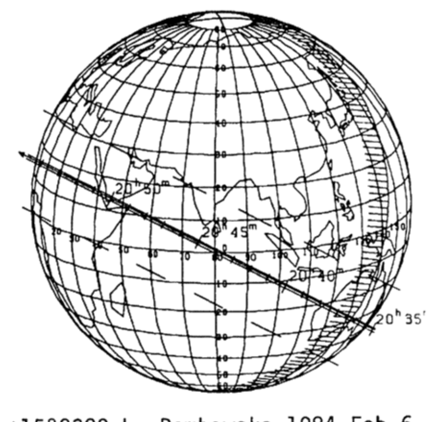
This plot showing the region of the head of Hydra is based on ATLAS ECLIPTICALIS. The arrow, in the approximate direction of (194) Prokne's motion, shows SAO 117122, to be occulted on 1984 Jan. 20. Four stars indicated by dots are shown on the TRUE VISUAL MAGNITUDE ATLAS but not on ATLAS ECLIPTICALIS. They are each almost as bright as SAO 117122, except for the star labelled A, which is 0.5 to 1.0 magnitude brighter than SAO 117122.



Anonymous by Bertha 1984 Jan 31

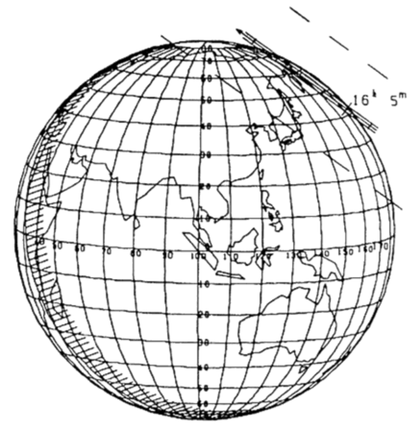


Anonymous by Bamberga 1984 Feb 3

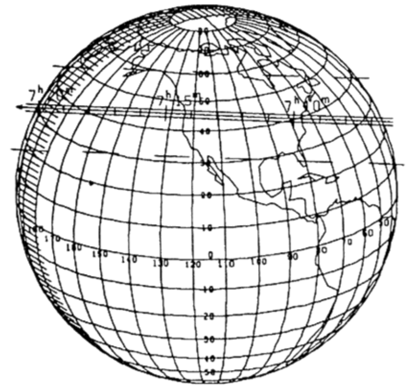


+15°2320 by Dembowska 1984 Feb 6

Anonymous by Bertha 1984 Feb 10



Anonymous by Prokne 1984 Feb 13



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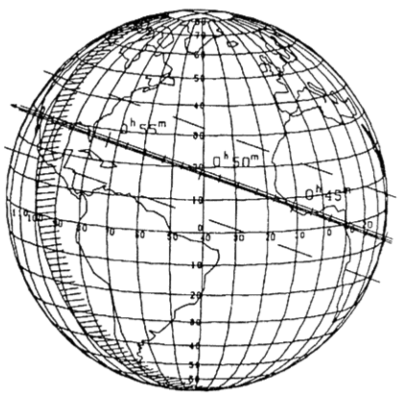
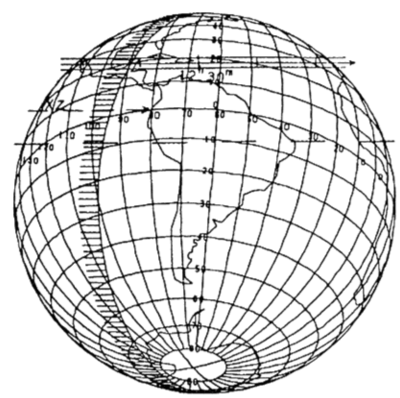
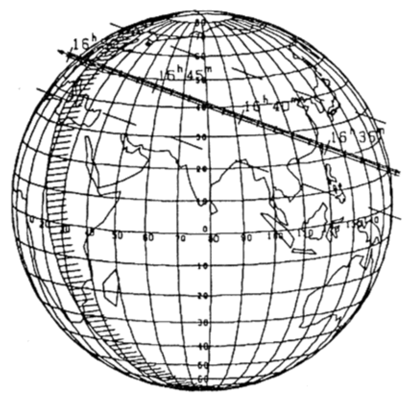


Anonymous by Victoria 1984 Feb 15



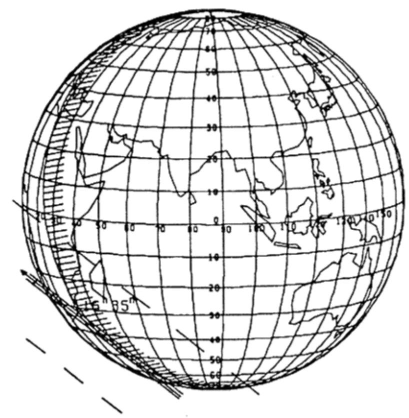
SAO 186422 by Interamnia 84 Feb 17



Anonymous by Victoria 1984 Feb 17

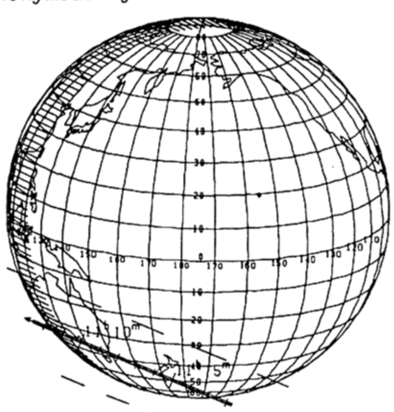
SAO 119464 by Metis 1984 Feb 19

Anonymous by Prokne 1983 Feb 19

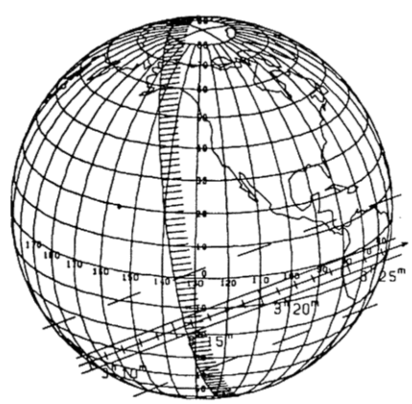


Anonymous by Prokne 1984 Feb 20

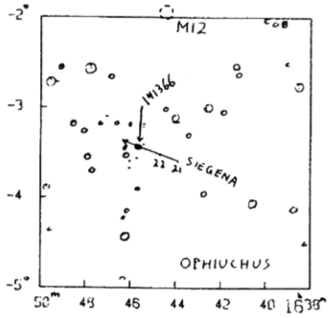
Anonymous by Victoria 1984 Feb 21



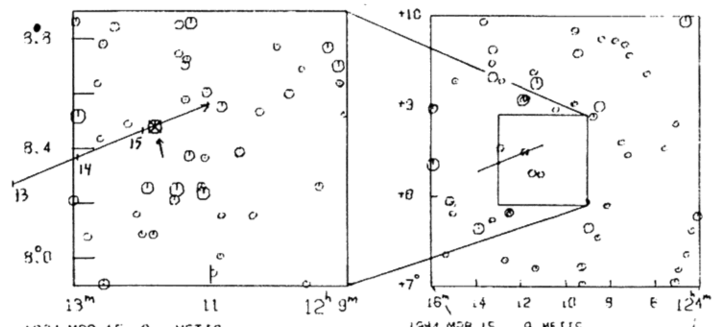
+16°1989 by Adorea 1984 Feb 22



Anonymous by Vesta 1984 Feb 23

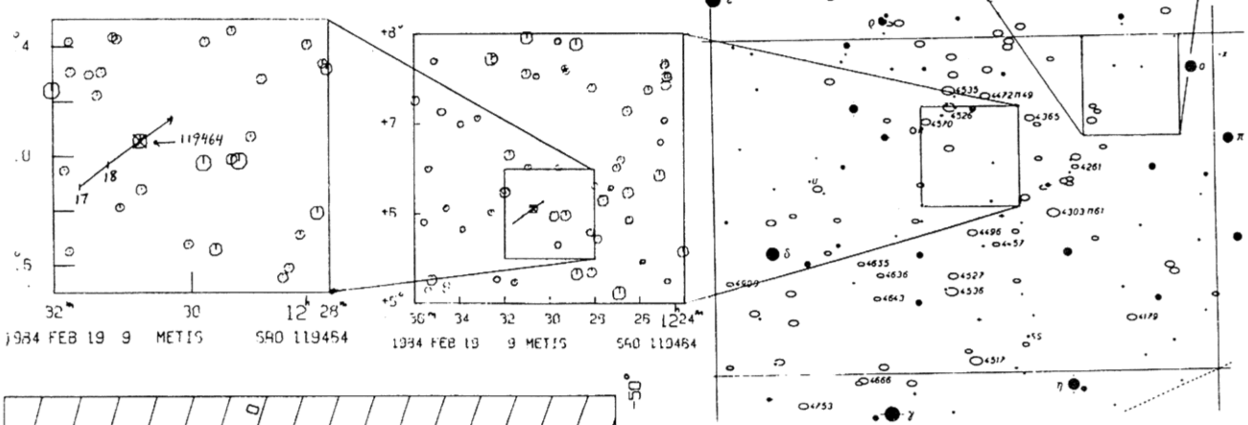


1984 FEB 23 366 SIEGENA SAO 141366



1984 MAR 15 9 METIS

1984 MAR 15 9 METIS



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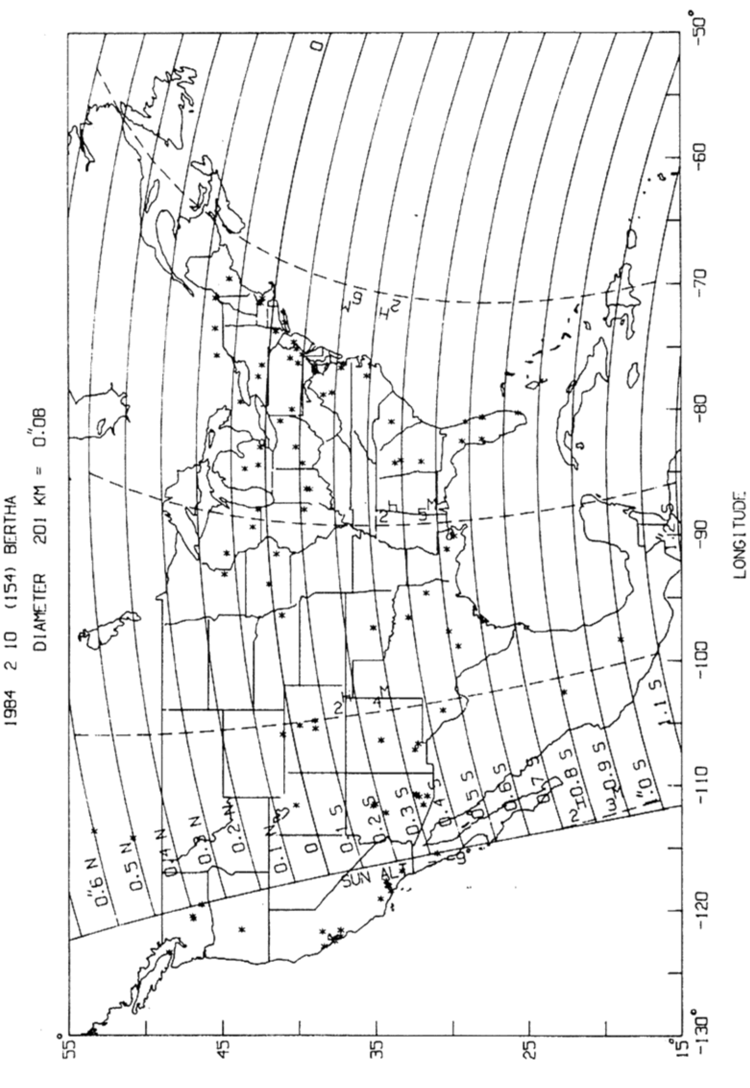
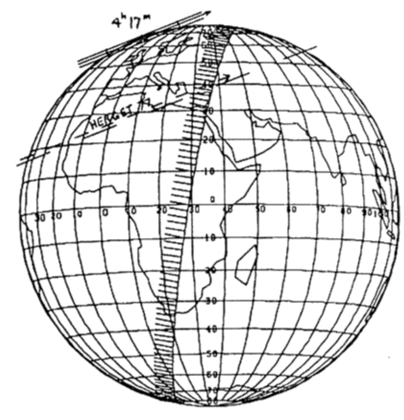
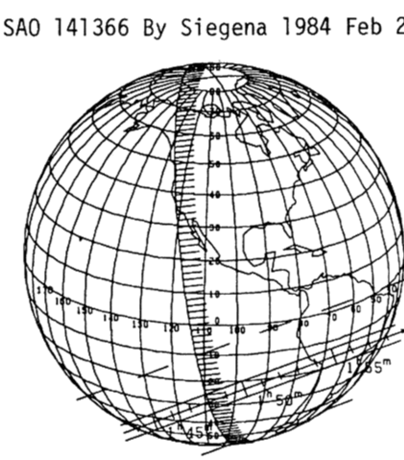
1984 FEB 19 9 METIS SAO 119464

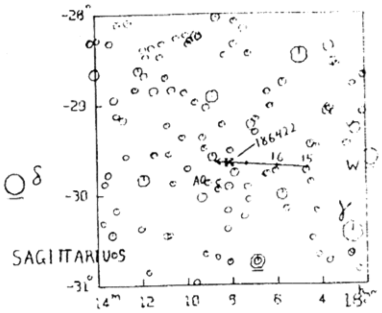




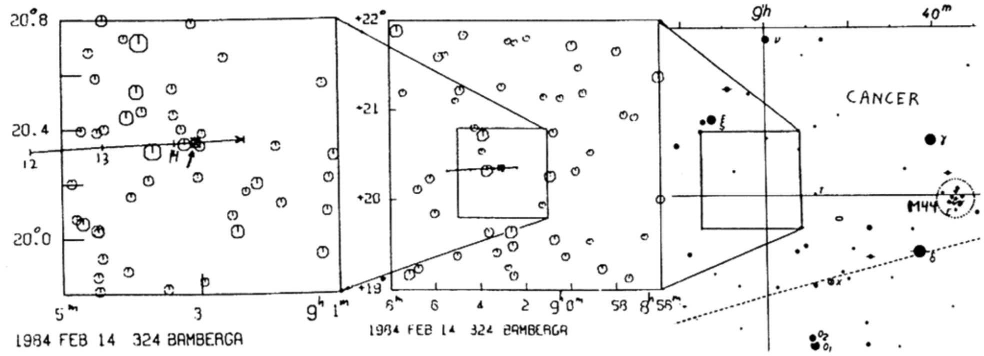
SAO 141366 By Siegena 1984 Feb 23



Anonymous by Vesta 1984 Feb 24

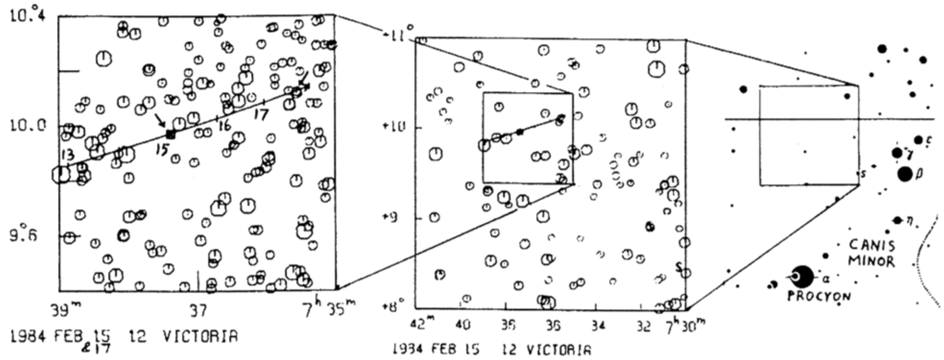


1984 FEB 17 (704) INTERAMNIA SAO 186422



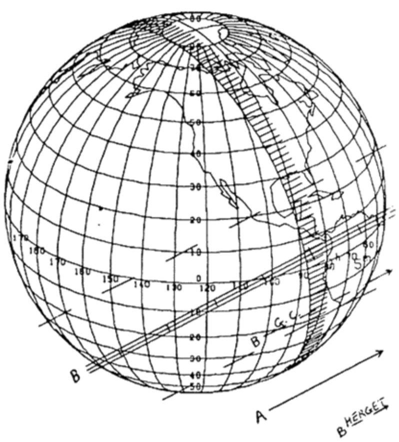
1984 FEB 14 324 BAMBERGA

1984 FEB 14 324 BAMBERGA

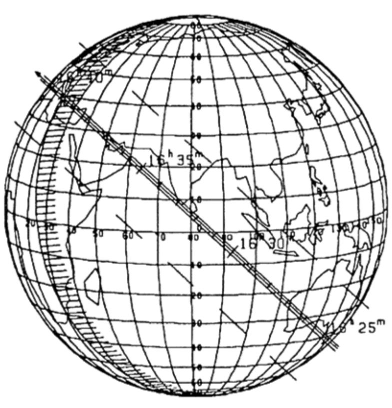


1984 FEB 15 & 17 12 VICTORIA

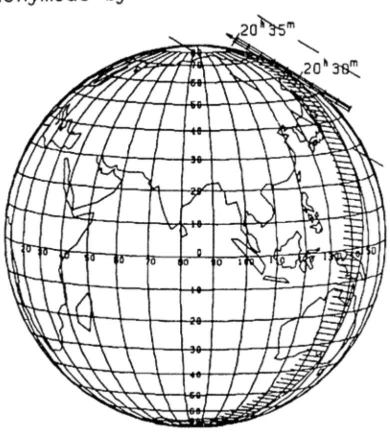
1984 FEB 15 12 VICTORIA



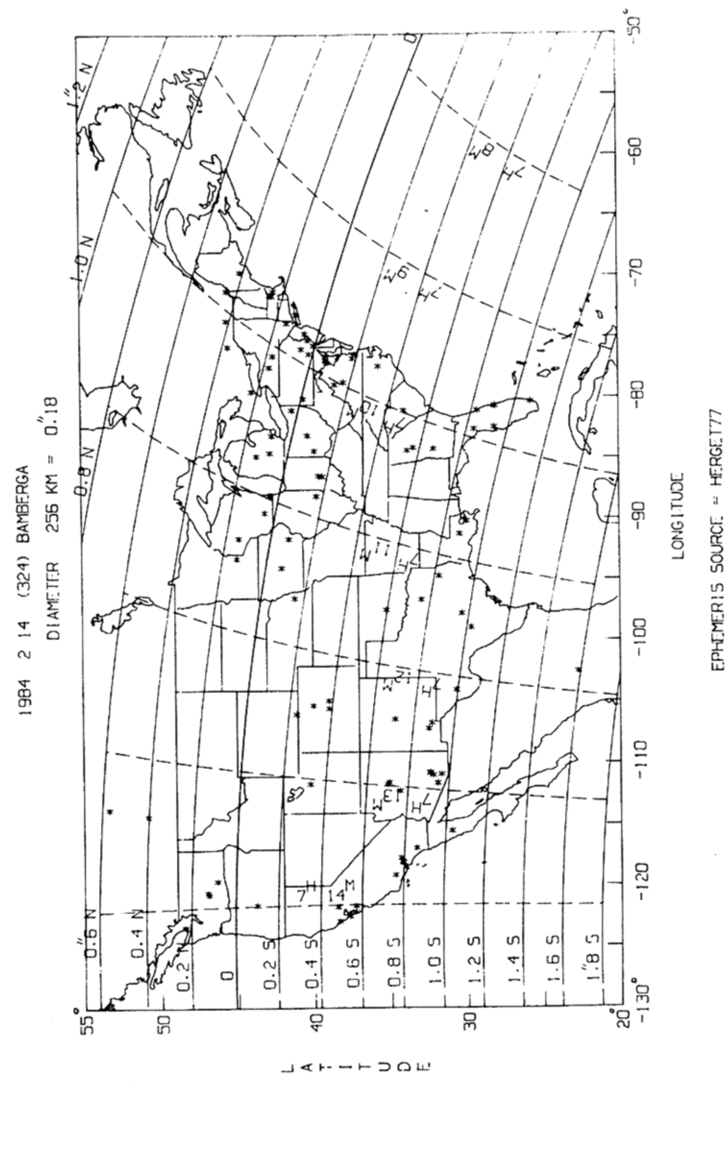
+24° 302B by Euphrosyne '84 Feb 25

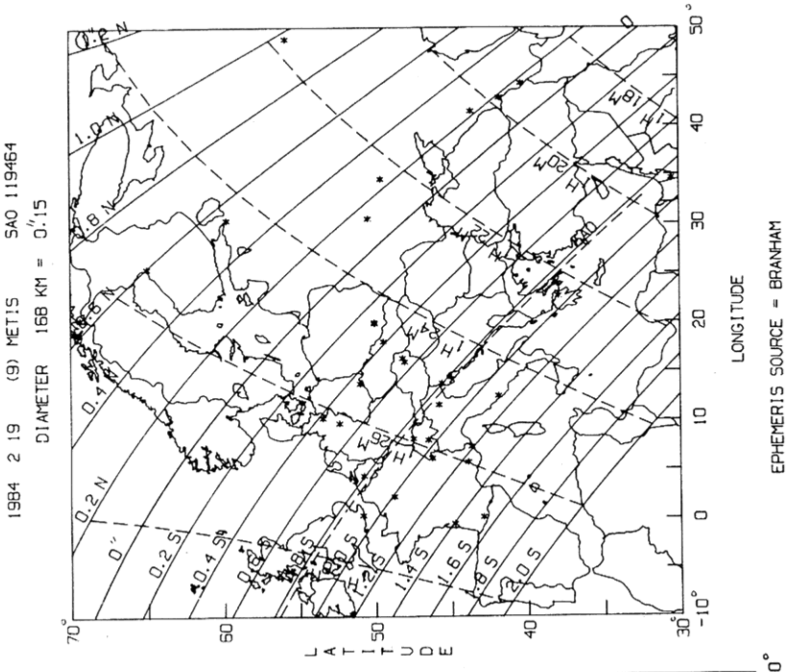


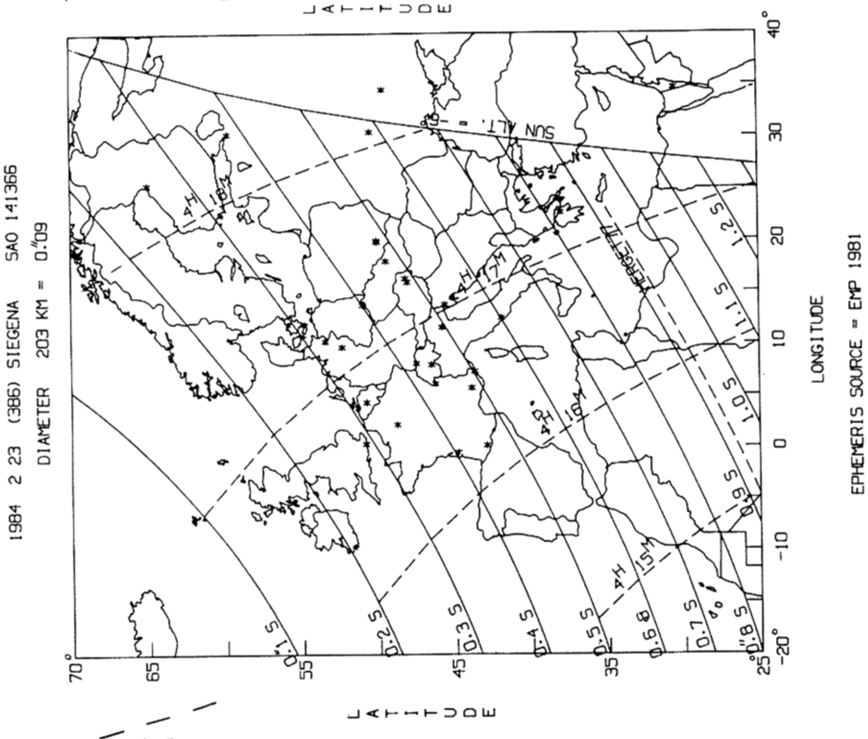
Anonymous by Prokne 1984 Feb 25

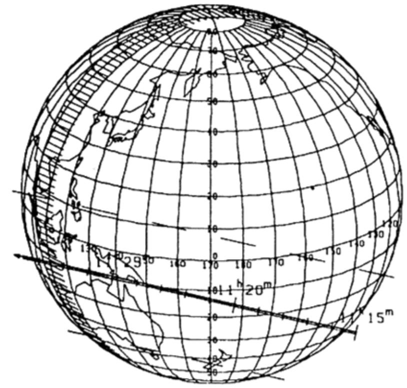


Anonymous by Metis 1984 Feb 25



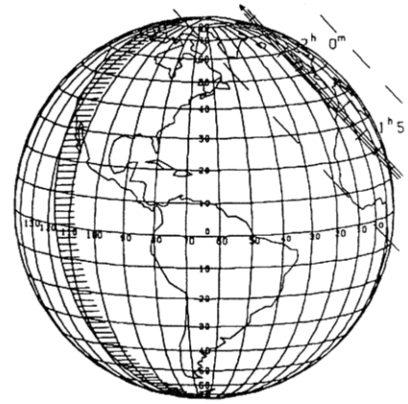




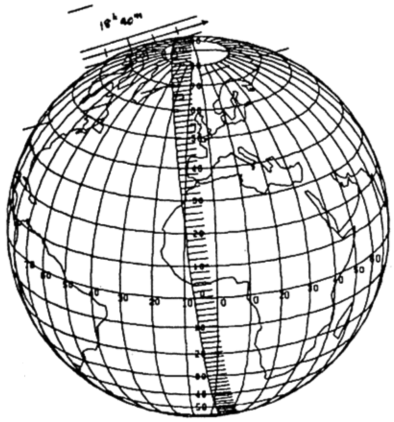


SAO 80634 by Andromache '84 Feb 26

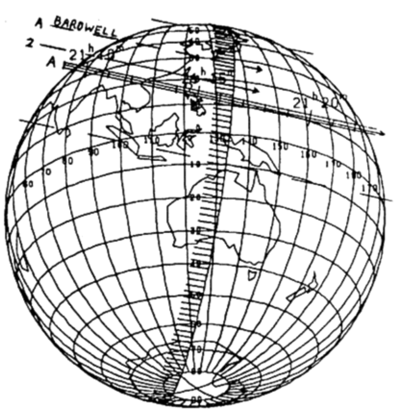
Anonymous by Metis 1984 Feb 28



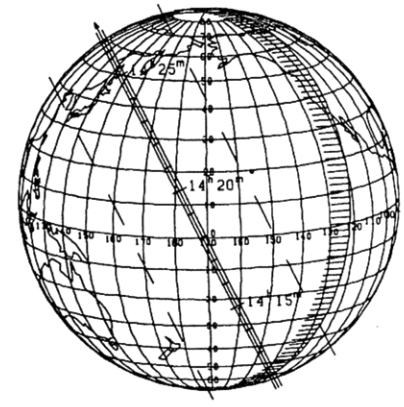
Anonymous by Prokne 1984 Mar 1



Anonymous by Vesta 1984 Mar 2

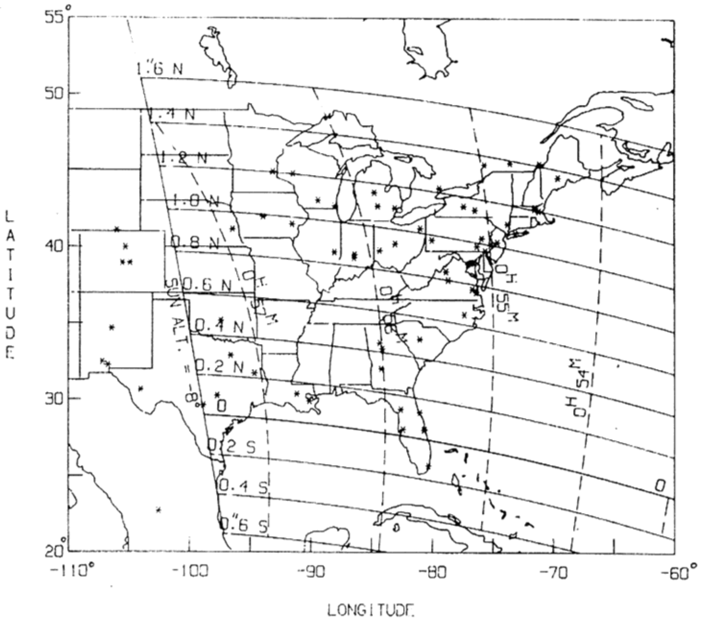


-25° 11485U by Germania 1984 Mar 4



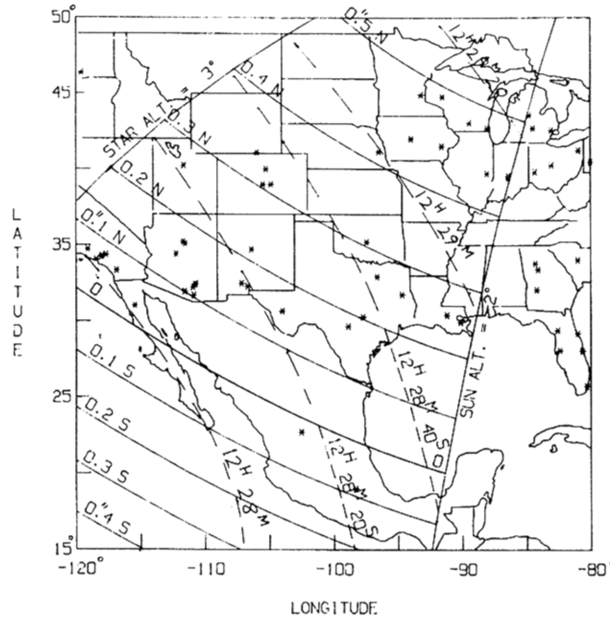
Anonymous by Elektra 1984 Mar 5

1984 2 15 (12) VICTORIA
DIAMETER 135 KM = 0."09



EPHEMERIS SOURCE = HERGET77

1984 2 17 (704) INTERAMNIA SAO 186422
DIAMETER 339 KM = 0."13

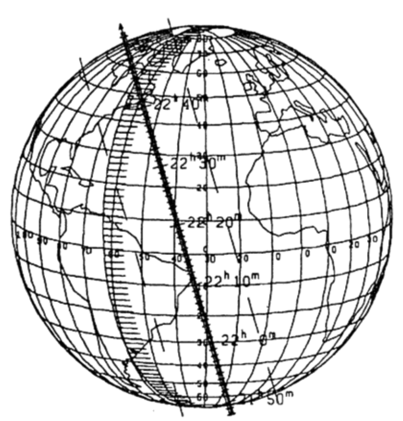


EPHEMERIS SOURCE = EMP 1977

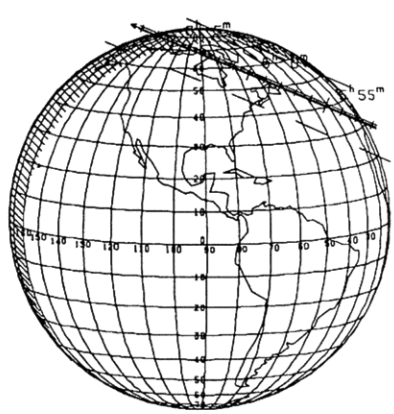
Anonymous by Bamberga 1984 Mar 5

Anonymous by Euphrosyne 1984 Mar 5

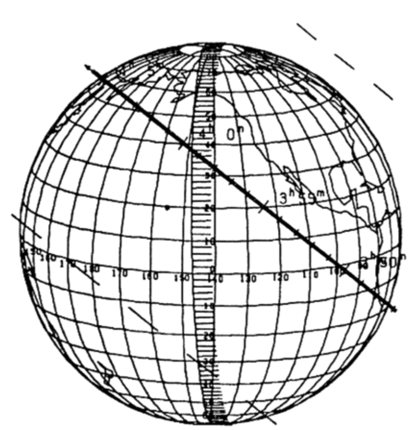
Anonymous by Thisbe 1984 Mar 10



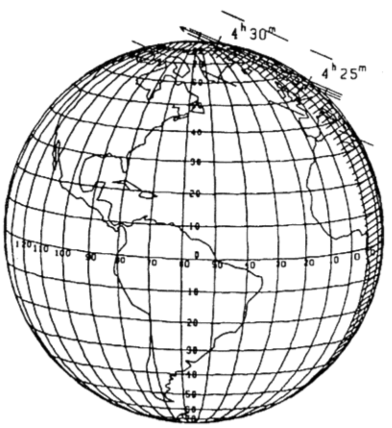
Anonymous by Victoria 1984 Mar 10



SAO 118750 by Euterpe 1984 Mar 13



Anonymous by P/Halley 1984 Mar 14



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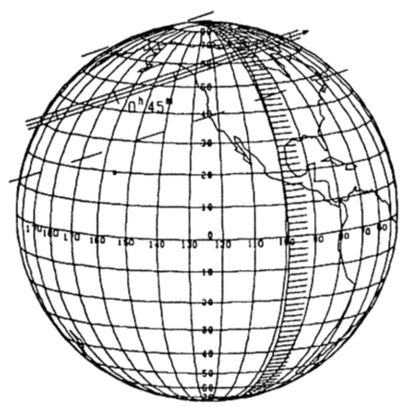
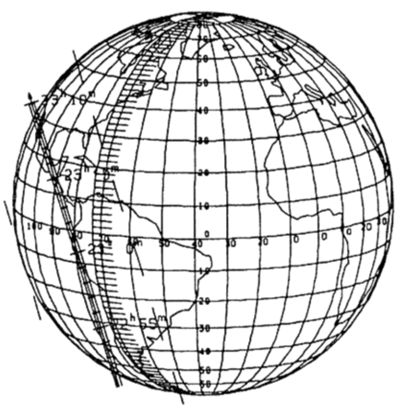
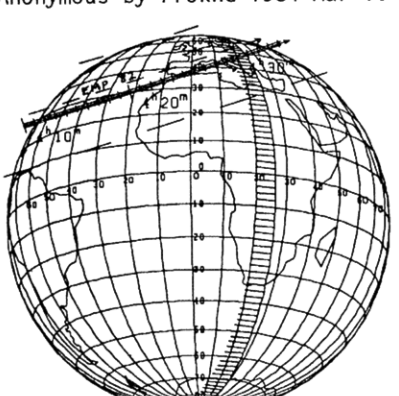


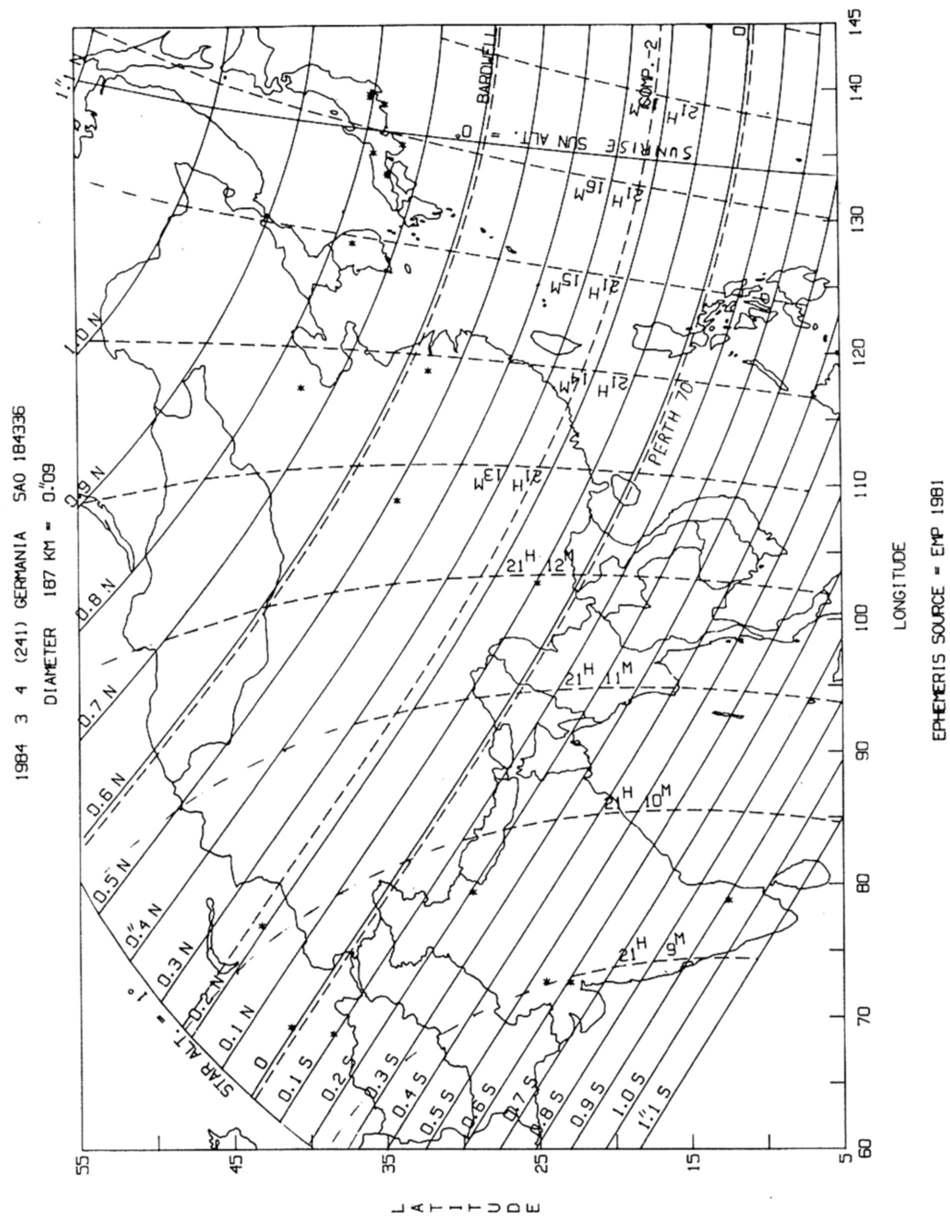
Anonymous by Juno 1984 Mar 16



Anonymous by Prokne 1984 Mar 16

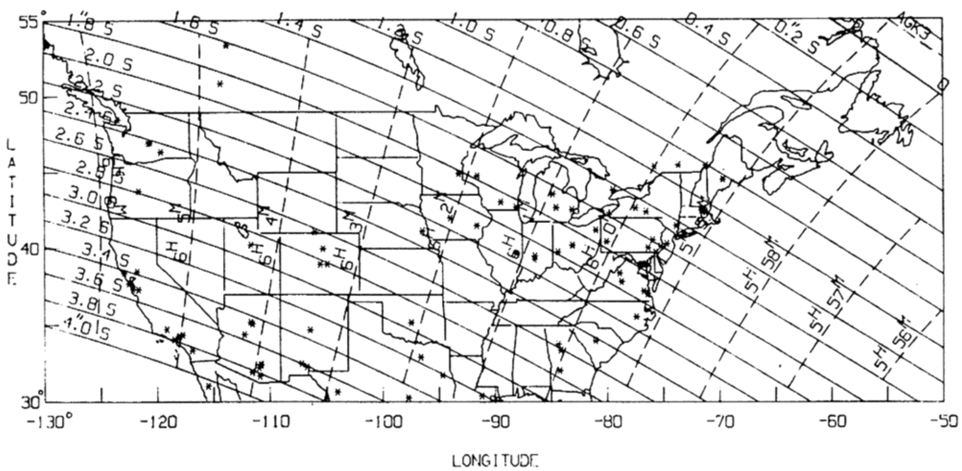


SAO 159989 by Kassandra '84 Mar 23

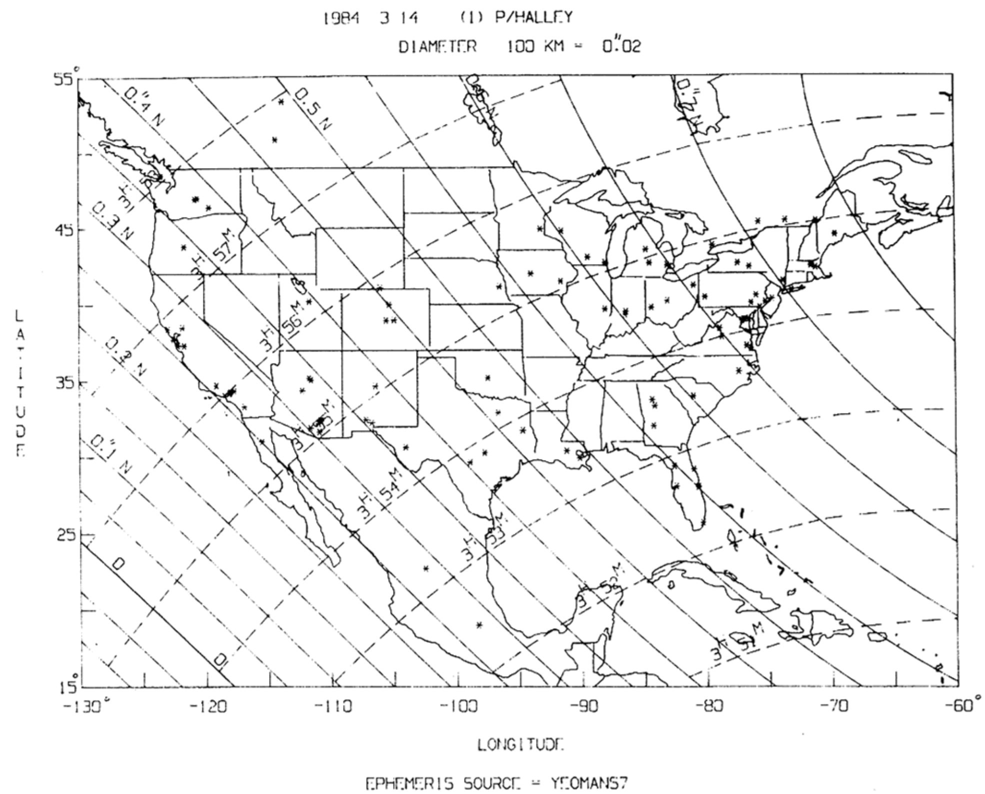


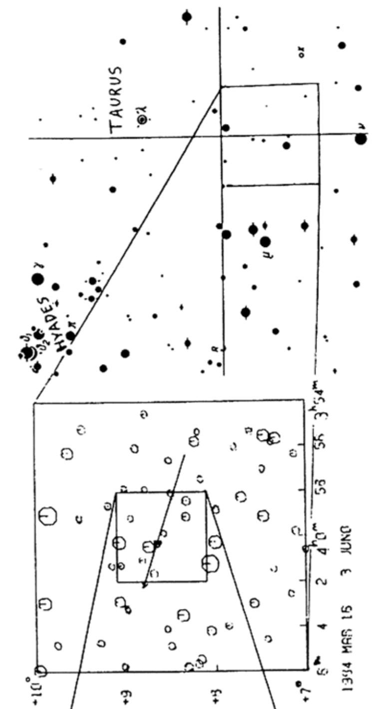
1984 3 13 (27) EUTERPE SAO 118750

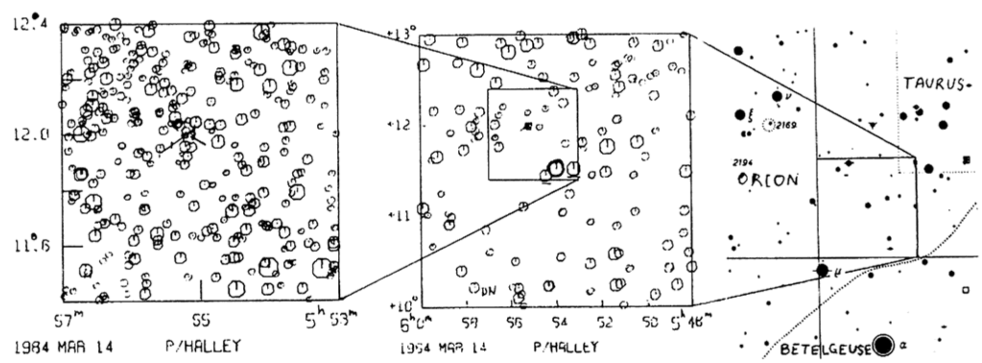
DIAMETER 116 KM = 0."13

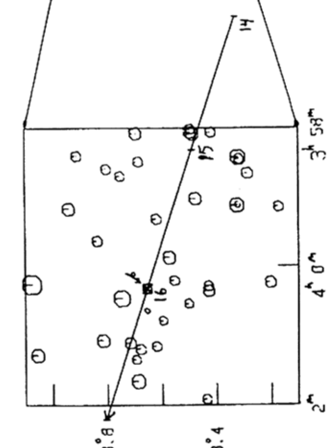


EPHEMERIS SOURCE = HERGET77


1984 3 14 (1) P/HALLEY
DIAMETER 100 KM = 0".02
LATITUDE
LONGITUDE
EPHEMERIS SOURCE = YEOMANS7


TAURUS
HYADES
1994 MAR 16 3 JUNO


1984 MAR 14 P/HALLEY
1984 MAR 14 P/HALLEY
TAURUS
ORION
BETELGEUSE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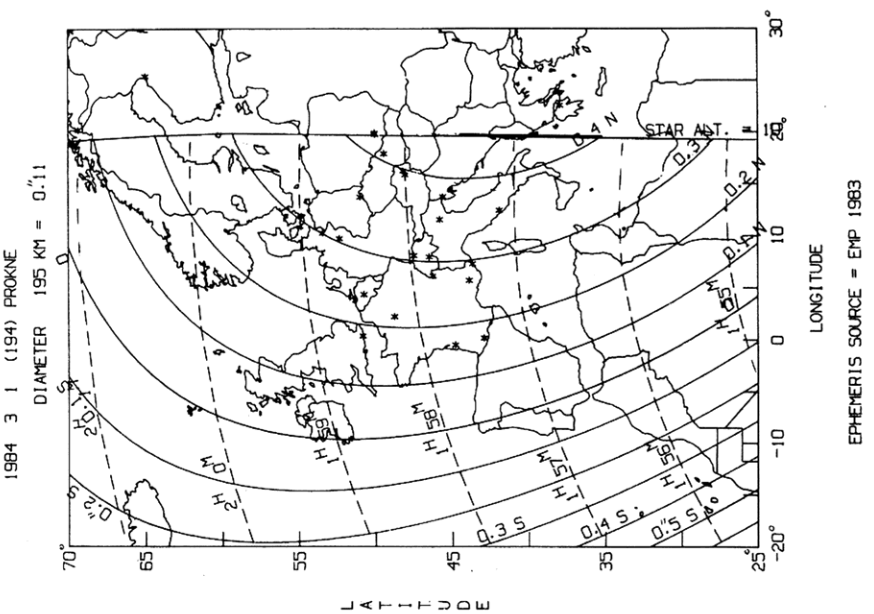
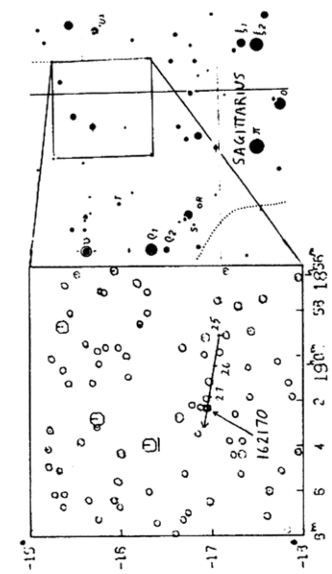
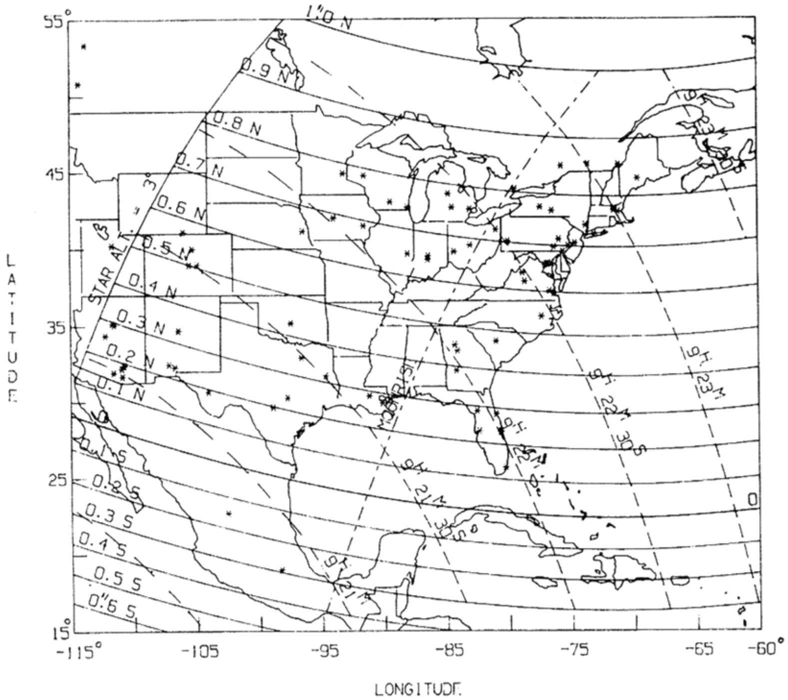

1984 3 1 (194) PROKNE
DIAMETER 195 KM = 0".11
STAR ALT.
LONGITUDE
EPHEMERIS SOURCE = EMP 1983
LATITUDE

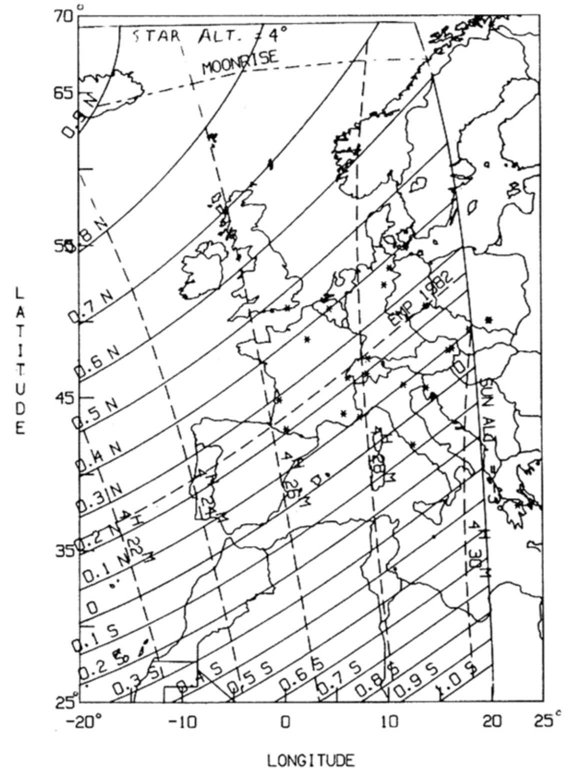

SAGITTARIUS
1994 MAR 27 201 PENELOPE SAO 162170
162170

1984 3 27 (201) PENELOPE SAO 162170
DIAMETER 92 KM = 0".05



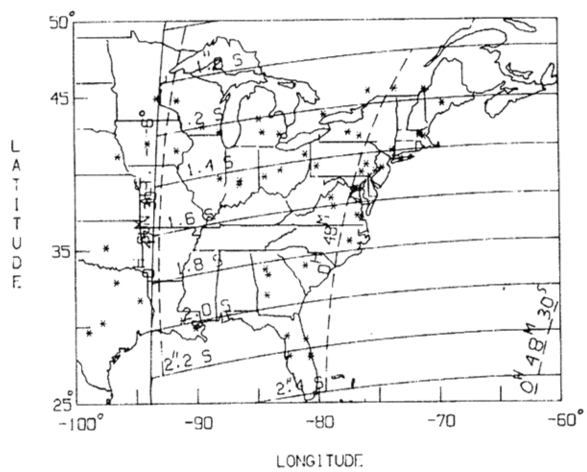
EPHEMERIS SOURCE = EMP 1981

1984 3 23 (114) KASSANDRA SAO 159989
DIAMETER 131 KM = 0".09



EPHEMERIS SOURCE = HERGET78

1984 3 16 (3) JUNO
DIAMETER 267 KM = 0".16



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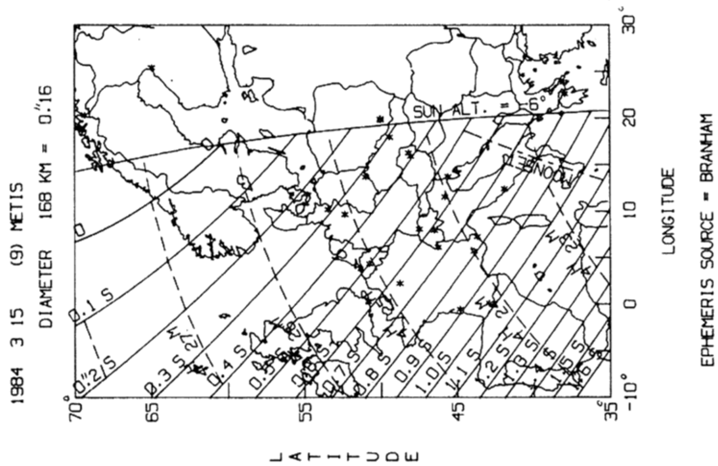
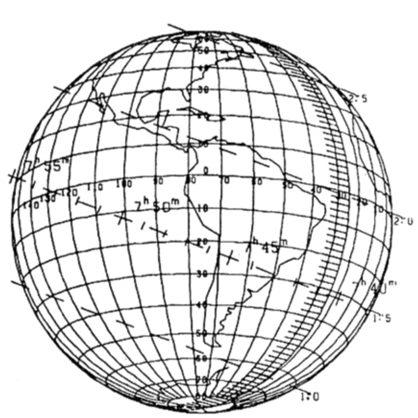
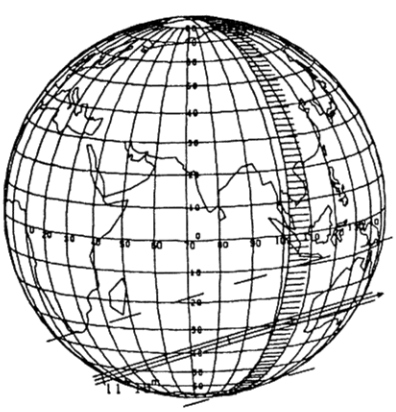




SAO 158913 by Saturn 1984 Mar 25



Anonymous by Juno 1984 Mar 26

SAO 163443 by Hygiea 1984 Mar 26