Occultation Newsletter

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FROM THE PUBLISHER

This is the first 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

Unfortunately, this issue is being prepared under considerable time pressure, as have been most of the issues during the past year, mainly in order to distribute charts and information about potentially favorable asteroidal occultations which will occur near the end of March. So again, I have not had time to prepare articles about grazes and double stars discovered during lunar occultations. The main part of my job with Computer Sciences Corp. involves a contract with NASA's Goddard Space Flight Center, to design propulsive maneuvers and trajectories for the 3rd International Sun-Earth Explorer satellite. We are planning a complex set of lunar swingby maneuvers to change the orbit drastically, eventually sending the spacecraft to Comet Giacobini-Zinner, as described on pages 135 and 136 of this February's issue of *Sky and Telescope*. The first lunar swingby will occur on March 30, and the last one in December, so this sometimes frantic work will occupy more of my time than usual during the remainder of this year. This will mean that I will have a little less time for IOTA work at a time when some very important occultations are occurring; some things which should be done simply won't be done, and some deadlines will not be met. I could use a little help, especially locally, to get some of the jobs done, such as the IOTA incorporation effort, which has come to a standstill lately.

I have not had time to process more of the Southern Astrographic Catalog data to create a data set needed to compute extended-coverage USNO total occultation predictions for the lunar eclipse of June 25. Since I do not want to (or have time to) distribute extended-coverage predictions twice during the year, I will not do so until either I have processed the additional S.A.C. data or until after the eclipse (when it will not make as much difference). At least, I should be able to do it in time for the waning-phase passages through the northern Milky Way starting in August.

The versatile push-button short-wave time signal receiver, Timekube, no longer is being manufactured, and Radio Shack is selling off its supply at reduced prices, as low as $17. I know of no comparable product which can be purchased for even triple the price; if you don't have one, now is the time to get one (or two or more, so that other observers could borrow or buy one from you). Even the CHU Timekubes are useful, since they include a button for WWV at 10 MHz.

The second printing of Robertson's Zodiacal Catalog, published as *Astronomical Papers prepared for use with the American Ephemeris and Nautical Almanac, vol. 10,* part B, has been out of print (no longer available from the Government Printing Office) for some time, and the USNO has too few copies left for distribution. Improved positions are available for most of the stars from the XZ and Perth 70 catalogs, so it might be useful to print a new catalog, anyway. IOTA probably could do this, if someone would volunteer to do the computer work to produce copy in some reduced format from data on magnetic tape. Another question concern accuracy; would most (or all?) who need positions to full accuracy be satisfied with the data on magnetic tape, so that positions could be printed only accurately enough to locate the stars on charts? IOTA already has a publication (and machine-readable data base) of the names of Z.C stars; perhaps a crossreference list also giving SAO, B.C., C.D., and Aitken numbers would be sufficient?

Thanks to the National Science Foundation, plans are progressing for observing the June 11th total solar eclipse from near the edges of the path in Java. Alan Fiala, USNO, will lead the effort to time the contacts and record Baily's beads from locations just inside the southern limit, while David Herald and I will lead the effort at the northern limit. If you will be in Java and might be interested in joining this effort to measure the solar radius, contact me.

If my time permits, I will try to produce material for a next issue of *O.N.* in May, but the eclipse trip noted above could delay it until July.

LETTER

To the Editor:

In reply to the editorial comment, and in regard to the elimination of errors in the Taylor method (see my article "Some Hints for Timing Occultations," *O. N. 3* (2), 34), I first would like to quote from Gordon E. Taylor's description of his method, published in N.A.O. Technical Note No. 29, January 1974, "The Visual Observation of Occultations":

"The accuracy of the observation (using the stop watch method – author) is enhanced if the observer listens to a number of seconds beats whilst visually examining the stop-watch dial. This enables him to determine the tenth or fifth of a second that the stop-watch is registering at each integral second. Having recorded the decimal of a second the observer stops the watch at the next convenient seconds beat. He may be a few tenths of a second late, but this will not matter as he has already correctly recorded the decimal part of the second."

According to the above, the Taylor method, practically, eliminates a *systematic error*, namely the delay, in relating the stop watch to the time signal. This is possible because the determination of the tenth or fifth of a second can be repeated several times, until the observer believes he has found the correct fraction of the second. However, an *uncertainty* of the estimate of the decimal second remains, as is the case with each estimate or measurement. In this way, the statement on errors remaining present in measurements with the Taylor method is correct. Due to the repeated reading of the watch, this uncertainty part probably will provide a smaller amount than is inherent in measurements with the stop watch when using methods other than Taylor's. For that reason, I prefer the use of the Taylor method in cases where I time occultations with the stop watch. I expect that the uncertainty in estimating the decimal part of a second with Taylor's method will not exceed $\pm 0^s1$ or so.

Dietmar Büttner

A SKY LIGHT STOP FOR CASSEGRAIN TELESCOPES

M. D. Overbeek

With the number of users of Cassegrain and Schmidt-Cassegrain telescopes increasing, it seems appropriate to address the frustrating problem they experience when observing faint objects against a bright background. Light by-passes the secondary mirror, flooding the observer's eye. No amount of baffling will eliminate such interference completely.

If the telescope is pointed at the bright sky or an illuminated wall, and the exit pupil is examined with a magnifier, the following will be seen: a bright circle a few millimeters across, is surrounded by a narrow dark ring, which is surrounded, in turn, by a large, bright area. The inner circle is the image of the primary mirror reflected by the secondary, the dark ring is the rim of the secondary, and the surrounding bright area is the image of the end of the telescope tube. It is this light which must be screened from the observer's eye by the use of a suitable diaphragm.

The diaphragm should have a smooth hole just smaller than the dark ring, and should be in the plane of the exit pupil. The size of the ring can be measured directly, or calculated by dividing the diameter of the primary mirror by the magnification of the telescope-eyepiece combination. The separation between the eye lens and the exit pupil is best determined by taping a soft wire to the outside of the eyepiece and manipulating the end of the wire until no parallax is discernible between it and the exit pupil when the magnifier is moved from side to side.

If it is properly made, the diaphragm will obstruct none of the light reaching the telescope from the object being studied, and under certain conditions, will extend the usefulness of the telescope by a magnitude or more. For more than a quarter of a century, I have used pupil diaphragms when observing occultations, and I can recommend their use to all serious users of Cassegrain telescopes.

[Ed: The pupil of the eye cannot be placed quite at the ideal location, the exit pupil of the system, if the diaphragm occupies that position. We would welcome a short note from someone who has solved that problem successfully with a transfer lens.]

MORE ON THE OCCULTATION OF 1 VULPECULAE BY PALLAS

David W. Dunham and Paul Maley

Some information about this important occultation was published in "Early Planning for the Occultation of 1 Vulpeculae by Pallas on 1983 May 29" in *O.N. 3* (1) 2. An important article about the event, including some material not published here, will appear in the May issue of *Sky and Telescope*. No meaningful improvement of the prediction, over the current prediction based on Sitarsky's orbit and Klemola's 1982 astrometry, is expected until 6 to 3 weeks before the event. Updates will be included on the usual Astroalert recorded phone message for asteroidal occultations, at 312,259-2376 in Chicago, IL. Starting on May 23rd, prediction updates also will be broadcast on WWV during the fourth minute of each hour.

Potential observers of the occultation are asked to contact regional coordinators. If they know those planning observations from home or other fixed-site locations, they can direct observers with portable equipment to other locations to give the best-possible coverage of the event. Regional coordinators may in turn specify local coordinators similarly to organize the coverage in smaller areas. Please contact your regional coordinator if yoy are willing to be a local coordinator. During the few days before the occultation, I will try to keep in touch with the regional coordinators to provide some overall coordination. The regional coordinators will collect observation reports for their respective regions, determine geographical coordinates, when necessary, and otherwise make sure that the reports are complete before sending them to me and/or to Gordon Taylor. As for other asteroidal occultations, the ILOC/IOTA lunar occultation report forms can be used, marked "Pallas" at the top, and with no copy sent to ILOC. The addresses of the regional coordinators listed below can be found in the 1982 November IOTA roster, so only names, cities, and phone numbers are given. Robert Millis, Lowell Observatory, Flagstaff, AZ, telephone 602,774-3358 or -7227 (home) will coordinate the efforts of all observers planning to record the occultation automatically, using, for example, photoelectric, television, or photographic equipment. The regional coordinators for visual observers are given below. If you live in, or plan to travel to, an area where the occultation by Pallas itself is likely to occur, please contact the regional coordinator for the area, giving your name, address, and telephone number, and specifying where you plan to observe. If you are mobile, or if you want additional information, you should send the coordinator a stamped, self-addressed envelope, so that he can send you a map, or other information, specifying where you might observe to fill in the overall coverage. First, these "southern" coordinators are listed here; they also will be listed in *Sky and Telescope*:

For FL, GA, and southern SC: Harold Povenmire, Indian Harbour Beach, FL, phone 305,777-1303.
For AL, AR, LA, MS, and TN: Benny Roberts, Jackson, MS, 601,373-6244.
For TX and OK: Paul Maley, 15807 Brookvilla, Houston, TX 77059, phone 713,488-6871 (Maley has a lot of information to distribute; please use 37¢ postage on your SASE).
For AZ and NM: Peter Manly, Tempe, AZ, 602,966-3920*
For southern CA: Richard Nolthenius, Los Angeles, CA, 213,392-9126 or 825-2925.*
For Mexico: Jose de la Herran, Apartado Postal 971, Mexico 1, D.F., Mexico, 905,550-5691. Backup phone numbers, for Paris Pismis, U.N.A.M., Inst. of Astronomy, Mexico City, are 905,548-5306 or -3538.
For Brazil: Jorge Polman, Recife, 0812,271864 or 270094.

For the more northern regions, coordination will not be attempted, and you do not need to contact the coordinators there, unless astrometry indicates a larger-than-expected north shift or unless the occultation path for the "speckle" satellite is specifically predicted to pass north of the nominal region for the main Pallas occultation. Hence, everyone should at least listen to the updates on WWV; if you are in one of the northern regions, and something is predicted to occur there, you should contact the regional coordinator, as described above. The "northern" coordinators, who will not be listed in *Sky and Telescope* (except for M. D. Overbeek), are:

South Africa: M. D. Overbeek, Edenvale, 11,53-5447.
Eastern Canada: David Brown, Montreal, Que., 514,481-4153.
Western Canada: Niel Lafra, Calgary, Alberta, 403,258-3151.
New England: Dennis DiCicco, 60 Victoria Rd., Sudbury, MA 01776, 617,443-8493.
NY: Thomas McFaul (New York City 212,397-9201) and Hopewell Junction 914,226-4587.
DC, DE, MD, NJ, eastern PA, and VA: David Dunham, Silver Spring, MD, 301,585-0989. After May 26, an alternate message center will be at 301,449-7170 (Margaret Taibi, Temple Hills, MD).
NC and northern SC: Robert Melvin, Fayetteville, NC, 919,588-4511.
IN, KY, MI, OH, western PA, and WV: Mark Allman, Columbus, OH, 614,863-2422 or 412,775-2304.
IL and WI: Berton Stevens, Rolling Meadows, IL, 312,398-0562.
IA, KS, MO, and eastern NB: Robert Sandy, Kansas City, MO, 816,763-4606.
MN, ND, and SD: Jim Fox, Afton, MN, 612,436-5843.
CO, WY, and western NB: Harold Reitsema, 4795 Hancock Dr., Boulder, CO 80303, 303,499-5496.
UT: Patrick Wiggins, Salt Lake City, 801,535-7316.
Northern CA and NV: James Van Nuland, San Jose, CA, 408,371-1307.*
ID, MT, OR, and WA: Richard Linkletter, Bremerton, WA, 206,479-1191. After May 26, Tom Webber, Auburn, WA, will serve as backup; 206,939-5904.

Nearly all previously reported secondary extinctions have occurred when the star was within an angular distance of ten diameters of the asteroid, where its gravitational domain is strongest. Hence, we recommend watching the star for 16 minutes centered on the time of closest approach. But be careful not to become too fatigued, which can cause disastrous delays in reacting to occultation events. Take a short break, if necessary, noting the start and end times of any such interruptions in observing. Be sure to watch the star closely from two minutes before to two minutes after the time of closest approach, when the occultation by Pallas will occur and when the possibility of secondary occultations is highest.

Most of the information in the remainder of this article supplements that published in the last two issues, or that which will appear in *Sky and Telescope*.

In 1980, Keith Hege and colleagues at the Steward and Sacramento Peak Observatories revealed that their analysis of speckle interferometric observations of Pallas indicated a possible satellite 175 km ±20 km in diameter and 750 km ±100 km from Pallas. The measured change in position angle was consistent with an orbit synchronized with Pallas' 7.88-hour rotation period. Such an object would be near the limit of detectability of last year's negative radar observations of Pallas using the Arecibo dish in Puerto Rico. Speckle observations of (433) Eros currently are being analyzed to see if the Pallas results could be explained alternately by an elongated shape rather than a satellite. Also, improvements are being made with the speckle recording systems which might speed up both the observations and their analyses. If these are successful, the position of the possible large satellite might be predicted for the time of the occultation of 1 Vulpeculae. If so, its occultation path may be predicted and included with the astrometric updates broadcast on WWV.

In addition to determining the detailed shape of Pallas and checking for possible satellites, we also want to determine the brightness and distance of 1 Vulpeculae's spectroscopic companion, and the diameter of the primary star. According to the 1982 *Yale Bright Star Catalog*, 1 Vulpeculae is a single-line spectroscopic binary with a period of 249.4 days, projected semi-major axis (for the visible star's orbit about the center of mass) of 28.7 million km, → →

* On May 28, the coordinators for AZ, CA, NV, NM, and UT will be at the Riverside ATM convention at Camp Oaks, CA. For last-minute coordination for these states, call Peter Manly or Steve Edberg at 714,585-9593.

and distance of 59 parsecs. Since lines for the companion are not seen in the spectra, it must be at least two magnitudes fainter than the primary, or mag. 7 or greater. The projected primary star's semimajor axis subtends about 0".003, which would be covered in half a second in case of a central occultation by Pallas. However, the true separation between the components is likely to be larger; since neither it, nor the position angle, nor the secondary star brightness are known currently, the nature of the step disappearances and reappearances can not be predicted. However, telescopic visual observers probably will see a step event at only one phase, since an event involving the companion will cause too small a drop in light to be noticed if the primary is visible. The secondary star probably will be visible to most telescopic observers while the primary is behind Pallas. If one of the secondary events is timed as well as both phases of the primary's occultation, you will provide three data points to define the outline of Pallas, not just two.

The estimated diameter of the primary star is 0".0003, which will be covered in 0.05 seconds in case of a central occultation. Geometry will increase this to an easily noticeable 0.2 seconds for an observer 17 km inside the edges of the occultation path, and longer for anyone located even closer to the edges. Fresnel diffraction of the star's light will prolong the gradual nature of both immersion and emersion significantly, so that visual observers at even the center of the path probably will notice that the events are not instantaneous. Visual observers can make comparisons with 1 Sagittae to estimate variations in 1 Vulpeculae's light due to these various causes.

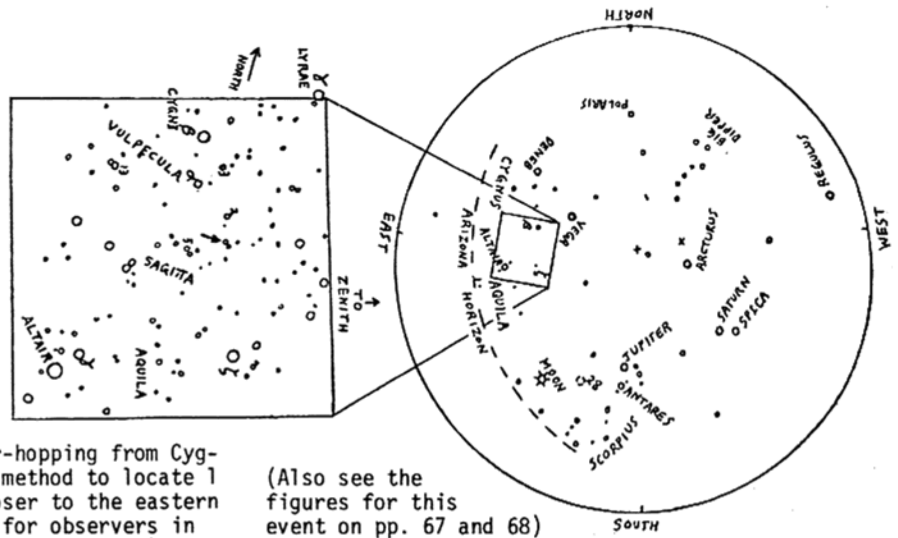
The Universal Times of events during this occultation should be determined accurately enough so that points around the limb of Pallas can be specified on the sky plane to an accuracy of 1% or less of Pallas' diameter, or 5 km. In the case of a central occultation, this requires a timing accuracy of half a second. This may seem simple to achieve, but to do it reliably requires considerable care. We need to stress quality as well as quantity. The results of an occultation of a 9th-mag. star by the asteroid (88) Thisbe recently was reported in the *Astronomical Journal*. Twelve chords were recorded during this 1981 October event by 3 photoelectric observers and 9 visual observers, 6 of whom had little or no previous occultation timing experience. Comparison with the accurate photoelectric timings showed that the average reaction time of the visual observers was 1.1 second, much larger than their estimates. This probably was caused by an unconscious delay in recognizing that an event actually had occurred, which is a problem for relatively marginal events such as this one where a quarter moon was nearby and the star was faint. Comparison of about 200 simultaneous photoelectric and visual lunar occultations observed in Japan has shown that reaction times for faint stars often exceed 1 second, similar to the experience with Thisbe. This should be less of a problem with a bright star like 1 Vulpeculae. Although the Japanese never achieved reaction times less than 0.30 second, their reactions for bright stars were nearly all less than 0.6 second.

Photographing 1 Vulpeculae provides a relatively easy way to obtain a permanent record of the star's light variations during the observing period, although somewhat better time resolution is possible with visual observation. A break in a star trail on an unguided photograph started and stopped at precise times can result in occultation times to about 0.3-second accuracy (1 Vulpeculae moves about 5" in this time due to earth rotation) and can detect events of slightly shorter duration, provided the focal length is at least about 800 mm. Many astrophotographers already are equipped to make such ob servations, which are easier than some photographs, since guiding is not needed and not wanted. If the field of view of your lens is less than 3.8°, you will not be able to record over the entire 16-minute period desired, and would need to repoint and take more exposures. Be sure that one is centered on the critical few minutes surrounding the time of closest approach. Useful tests of pointing and exposure can be made a month and a week before May 28, when moonlight conditions will be similar to those for the occultation; artificial occultations of various lengths can be simulated by moving a piece of cardboard in front of the lens.

Jay Anderson notes that weather prospects are generally good for most of the path in late May, with only a minimal possibility of a large weather system with extensive cloudiness. Although the eastern portions of the track in North America are more humid than the western parts, the local time of the event is later at night in the east, giving convective thunderstorms which form in the afternoon more time to dissipate. Overall, the weather prospects are slightly worse in eastern Texas and are best in the desert regions of northwestern Mexico.

If the path shifts substantially south, observers living in, or willing to travel to, the Virgin Islands, Puerto Rico, the Dominican Republic, Cuba, Brazil, and especially Mexico will be crucial for providing adequate coverage of the event. Hundreds of amateur and professional astronomers traveled from the U.S.A. to Mexico for the total solar eclipse in 1970, with no problems, and Dunham crossed the border several times to successfully observe lunar grazing occultations and an annular eclipse during the 1970's. On May 28th, observers will not have to travel as far into Mexico as they did for the 1970 total eclipse. Those traveling more than about 20 miles south of the border need a temporary tourist permit, obtainable with proof of citizenship (voter registration or birth certificate is adequate) and automobile registration. Minors not accompanied by parents also need a notarized letter signed by a parent or guardian giving permission to travel in Mexico. Mexican auto insurance for one day can be purchased from numerous establishments just north of the border, and is highly recommended. Equipment should be registered with U.S. customs before crossing the border. Mexico has similar forms which may or may not be obtainable from a local Mexican consulate, where the tourist permit also can be obtained in advance. Without these, you may be delayed an hour or two at the border (expect some delay in any case, since Memorial Day weekend traffic probably will be heavy). If telescopes and other equipment are packed in suitcases, you will appear to be more like a normal tourist, and will be less likely to be questioned by the Mexican authorities about unregistered scientific equipment.

The circle chart shows the view of the whole sky at the time of the occultation for an observer in Florida; the appearance will be similar for others in eastern North America. The circle represents the horizon, with the cardinal directions indicated; the zenith is marked with a "+" at the center. The 94% sunlit Moon, Jupiter, Saturn, all 1st and 2nd-magnitude stars, and some 3rd-magnitude stars in strategic constellations are shown. This should help even those with little or no previous knowledge of the constellations to zero in on the region of interest in the Summer Triangle, marked by Vega, Deneb, and Altair. Tests with inexperienced observers show that star-hopping from Cygnus seems to be the most reliable method to locate 1 Vulpeculae. This area will be closer to the eastern horizon, shown by the dashed arc, for observers in Arizona (and in Mexico and the Rocky Mountains). The Arizona zenith is marked with an "x" between Arcturus and the Big Dipper. The eastern horizon and zenith for observers in the central time zone will be midway between those for Florida and Arizona. In California, the Summer Triangle will be even lower, with Altair and the Moon just rising.



(Also see the figures for this event on pp. 67 and 68)

The rectangular area, about 20° on a side, is blown up to show all stars to about 6th magnitude, including three stars named on the circle chart: Altair, Beta Cygni (Albireo, the famous double star), and Zeta Aquilae. The stars shown should be easily visible with binoculars and small finder scopes. The arrow near the center marks the target star, 1 Vulpeculae. Some other stars with Flamsteed numbers in Vulpecula are numbered on the chart. Another star, 1 Sagittae, lies only a third of a degree above and to the right (southeast) of 1 Vulpeculae, and is about a magnitude fainter.

All potential observers should practice finding the star some night before the occultation, preferably while a bright moon is present. The small broken circle marked "28" shows the moon's position 24 hours before the occultation. During the night of May 26-27th, the moon will be full, and close to Jupiter. Some weekend before Memorial Day weekend, a small "star party" might be held for training observers to locate the star quickly.

PRELIMINARY REPORT OF OCCULTATIONS OBSERVED DURING THE 1982 DECEMBER 30TH TOTAL LUNAR ECLIPSE

David W. Dunham

Thomas W. Langhans, San Bruno, CA, timed 65 occultations during last December 30th's exceptionally dark eclipse, the largest number of timings reported to me by one observer so far. His observations will be particularly useful since 50 of the timings were of reappearances! Langhans used a 36-cm Schmidt-Cass.

Also in the San Francisco Bay area, Rick Baldridge obtained the second largest number of timings, 55, using a 16-inch Dobsonian loaned by the Peninsula Astronomical Society and set up at Monte Sereno in the Santa Cruz Mountains. Judy Sato provided valuable assistance by keeping track of the next occultation and writing down timings from the electronic stopwatch used by Rick. He reported that both disappearance and reappearance of 6.8-mag. Z.C. 1014, the brightest star occulted in North America during this eclipse, were gradual, lasting about a quarter of a second. Some other observers also remarked about slow events for this star. He noted that, with a little more planning and practice, they could have made perhaps twice as many timings. In nearby San Jose, Jim Van Nuland timed 19 occultations using an 8-inch Newtonian.

Farther east, the moon was lower, but Benny Roberts was able to time 52 occultations at Jackson, Mississippi. Gerry Samolyk reported 92 timings of 47 occultation events by 6 observers at the Milwaukee Astronomical Society Observatory; Gary Wedemayer timed 39 of the occultations. At Scaggsville, Maryland, Craig Patterson was able to time twenty occultations using a six-inch Newtonian before low altitude prevented accurate timing at mid-totality. Even farther east, Philip Dombrowski timed 5 occultations with a 10-inch Newtonian at Glastonbury, Connecticut.

Grazes of the 10th-magnitude star C3747 were observed at both the northern and southern limits, to try to obtain an improved value for the polar diameter of the moon. Paul Maley, Houston, TX, traveled to Kailua on the island of Hawaii, where he timed 10 occultation events during the southern graze. William Albrecht got 6 additional timings near Pahoa on the east side of the island.

Dick Linkletter, Joe Palmer, Ted Roscoe, Dave Becker, Tom Webber, and Jere Felten traveled from the Seattle area to North Powder, Oregon, to observe both the northern graze of C3747 and a southern graze of a 7.6-mag. star. Although the sky was clear, wind and zero-degree temperatures made observing quite difficult. Tape recorders were kept under jackets to keep them functioning, but this and the wind muffled the recorded voices so that they were virtually unintelligible. It is not yet clear how much data will be salvaged from this valiant effort.

Oscar de las Alas, of the Manila Weather Bureau, was the most successful graze observer during this eclipse. Observing with a 3-inch refractor at Bulacan, Philippines, he timed 11 events during the southern-limit graze of 8.2-mag. SAO 78665. Don Stockbauer traveled northeast from Houston to Timpson, TX, where he timed the graze of SAO 78519, as well as several total occultations (13 altogether). Paul Newman observed the same graze from his home in Garland, TX.

Graham Blow, director of the Occultation Section of the Astronomical Society of New Zealand, estimates that 150 occultation timings will be reported from that country, mostly from the northern part. He made one of these, recording an occultation of a 7th-mag. star photoelectrically during a break in the clouds at Mt. John Observatory on the South Island. Gordon Herdman, Auckland, was the most successful observer there, timing 48 occultations with a 20-cm Schmidt-Cass. He was able to see occultations of stars not included in my predictions, which were complete through 12th magnitude.

Others who have reported useful occultation timings include Michael Crist, Burns, TN, – 9 timings; Phillip Steffey, Santa Monica, CA, – 7; Robert Hays, Worth, IL, – 9; Richard Nolthenius, Yosemite Valley, CA, – 5; Michael Morrow, Ewa Beach, HI, – 10; Carroll Evans, Jr., Inyokern, CA, – 9; Robert Lyons, Everett, WA, – 8; and Paul Teicher, Farmingdale, NY, – 3.

In late December, my wife and I were visiting my parents in southern California. We had assembled an image-intensifier unit for our low-light-level video camera, and had reserved time on the University of Arizona's 40-inch reflector at Mt. Lemmon, as well as on the University of California's 30-inch at Lafayette, east of San Francisco. When we had to decide where to go, at noon on the 29th, the weather forecast for eclipse time was bleak, especially along the California coast. So we opted for Arizona. Although the clouds thinned encouragingly in the evening, this trend stopped at midnight. When totality began, snow started to fall, and we got no data. This was very disappointing, especially when we found out that a high-pressure area had moved into California more quickly than predicted, producing clear skies throughout most of the state for the eclipse. Image-intensified video recording of occultations during an unusually dark eclipse could provide valuable accurate data on the entire lunar profile which would be especially useful for analyzing total solar eclipse contact timings to determine variations of the solar radius. Unfortunately, this was not accomplished on December 30th, and as far as I know, Graham Blow got the only photoelectric timing (just one) during this eclipse. All of the major observatories in the southwestern U.S.A. where photoelectric observations were planned, including McDonald, Kitt Peak, Lowell, and Table Mountain Observatories, were clouded out. Unfortunately, the total lunar eclipses during the next decade will not occur in rich Milky Way fields like the 1982 eclipses, few of them are visible from North America, and the eclipsed moon will not be dark enough to see occultations of 12th-mag. stars unless we are lucky enough to have another major volcanic eruption at the right time and latitude.

ALL ABOUT UPPING YOUR ECLIPSE OCCULTATION TALLY

Don M. Stockbauer

I made a special effort to time total and grazing occultations during the July 6th and December 30th eclipses. What I experienced may be of value to those attempting observations during eclipses in the future.

I think that a tape recorder should be used to record observations. Since the events come fast and furious, stopping to read a stopwatch or write down an eye-and-ear timing can result in missing events. Also, the recorder is excellent for rapidly noting personal equations, accuracies, and any special comments such as slow events or steps. Of course, use fresh batteries and wear it under your coat if it is cold. Periodically throughout the eclipse, make sure the recorder is still working (reels turning), and use the longest tape available to minimize the number of times you must change it; a 120-minute cassette would cover practically the whole eclipse, requiring only flipping the cassette after 60 minutes. An alarm could be set to remind you to flip the cassette.

An assistant, even one with no astronomical knowledge, is extremely useful. The problem is this: constant referral to the predictions means missing observations while looking away from the telescope. If an assistant is available, the data on the next event can be obtained without ever looking away from the telescope, and the data does not have to be committed to memory. I see no way around this problem if you observe alone; if you know of a way, let me know. [Ed: Two suggestions: the first is covered by the article immediately following this one; the second is to use two tape recorders, one to record timings, the other to play back a pre-recorded tape carrying timely announcements of the same information you would expect from an assistant (If you use WWV or CHU, inter alia, to guide you in making your pre-recorded tape, listen to the signals by earphone, to avoid having false time references appear on your timing tape.). However, neither suggestion can replace the valued ability of an assistant to delete those upcoming events which are beyond current observability limits.] An assistant is also nice to have along to ensure that the time signal is strong, to ward off the curious, etc. I believe that with an assistant I could have doubled or tripled my number of timings.

Since being flexible and receiving weather forecasts until the last possible moment helps to ensure clear skies at the observing location, many times you must observe from a location for which you have no exact predictions. Applying A and B factors with a calculator is a long, tedious process, and there might not be enough time. One solution for those with access to computers would be to obtain detailed USNO predictions for several sites in the potential observing areas, enter the coordinates, times, and A and B factors for the sites beforehand on files and apply the factors with a program when a definite site is chosen. If a calculator must be used, and time is running short, you may not have time to apply the factors to your entire prediction set. Apply the factors to as many events as you have time for, giving priority to reappearances and higher observability codes [Ed: especially where large factors are involved]. Say, apply the factors to all events of observability code 4 or greater, which will produce from about 20 to 50 events, depending on the richness of the star field. Then fill in any long gaps with events of code 3 or less for as many events as time will permit. A programmable calculator speeds up the process and reduces the chance of error.

If you are attempting a graze during the eclipse, don't get so wrapped up in doing totals that you don't give yourself enough time to identify the star. Since during totality, very faint stars can be seen near the moon, several may be near the graze star. It probably is best to locate it by the position angle for an equatorially mounted scope or the vertex angle for an altazimuth mount.

I found that the best way to locate the point of a total reappearance was through the position angle. To try to use the star field pattern requires a very low power eyepiece which does not let you see stars as faint as with a medium power eyepiece. Also, referring to charts and studying star patterns is time-consuming, and will result in fewer observations. The position angle is quick and direct, and your assistant can read it to you immediately. A reticle eyepiece would be best to use (see *O.N. 1* (4), 34). Even without one, I was able to locate the point of reappearance fairly accurately by slewing in right ascension and declination and establishing the orientation of the moon in the eyepiece. For altazimuth scopes, all this applies, except vertex angle is used instead of position angle.

During the December 30th eclipse, I found that it can get uncomfortably cold, even in Texas, especially after three solid hours. I discovered that polyester socks might look nice, but leave a lot to be desired as thermal insulators. Also, I had the strange experience of having a hair drier fog up further a corrector plate with only a little moisture accumulated. It took about 5 minutes of holding the heat on it to clear it. In the meantime, 4 bright stars reappeared.

I think we should have more notes from other observers about their ideas for gleaning more occultation timings during an eclipse. With the U.S.A. going through a lunar eclipse drought, we need to make every one count.

A 'TIME CAPSULE' FOR OCCULTATION OBSERVERS

Mark Gingrich

A new calculator accessory has made occultation timing a little easier. Called the Hewlett-Packard 82182A Time Module, the approximately 3-cm-square by 1-cm plastic capsule plugs into an HP-41C programmable calculator, adding a stopwatch, clock, alarm, and calendar to the machine's repertoire.

The merging of clock features with the calculator's memory and programming capability inspires a legion of astronomical applications — some of interest to occultation observers.

For example, take the problem of timing several events within a short interval. By executing the "SW" command, the calculator's keyboard and display are transformed to function as a stopwatch. A timing is saved automatically in its own storage register whenever the "ENTER↑" key is depressed. In this way, up to 63 timings can be stowed within a bare-bones HP-41C, each to 0.01-second resolution; additional memory permits more than 300, enough to keep up with the action when star clusters are occulted during a lunar eclipse.

Often, absent-minded observers — myself included — lose track of the time and miss an occultation; the alarm feature is a practical remedy. At the start of the evening's observing run, alarms can be set to go off (the calculator politely beeps) a few minutes before each occultation. Or, if you prefer, the calculator, by fiat of a simple program, will beep at you, convert the keyboard and display to stopwatch mode, load the stopwatch with the current Universal Time (maintained by the Time Module's clock), and start the stopwatch. The observer simply steps up to the eyepiece and pushes the "ENTER↑" key to record the event. Aside from the convenience, this maneuver obviates the need to synchronise the stopwatch repeatedly with time signals, thus lessening any additional uncertainty in the timing.

A novel feature is the Time Module's calibration procedure: fine tuning of the crystal time base is performed via the calculator keyboard. A number — the so-called "accuracy factor" — is keyed in and stored; as a result, the clock rate is adjusted by as much as ±0.1 percent. An occasional check against time signals will attest to the clock's exactness; otherwise a refined accuracy factor is inserted. After more than six months of use and some initial crystal aging, my Time Module exhibits a clock error of less than two seconds per month.

One drawback, from an astronomical standpoint, is the limited range of the clock-rate adjustment. A speed-up of about 0.3 percent — three times the maximum allowed correction — would have enabled the clock to run at sidereal rate. Indeed, the HP-41C would have made an accurate, portable sidereal clock. This wish can be fulfilled, however, with a straightforward calculator program. By retrieving the time and date from the Time Module, and armed with the observer's geographic longitude, the local sidereal time can be computed in only a few seconds. A simple program loop could update the time every second or so — the calculator, in effect, mimicking a sidereal clock.

Meteor watchers also will want to take the HP-41C/Time Module into the field, particularly to assist during hourly meteor counts. A simple program routine — only a few lines suffice — can tally each meteor espied with the press of a button. When the hour expires, the calculator automatically stores the count and starts anew. This leaves the observer free to concentrate on the sky, not on bookkeeping.

Undoubtedly, amateurs will dream up other applications, but prospective users might wonder how much this newfangled contrivance costs. The Time Module's list price is $75, although, by itself, it is as useful as photographic film without a camera. The Time Module was designed specifically for the HP-41C (or HP-41CV); retrofits are not possible with other Hewlett-Packard models. Hence, for the complete system, the cost escalates to well over $200, and those who desire the stopwatch features exclusively surely will find this prohibitive. On the other hand, amateurs who relish the flexibility of a handheld computer mated with a precision timepiece won't regard the price as too extravagant. The product, after all, is unique. It can spare us a few of the mundane tasks we occasionally goof up in the shivering hours before dawn. In more ways than one, it is a time-saver.

OBSERVATIONS OF ASTEROIDAL AND COMETARY OCCULTATIONS

David W. Dunham

Three of the 1982 November asteroidal occultations were successfully observed, with several chords determined for two of them. R. Millis *et al.* determined the diameter of (88) Thisbe to be 232 ±12 km from analysis of 12 observations of the occultation of 9th-mag. SAO 187124 on 1981 October 7, as reported in *Astronomical Journal 88* (2) 229. Three of the observations were photoelectric and showed that the average reaction time of the visual observers was 1.1 second. Consequently, only the durations reported by the observers could be used, but even so, these were crucial for obtaining a sufficient distribution across the occultation path for a meaningful diameter determination. Details are given in the article, reprints of which can be requested from Millis at Lowell Observatory, Flagstaff, AZ 86002.

Comet 1980b (Bowell) and 15th-mag. star, 1982 September 30: Brian Marsden reports in *I.A.U. Circular* (IAUC) 3751 that W. Combes, J. Lecacheux, B. Sicardy, Y. Zeau, T. Encrenaz, and L. Vapillon, Observatoire de Meudon; and D. Malaise, Institut d'Astrophysique, Liege, report photoelectric observations of a close (10,000 to 20,000 km of nucleus) approach of Comet Bowell to a 15th-magnitude star using the 1-m reflector at Pic du Midi, France. At closest approach, half or more of the star's light was absorbed. However, the next night, the same astronomers reported less than 0.25 absorption of the light of a 14th-mag. star when the nucleus of Comet 1981f (P/Churyumov-Gerasimenko) passed within 2000 km of their line of sight to the star. The appulses had not been predicted; the observers simply monitored stars in the apparent paths of the comets during the two nights to see what would happen.

(690) Wratislavia and B.D. +24° 522, November 14: A moderate north shift based upon Lick Observatory astrometry in late August, when Wratislavia passed close to the star, was predicted on p. 6 of *O.N. 3* (1). Extensive plans were made to observe the occultation from the northern U.S.A. until more Lick Observatory astrometry on November 9 showed a much larger shift, 1".49 north ±0".2. Similar to the experience for (481) Emita on October 7, discussed in *O.N. 3* (1) 5, this showed that astrometry obtained when an asteroid passes close to the target star a few months before the occultation is not nearly as accurate as we had hoped. During such a long time, the R.A. and Dec. differences of the asteroid from its predicted ephemeris seem to change as the distance to the asteroid changes. For Emita, the differences were nearly inversely proportional to the distance, but for Wratislavia, the differences grew considerably more than in simple inverse proportion. The behavior undoubtedly depends on the unknown errors of the orbital elements; problems like this seem to be less frequent with the better-observed lower-numbered minor planets. Fortunately, the occultation by Wratislavia was observed, by Andrew Lowe at Ardrossan and Douglas Hube at the Devon Astrophysical Observatory, both near Edmonton, Alberta, at 1".36 N on the map in *O.N. 2* (16), 232. The timings were reported on IAUC No. 3747. Hube noted that his immersion time was inaccurate and uncertain; also, since the two stations were separated by only 13 km relative to (690)'s motion, an accurate diameter can not be determined. However, the good agreement with the emersion timings implies a fairly central event, with Lowe's 156-km chord length being only a little shorter than (690)'s TRIAD diameter of 175 km.

(375) Ursula and SAO 55791, November 15: Klemola's Lick Observatory astrometry on November 9 indicated a path at 0".71 N ±0".06, passing from Oregon to Texas on the map in *O.N. 3* (1), 19, and also passing near Manila in the Philippines. During the two nights before the occultation, plates were taken with the long focal length U.S. Naval Observatory 61-inch astrometric reflector at Flagstaff, AZ, and reduced using numerous faint secondary reference stars whose positions had been determined in the system of the AGK3R from the large-field Lick plate taken on the 9th. The resulting prediction, computed by Lowell Observatory astronomers, was at 0".64 N, with a scatter of only a few hundredths of an arc second, in virtually exact agreement with my "AGK3" predicted path, but about a radius south of Klemola's path. Observers in Oregon, Utah, and Texas were alerted so that both the Lick and USNO predictions would be covered. Due to the favorable astrometric and weather prediction, and the fact that some flights from Washington, DC, to Salt Lake City, UT, are relatively inexpensive (less than to Texas), I made plans to join Kimball Hansen, of Brigham Yound University, Provo, UT, to observe the occultation visually from central Utah. Although I saw the occultation, from a location about 3 km west of Fillmore, UT, I was dismayed to learn after the event that my tape recorder had failed to record the event. Due to sub-freezing temperatures, I kept the recorder under my jacket, hung from a loop of twine around my neck, with the microphone dangling out from the front of the jacket. Since WWV reception was poor, I kept the Timekube receiver on my lap, and tried to keep it and the microphone in a good position for recording the faint signals with one hand while I observed. Unfortunately, a couple of minutes before the occultation, I accidentally bumped the switch on the microphone to the "off" position. I recommend taking some action to avoid your having the same mishap. I would suggest taping the switch on your microphone in the "on" position, except that there is a cogent reason for not doing so: cold-weather control of the "off-on" condition of the tape recorder should be via the remote control switch (located on the microphone), whose position can be monitored easily, by the tactile sense, at any time before, during, and after the recording period. The switches on the body of the tape recorder, which can not be monitored after your jacket has been zipped up, are the ones which should be taped in the "record" position. It is easy to lose occultation timings by bumping into something, changing the positions of those inaccessible switches. Also, the microphone should not only be plugged into the tape recorder, but the plug should be taped in place so that it can not be pulled out accidentally. The plug may be left taped permanently, if desired, but the tape recorder should not be stored with the body switches in any of the "on" positions unless the batteries are removed. The only practical solution is to feel the remote control switch at frequent

enough intervals, to insure that it has not been turned off inadvertently. As it turned out, the occultation was nearly central at my location, which was nearly in line with a successful observer in Texas, so any timings I might have made would have been largely redundant. Kimball Hansen was hampered by thickening cirrus clouds at Oak City, about 40 km north of my location, but apparently was able to time the star's disappearance. Paul Maley organized a chain of 14 observers from just west of Beaumont to well west of Houston, TX, to bracket the southern part of the possible occultation zone. Most of them were defeated by clouds, but Maley, Tom Williams, and Al Kelly successfully timed the occultation, as reported in IAUC 3751 (which, however, does not give the heights above sea level, which were all less than 12 m). John West also timed the occultation at Bryan, TX. All of the Texan observations were nearly central, spanning about 80 km, most with chord lengths a little greater than the 200-km TRIAD diameter. Observers in Dallas and Ft. Worth covered the northern part of Klemola's uncertainty zone, but all had no occultation. John Cotton, Dallas, planned to drive south to Hillsborough, TX, where he might have had a short occultation. However, he stopped about 20 km farther north, due to a shortage of time, and saw a miss, the closest one on the north side. Astronomers from Lowell Observatory set up three 14-inch Schmidt-Cass telescopes with photometers in southeastern Utah, and recorded the occultation at two of their sites. Analysis of all the observations should give a fairly good diameter of Ursula's outline, although no short chords near the limits were observed. The USNO-Flagstaff astrometry, utilizing Lick reference stars, was extremely accurate, apparently to within 0".01! This combination was similarly accurate for last September's occultation by (19) Fortuna (see *O.N. 3* (1) 5) and for the 1981 March occultation by (48) Doris reported in *O.N. 2* (15) 201. If we had known that the astrometry would be so accurate, we would have concentrated the efforts by mobile visual observers near the limits, where they could have timed short chords to define Ursula's outline more accurately. We will keep this in mind for future events; this occultation taught us some valuable astrometric and observational lessons.

(375) Ursula and SAO 55766, November 17: Klemola also measured the Lick Observatory plates of Nov. 9 to update this prediction. My calculation gave a path of 0".81 N ±0".04, crossing Queensland. I telephoned the prediction to David Herald, but unfortunately he could not locate any observers within the predicted path.

(93) Minerva and SAO 76017A, November 22: Penhallow's preliminary astrometry for this event was given in *O.N. 3* (1) 6. Predominantly cloudy skies foiled most astrometric attempts for this occultation, the brightest star to be occulted by an asteroid in the U.S.A. since 1978 June, during the week preceding the event. Three exposures were obtained at Lick Observatory on the 16th during a short break in the clouds, the result for the path being 1".45 S ±0".2. Based upon experience with Lick astrometry for other recent occultations, I biased the prediction 0".1 farther south. Unfortunately, the scatter in the Lick results was unusually large, giving a total prediction uncertainty of about four diameters. Attempts to improve the prediction with further astrometry, involving only one or two exposures not permitting any useful statistical analysis, were made at Agassiz Station, Harvard, MA, and at Blue Mesa Observatory, NM, but these did not help, having scatter even greater than the Lick result. Unfortunately, clouds and a broken computer needed for automatic plate measurement prevented astrometry at USNO-Flagstaff. So, we tried to cover the entire uncertainty range, with observers in TX and OK covering the southern half and those in AZ covering the northern half. A massive storm system covered the eastern U.S.A. However, Wayne Osborn managed to record the occultation photoelectrically at Mt. Pleasant, MI, obtaining the northernmost chord. I tried to contact several possible observers, with the help of regional coordinators, in areas where clear skies were forecast, but this was not very successful in the middle of a weekend when I also was planning to record the event with video equipment. I arranged to use Carl Schweer's 14-inch Schmidt-Cass. near Ardmore, OK. Bad weather in Atlanta delayed my connecting flight by over two hours, so that I arrived at Schweer's observatory only 10 minutes before the occultation, insufficient for finding the star and setting up the equipment. It did not matter, since the actual path was in the northern part of the uncertainty zone, far north of us, at about 1".35 S on the maps in *O.N. 2* (16), 232 and 233. Peter Manly organized observers around Phoenix, AZ; he successfully timed the occultation, as did Gerald Rattley, Gary Fillingham, and Scott Stiers. George Balazs saw a miss from a site north of Phoenix, limiting the event on the north side, while a miss also was recorded at the University of Arizona's Mt. Lemmon Observatory, bracketing the occultation to the south. The three Lowell Observatory photoelectric teams successfully recorded the occultation at sites near Phoenix, Florence, and Picacho, AZ. The occultation path also crossed part of southwestern Europe. The event was recorded with video equipment at Pic du Midi Observatory by French astronomers, as reported on IAUC 3746. The southernmost chord currently known was timed by Carlos Schnabel at Barcelona, Spain. The longest chord, timed by Peter Manly, was 168 km long, in good agreement with Minerva's TRIAD diameter of 170 km. The observed chords span about 110 km, so it should be possible to determine a reasonably good diameter from the timings. Further results from this occultation, as well as from the November 15th occultation by (375) Ursula, will be reported in future issues. There have been no reports of secondary occultations.

(14) Irene and SAO 93544, 1982 December 13: Astrometry by Penhallow on December 8 gave a path at 1".1 S ±0".1, crossing Lima, Peru, and passing near Brasilia, Brazil. I sent telegrams to the Peruvian Astronomical Association in Lima and to Jorge Polman in Recife, to relay to possible Brazilian observers.

(59) Elpis and SAO 118599, 1983 January 19: Astrometry by Penhallow gave a time correction of 12 min. early and a path shift of 1".6 S ±0".2, putting it in the southeastern Pacific. The astrometry agreed better with the EMP 1979 orbit than with the Herget orbit used for the predictions. If the shift for Elpis was the same on Feb. 21, the path of the occultation on that date may have crossed Japan or China.

(52) Europa and A.C. +18° 8^h 8^m 92, January 19: Klemola's astrometry for this event showed that the EMP 1982 ephemeris for Europa was better than the

Herget ephemeris, and that the star was located about halfway between the A.C. and Lowell positions. Overall, this gave a path off the earth's surface, similar to the A.C. path shown on p. 38 of the last issue.

(106) Dione and SAO 80228, January 19: Penhallow's astrometry for this event indicated a path 0".71 S ±0".12, crossing Spain and Italy on the map cn p. 39 of the last issue. I telephoned this result to the Royal Greenwich Observatory and to Hans Bode in Germany. However, Eberhard Riedl, at Kiel, German Federal Republic, timed a 7.5-second occultation starting at U.T.C. $18^h\ 59^m\ 43^s.5 \pm 0^s.5$. He used a 9-inch reflector at longitude 10° 07' 49".4 E., latitude +54° 19' 46".2, height 41 m. He was located at a shift of about 0".1 S, near the AGK3 path, which also crossed southern England. I have heard that some observations also may have been made in Denmark. Klemola measured improved positions for the AGK3 stars used for Penhallow's plate solutions, but these agreed reasonably well with the AGK3 data. Subsequent tests led Penhallow to conclude that a poor model for magnitude equation caused his astrometric error, so he plans to not consider magnitude equation for future plates.

(19) Fortuna and AGK3 +11° 201, February 3: A 6.72-second occultation was observed visually by J. Pinson with a 21-cm telescope at the Club Antares Observatory at La Seyne sur Mer, France, starting at U.T.C. $18^h\ 24^m\ 33^s$. This was consistent with a 5.3-second occultation recorded photoelectrically at CERGA's Calern laser ranging station nearby, as reported on IAUC 3776. A secondary drop in the photoelectric record about a minute after the occultation had a very slow recovery, probably indicating an instrumental origin.

(52) Europa and A.C. +20° $7^h\ 52^m$ 82, February 8: Joe Churms telephoned me his measurements of plates he took with the Astrographic Catalog camera at Cape Observatory, South Africa, on February 7. I predicted a 1".7 S ±0".2 shift, putting the path over Cape Province, which I phoned to M. D. Overbeek. Apparently, adverse weather prevented observation of the occultation.

(346) Hermentaria and SAO 99839, 1983 February 23: Penhallow's astrometry indicated a path shift of 1".40 S ±0".10, placing it over a remote section of Brazil and the south Atlantic.

MORE PLANETARY OCCULTATIONS DURING 1983

Andrew Lowe and David W. Dunham

Lowe has manually compared the SAO catalog with asteroid ephemerides generated with Keplerian formulae using the precision osculating orbital elements published in the Leningrad Ephemerides of Minor Planets for 1983, similar to the calculations he performed to find additional asteroidal occultations during 1982 published in *O.N.* 2 (15) 198. Since planetary perturbations were neglected, accurate calculations by Dunham showed that, in about a third of the cases, the occultation shadow was predicted to miss the earth's surface far enough so that there was

1983 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	Ephemeris Source
Feb 21	$10^h 47^m$	Armor	14.9	3.50	93351	8.7	G0	$3^h 11^m.4$	18°09'	6.2	5^s	18	51	New Guinea	79°	21°	58+	all	EMP 1982
Feb 22	19 32	Athor	13.4	2.49	186445	7.9	B9	18 08.8	-29 35	5.5	3	9	36	Japan	61	174	73+	none	EMP 1981
Feb 23	1 19-33	Hermentaria	11.7	2.08	99839	8.7	G5	11 50.1	14 30	3.1	8	23	30	S.Africa,CaribbeanSea;se.USA?n	158	78	75+	w 5°E	EMP 1983
Feb 26	2 45	Athor	13.4	2.45	186632	9.4	A2	18 15.8	-29 44	4.0	3	9	36	South Africa	63	134	78+	w 27°E	EMP 1981
Mar 28	6 01	Phyllis	12.6	1.47	157659	9.2	M0	12 59.0	-15 43	3.4	7	23	29	Labrador Sea; ne U.S.A.?s	164	25	99+	all	EMP 1982
Apr 2	19 45-52	Pluto	13.7	28.98		12.0		14 09.3	5 36	1.9	133	47	56	(Austrlia,Asia,Afrca,Europe)?n	156	48	74-	e 45°E	USNOC162
Apr 4	7 20-28	Pluto	13.7	28.97		10.0		14 09.2	5 37	3.7	132	47	28	(Atlantic Ocean, Americas)?s	157	65	60-	e 90°W	USNOC162
Apr 29	11 44	Peitho	12.8	1.84	184174	9.2	K2	16 06.5	-22 29	3.6	10	25	25	Miss; (w. Canada, w. U.S.A.)?s	154	3	95-	all	EMP 1982
Jun 28	4 12-43	Arachne	13.1	1.95	182991	9.3	G5	14 52.1	-25 02	3.8	21	55	27	Patagonia, western U.S.A.	132	78	93-	e115°W	EMP 1982
Jul 2	19 26	Leto	11.2	2.20	109852	9.3	F5	1 21.0	1 38	2.1	5	12	25	Indonesia	81	17	57-	all	HERGET78
Jul 12	7 45	Bruchsalia	12.1	1.43	147550	9.1	K7	0 56.3	-11 07	3.1	6	14	21	Patagonia	100	126	5+	none	EMP 1981
Aug 9	6 23	Vibilia	12.7	2.31	183812	8.6	K0	15 45.5	-20 15	4.1	16	36	25	Miss; western U.S.A.?s	103	97	0+	none	HERGET77
Aug 15	23 57	Dodona	13.8	2.71	158244	8.5	K2	13 53.7	-18 59	5.3	4	11	37	Peru, Brazil	71	26	55+	all	EMP 1982
Sep 2	15 55	Lacrimosa	14.3	3.10	78100	8.7	K0	6 09.4	24 56	5.6	4	12	43	New Zealand (low)	67	5	26-	all	HERGET78
Sep 4	21 32-39	Ulla	13.6	2.41	129717	6.6	G5	2 06.0	-6 55	7.0	11	30	31	w. Siberia, w. China, e. India	132	104	7-	e 80°E	EMP 1982
Sep 9	4 04-12	Kalypso	12.3	1.65	146920	9.5	G5	23 46.2	-5 42	2.9	10	22	22	e.Canada, centralUSA, nwMexico	170	161	6+	none	HERGET79
Sep 22	21 21-29	Lilaea	14.2	2.80	94752	8.8	A	5 37.9	17 10	5.4	9	27	39	Somalia,sIndia,seAsia,PhilipIs	94	78	99-	all	EMP 1981
Sep 30	5 27-35	Bredichina	13.9	2.51	213064	8.3	F5	21 28.4	-31 59	5.6	26	79	35	Miss; eastern U.S.A.?s	126	145	45-	e105°W	EMP 1982
Oct 10	7 34-42	Eukrate	11.0	1.31	38894	8.9	A0	3 27.1	47 23	2.3	11	17	13	Brazil, north Atlantic Ocean	128	151	18+	none	EMP 1982
Oct 10	11 27	Sapientia	13.5	2.24	94339	9.1	A5	5 05.1	16 55	4.4	40	110	30	New Zealand?s	119	170	19+	none	EMP 1981
Oct 14	13 16	Faina	13.4	2.47	210234	7.9	B9	18 26.7	-33 32	5.4	5	13	32	New Zealand?n (low)	76	23	57+	all	EMP 1982
Oct 30	16 31	Athor	12.7	1.81	189672	8.9	K0	20 43.4	-25 29	3.8	5	13	26	Indonesia (low)	90	160	33-	none	EMP 1981
Nov 5	5 40	Lanzia	13.9	2.91	117317	8.9	K0	8 56.4	5 23	5.0	6	17	36	eastern U.S.A., Canary Islands	87	91	0+	none	EMP 1982
Nov 20	5 24-31	Byblis	14.4	2.85	78120	9.1	A0	6 11.0	21 27	5.3	9	29	41	Scandinavia, n.Canada,n.Alaska	144	39	100+	all	EMP 1982
Dec 14	23 30-45	Lacrimosa	12.9	1.90	78799	9.3	K0	6 48.1	25 38	3.7	10	25	26	central Africa, Brazil	161	82	73+	w 30°E	HERGET78
Dec 16	14 58	Ara	13.4	2.72	113068	8.6	F5	5 40.3	7 19	4.8	9	19	26	New Zealand; Australia?n	164	46	86+	w169°E	HERGET78

little hope for an actual occultation (even a secondary one) visible from a region inhabited by potential observers. These rejected events generally occurred early in 1983, far from the osculation epoch in September. The searches were restricted to minor planets with diameters greater than 100 km given in Dunham's list described on p.

← Table 1 ↓ Table 2

1983 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.
Feb 21	774	Armor	100	0.04	443		0.193	79°	93351	+17° 515	C	0.15	370	18	1.0	XA	N18° 245	0".25	0m.1	3h13m.3	18°17'
Feb 22	161	Athor	100	0.06	283	CMEU	0.464	96	186445	-2914632		0.14	257	7	0.8	X				18 10.9	-29 35
Feb 23	346	Hermentaria	102	0.07	401	S	0.198	305	99839	+15 2388		0.23	352	28	1.2	SA	N14 1244	-0.47	0.4	11 51.8	14 18
Feb 26	161	Athor	100	0.06	283	CMEU	0.460	95	186632	-2914797		0.07	126	4	0.4	X				18 17.9	-29 43
Mar 28	556	Phyllis	73	0.07	197		0.230	289	157659	-15 3579		0.67	719	70	3.0	S				13 00.7	15 54
Apr 2		Pluto	3000	0.14	*****		0.026	297								H				14 11.0	5 27
Apr 4		Pluto	3000	0.14	*****		0.026	296		+06 2851						H				14 10.8	5 28
Apr 29	118	Peitho	108	0.08	402		0.193	268	184174	-2211380		0.30	405	38	1.5	X				16 08.5	-22 34
Jun 28	407	Arachne	104	0.07	374	C	0.084	337	182991	-2411740		0.18	251	50	0.9	S				14 54.0	-25 10
Jul 2	68	Leto	128	0.08	424	S	0.358	69	109852	+01 255		0.09	149	6	0.5	XA	N 1 155	0.11	-0.1	1 22.7	1 49
Jul 12	455	Bruchsalia	101	0.10	248	C	0.389	84	147550	-11 181		0.53	553	33	2.3	S				0 58.0	-10 56
Aug 9	144	Vibilia	132	0.08	532	C	0.120	112	183812	-19 4221		0.33	547	66	1.8	PX		0.47	-0.2	15 47.4	-20 21
Aug 15	382	Dodona	106	0.05	361	EMP	0.353	105	158244	-18 3702		0.41	806	28	2.5	PS		-0.49	1.5	13 55.5	-19 09
Sep 2	208	Lacrimosa	105	0.05	397	U	0.299	89	78100	+24 1159		0.38	848	30	2.4	XA	N24 635	0.35	0.7	6 11.5	24 56
Sep 4	909	Ulla	113	0.06	491	C	0.138	183	129717	-07 366		0.63	1095	109	3.6	YG		0.60	2.7	2 07.7	-6 45
Sep 9	53	Kalypso	110	0.09	393	C	0.229	238	146920	-06 6296		0.16	196	17	0.8	X				23 47.9	-5 31
Sep 22	213	Lilaea	105	0.05	421	CMEU	0.143	95	94752	+17 977		0.06	132	11	0.4	XA	N17 515	-0.03	0.5	5 39.8	17 11
Sep 30	786	Bredichina	103	0.06	432		0.052	314	213064	-3216614		0.22	403	101	1.3	S				21 30.4	-31 50
Oct 10	247	Eukrate	143	0.15	458	C	0.340	345	38894	+47 845		0.05	48	4	0.2	SA	N47 379	0.40	-2.0	3 29.5	47 30
Oct 10	275	Sapientia	107	0.07	409	C	0.040	126	94339	+16 700		0.07	107	40	0.4	XA	N16 436	0.01	-3.1	5 07.0	16 58
Oct 14	751	Faina	113	0.06	376	C	0.320	88	210234	-3313269		0.03	46	2	0.1	YG		-1.06	-1.8	18 28.9	-33 31
Oct 30	161	Athor	100	0.08	267	CMEU	0.377	61	189672	-2515021		0.27	360	17	1.4	S				20 45.4	-25 22
Nov 5	683	Lanzia	118	0.06	498		0.227	134	117317	+05 2088		0.35	745	37	2.2	SA	N 5 1329	-0.37	-1/1	8 58.1	5 15
Nov 20	199	Byblis	101	0.05	484		0.134	287	78120	+21 1159	U	0.05	101	9	0.3	XA	N21 638	-0.04	-0.0	6 13.0	21 26
Dec 14	208	Lacrimosa	105	0.08	395	U	0.192	277	78799	+25 1462		0.56	767	70	2.8	XA	N25 765	0.51	-0.2	6 50.2	25 35
Dec 16	849	Ara	151	0.08	878	C	0.207	255	113068	+07 984		0.13	260	15	0.8	SA	N 7 642	0.15	-0.6	5 42.2	7 19

24 of the last issue which might not have been included in Gordon Taylor's or the Lowell Observatory searches which formed the basis for the list of 1983 events published in *O.N.* 3 (1) 9. The two possible occultations were not found by us, but rather by Dennis DiCicco, Sky Publishing Corporation.

Information about the events is given in the two tables in the same format as those in the main list of 1983 events in *O.N.* 3 (1) 9. By the time this issue of *O.N.* is distributed, the occultations in February will have occurred. Preprints of this article, and finder charts, have been distributed to IOTA coordinators in the possible areas of visibility. Regional maps and finder charts for upcoming events will be distributed, or published here, as appropriate. You can receive local circumstances for these additional appulses by sending a self-addressed stamped (for those in the U.S.A.) envelope to Joseph Carroll, 4216 Queen's Way, Minnetonka, MN 55343; see *O.N.* 3 (1) 17 and (2) 37.

Wayne Warren provided Yale Catalog data used for the prediction of the occultations by (909) Ulla on September 4 and by (751) Faina on October 14. When possible, the predictions here have been computed using ephemerides generated from orbital elements published by Paul Herget in the *Minor Planet Circulars*. For these minor planets, shifts for predictions using other sources are listed in Table 3. Predictions for all of the asteroidal events have been computed using Leningrad (I.T.A.) elements, usually taken from the E.M.P. for 1982.

Table 3.

Ephemeris Differences for 1983

Date	MP#	Shift	Δt	EPHEM SOURCE
Jul 2	68	0".14S	0m.9	EMP 1982
Aug 9	144	0.01S	0.5	EMP 1980
Sep 2	208	0.78N	2.1	EMP 1982
Oct 10	247	3.68N	-0.4	HERGET78
Dec 14	208	0.87N	-5.8	EMP 1982
Dec 16	849	0.06N	-0.3	EMP 1982

New orbital elements given in the 1983 E.M.P. have been used for the occultation by (346) Hermentaria on Feb. 23. The ephemeris for Pluto published in *U.S. Naval Observatory Circular* No. 162 has been used for our calculations.

Lowe's street address given in the November, 1982, roster is incomplete; it is 4944 Dalton Drive, Apt. 75, N.W.

Notes about individual events

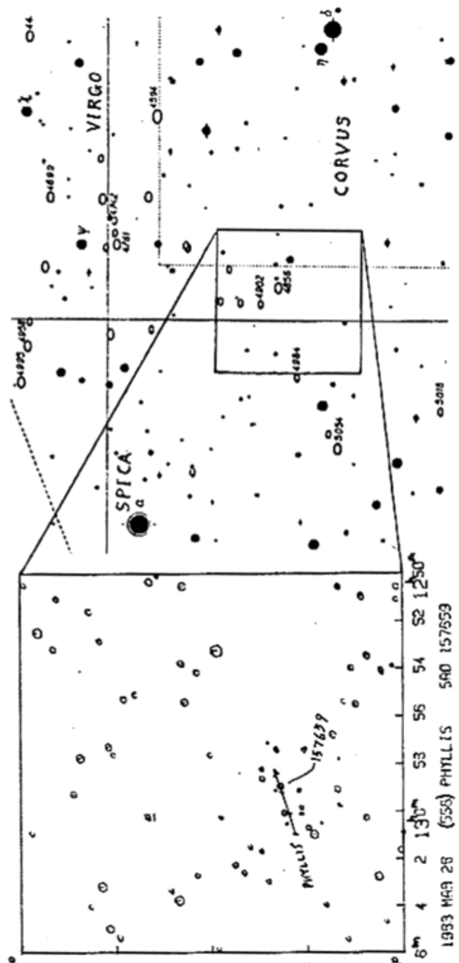
Feb. 21: SAO 93351 is Couteau double star #359, with equally bright components separated by 0".15 in p.a. 170° at discovery. Since then, these parameters probably have changed due to orbital motion. Since the separation probably will be greater than the angular diameter of Armor, observers should not expect complete disappearances of the star, but only one or two dimmings by 0.7 mag. as the components are occulted individually.

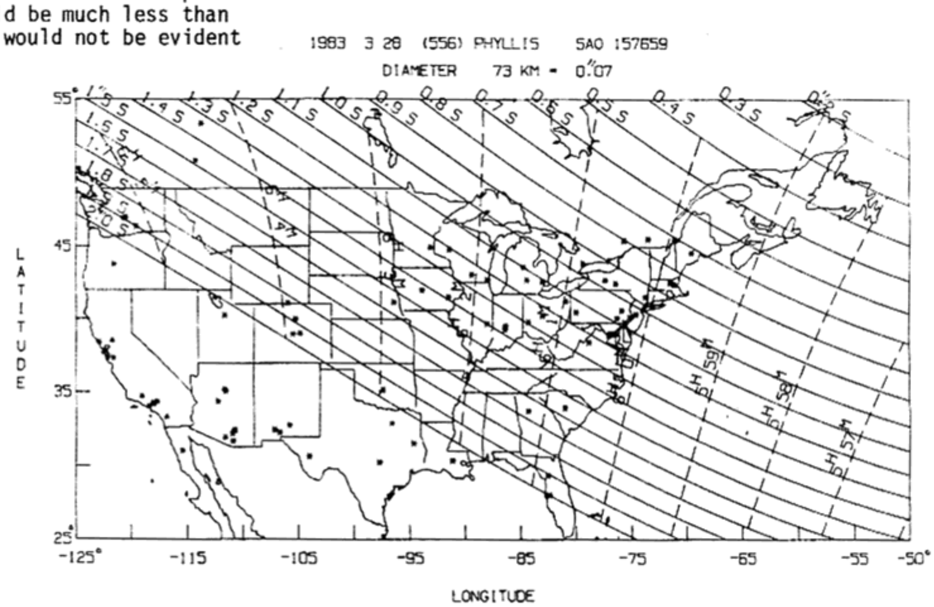
Mar 28: Lowe assumed a diameter of 146 km for (556) Phyllis, an incorrect value which he obtained from the list on p. 25 of the last issue. That value is wrong due to a transcription error. Phyllis' diameter is unknown, but judging from its brightness, it is not likely to be greater than 73 km, the value used for the calculations here.

Apr. 2: The star is in the Toulouse Astrographic Catalog, zone +6°, plate 14h 8m, no. 97. It is marked "A" on the detailed A.C.-based finder chart on p. 57. Pluto is predicted to pass 2."4 south of the star (geocentric), so there probably will not be an occultation.

Apr. 4: This star is also in the Toulouse Astrographic Catalog, zone +6°, plate 14h 8m, no. 94; the A.C. mag. is 10.5. It is marked "B" on the A.C.-based finder chart on p. 57. Robert Millis, Lowell Observatory, identified the star in the B.D. catalog, which gives 9.5 for its magnitude. Pluto is predicted to pass 0."6 north of the star (geocentric). Millis reports that recent astrometry by Klemola indicates that Pluto will pass 0."4 north of the star (geocentric), in which case, the occultation shadow would pass a short distance above the North Pole, but the uncertainties are large enough that an occultation is possible for North America (in which case, it would be a very important event). Unfortunately, other pressing commitments did not allow Dunham to prepare a regional map for this event in time to be included in this issue. Accurate astrometry a week or so before the occultation should enable a reasonable path prediction. An occultation by Charon is not likely, since it will be north of Pluto.

Nov. 20: The star is the eclipsing variable FT Orionis. The component magnitudes are 9.7 and 9.9. Since the expected separation of 0."0002 is approximately the separation of the Fresnel diffraction fringes, only good photoelectric records, with time resolution of 4 milliseconds or less, will be likely to detect the duplicity. If the occultation occurs near the time of an eclipse (which should be predictable), the separation could be much less than 0."0002, so that the duplicity would not be evident even photoelectrically.

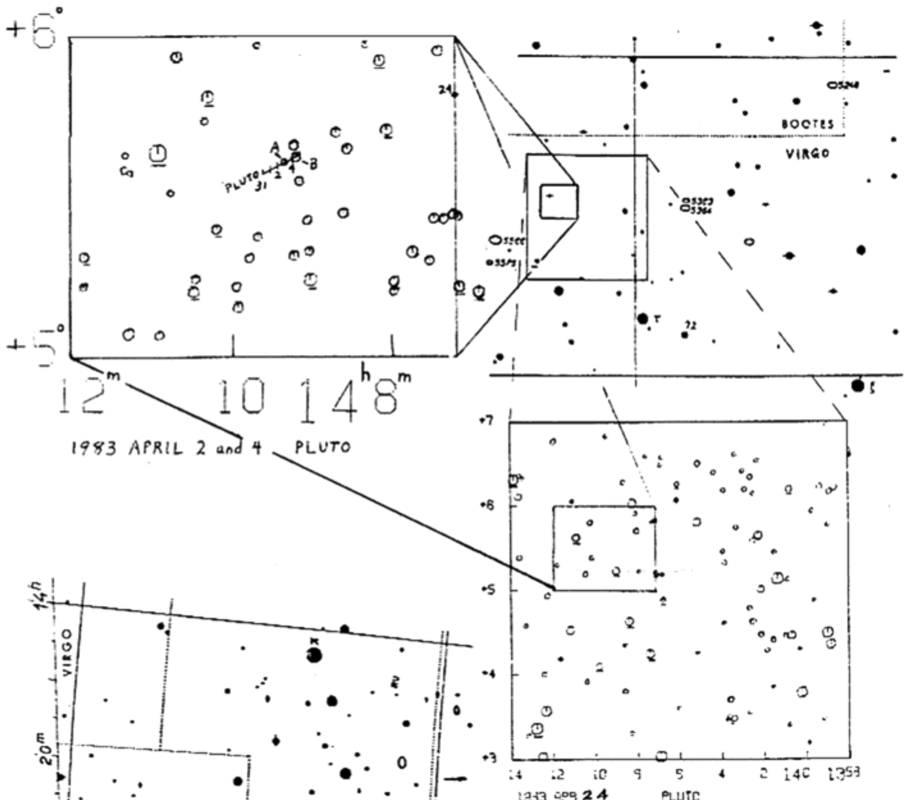


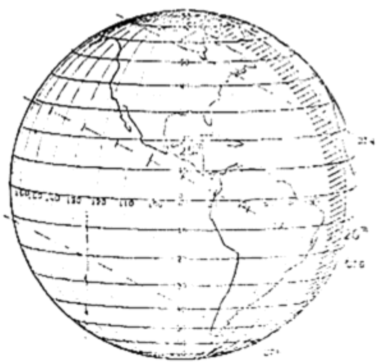


SAO 157659 by Phyllis 1983 Mar 28

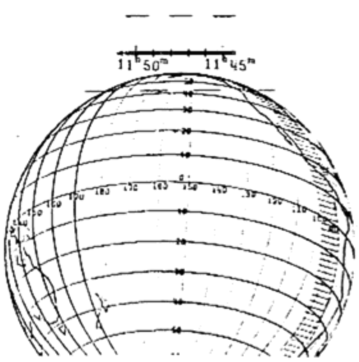
EPHEMERIS SOURCE = EMP 1982

Anonymous by Pluto 1983 Apr 2

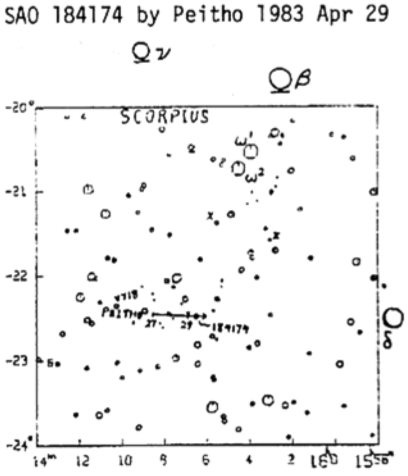


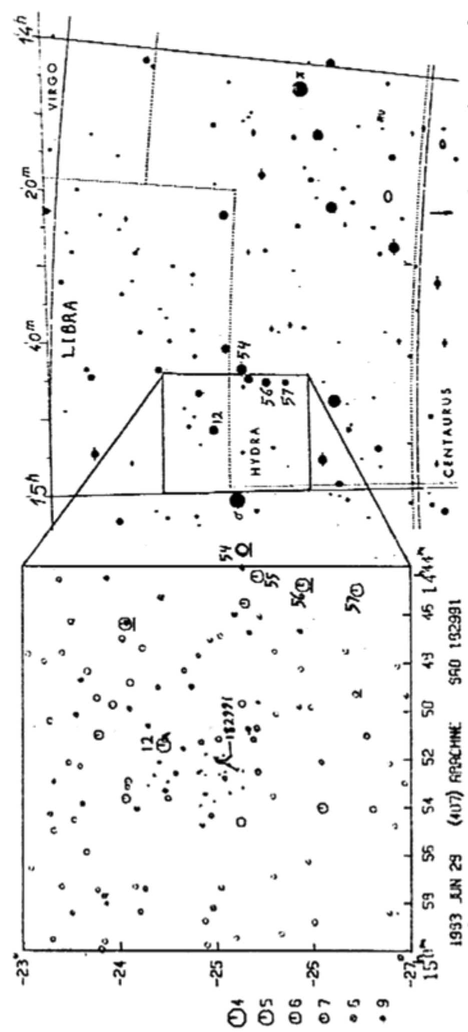


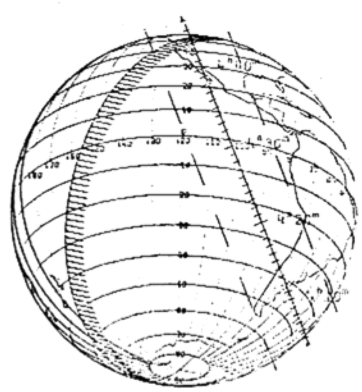
+06° 2851 by Pluto 1983 Apr 4



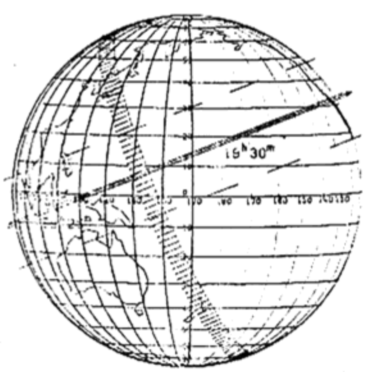
SAO 184174 by Peitho 1983 Apr 29



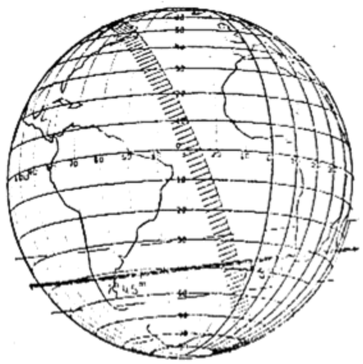




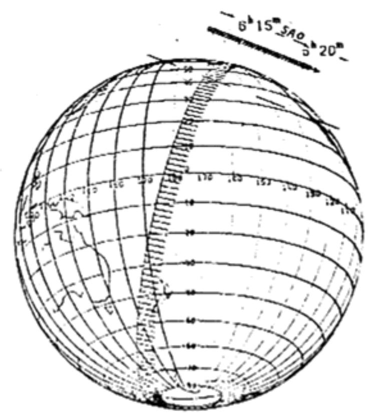
SAO 182991 by Arachne 1983 Jun 28



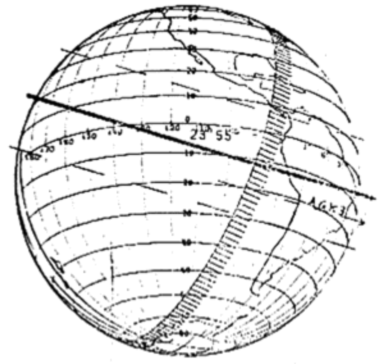
SAO 109852 by Leto 1983 Jul 2



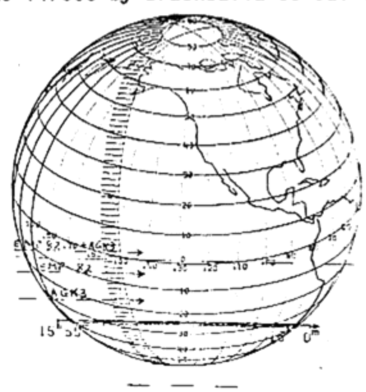
SAO 147550 by Bruchsalia 83 Jul 12



SAO 183812 by Vibilia 1983 Aug 9



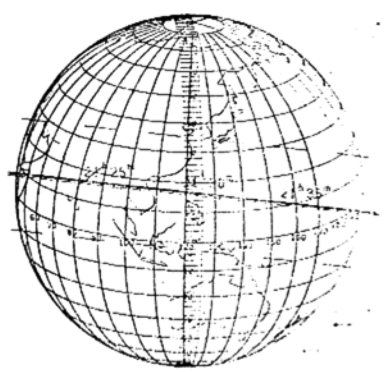
SAO 158244 by Dodona 1983 Aug 15



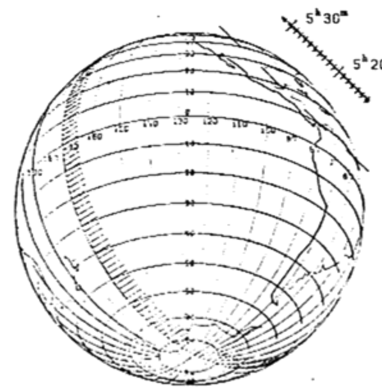
SAO 78100 by Lacrimosa 1983 Sep 2

SAO 129717 by Ulla 1983 Sep 4

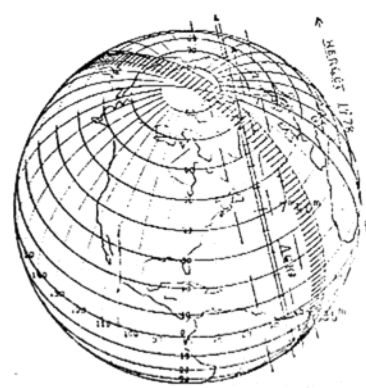
SAO 146920 by Kalypso 1983 Sep 9



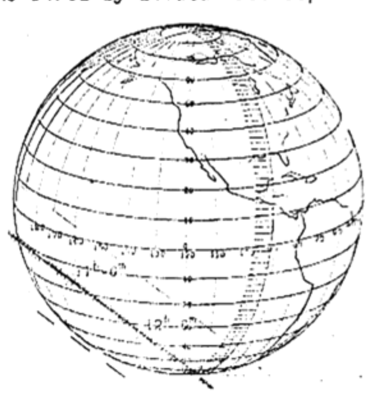
SAO 94752 by Lilaea 1983 Sep 12



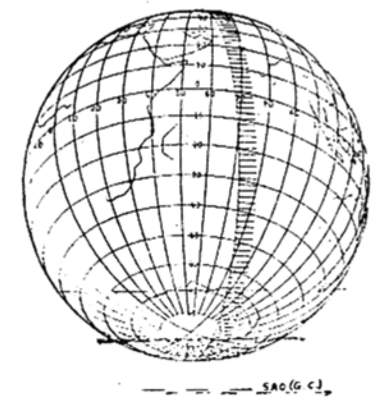
SAO 213064 by Bredichina 83 Sep 30



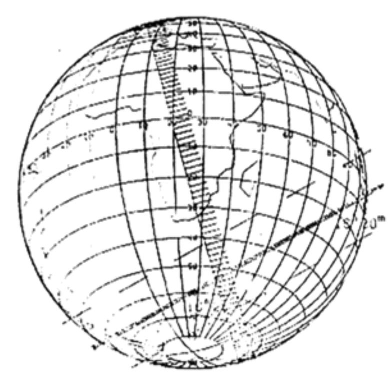
SAO 38894 by Eukrate 1983 Oct 10



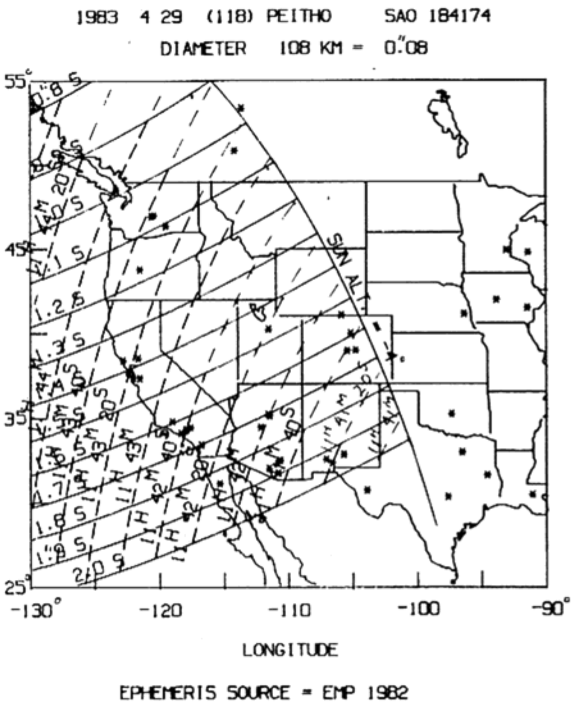
SAO 94339 by Sapientia 1983 Oct 10



SAO 210234 by Faina 1983 Oct 14



SAO 189672 by Athor 1983 Oct 30



ON DIGITAL QUARTZ WRISTWATCHES AS TIME SOURCES

Don M. Stockbauer

I recently bought a digital quartz LCD wristwatch to replace my old analog model, for about $35. I compared it against WWV and was quite surprised at its uniformity and accuracy. In the course of one month it uniformly lost exactly one second. I believe that it probably could be adjusted to even higher accuracy, but the important point is that the drift is very slow and very uniform. I believe that such a watch should be a part of every graze observer's equipment because it would be a good time source in case of complete loss of shortwave time signals. [Ed: For a tuning-fork-controlled timing device, see "Digital Electronic Timer," by T. H. Campbell, Jr., *o.N. 1* (7) 61. For other quartz-controlled devices, see "The Danish Time-Cube," by N. P. Wieth-Knudsen, *o.N. 1* (8) 79, and "Auditory Electronic Occultation Timer," by C. J. Bader, *o.N. 1* (10) 100. For earlier report of use of digital watch for occultation work, see "The Lacombe Graze," by F. J. Howell and F. Loehde, *o.N. 1* (8) 78.]

First, determine the uniformity of your watch against WWV. If it has a uniform, linear drift, or almost no drift, over a period of a week or so, it is good enough for this method. Record its drift in seconds per day.

The basic method is outlined in "Some Comments on Reading-out Graze Tapes," by R. R. Bailey, *o.N. 1* (8) 75. Bailey suggests that a graze observer still can obtain data if he cannot receive time signals. The observer goes to a neighboring station, records several minutes of time signals on his tape, leaves the tape running, and returns to his station and observes the graze. Then he returns to the other station and records several more minutes of time signals. All this applies using a wristwatch, except that the observer reads the time from the watch onto the tape instead of going to a neighboring station. You also could have an assistant read the time onto the tape continuously throughout the graze. Be sure that you read out the time exactly in synchrony with the wristwatch. I think about five minutes of readings from the watch before and after the graze should give a good idea of the uniformity of the recording, but if you can do more it would be even better. You need to avoid a very long observing period combined with only short periods of reading from the watch. A cassette that has 30 minutes or more per side would be best for this method. While Bailey suggests a least squares fit be performed to reduce the data, I feel that an adequate method would be to play the tape back and compare it to an accurate stopwatch. If the tape drifts uniformly with respect to the stopwatch, the results can be trusted. To determine the quality of the recording, measure the duration of the tape with the stopwatch. For example, if the tape is from $5^h\ 00^m$ to $5^h\ 15^m$, and the stopwatch measures this duration as $15^m\ 15^s$, then 60^s of tape time equals 61^s of stopwatch time. Starting the tape at $5^h\ 00^m$ and the stopwatch at the same time, $5^h\ 01^m$ on the tape should read $1^m\ 01^s$ on the stopwatch, $5^h\ 02^m$ will read $2^m\ 02^s$, etc. If the graze was from $5^h\ 05^m$ to $5^h\ 10^m$, then $5^h\ 10^m$ on the tape should read $10^m\ 10^s$ on the stopwatch, etc. To obtain absolute times, calculate the ratio of the duration of an interval on the tape to the duration of the same interval as measured by the stopwatch. For the above example, it is $15^m\ 00^s$ divided by $15^m\ 15^s$, or 0.9836. Start the stopwatch at the first whole minute of the tape and make sure the two are drifting uniformly up until the graze begins. Read the times of the graze events from the stopwatch, and when the graze ends and your wristwatch times again are being announced, make sure the tape has drifted by the expected amount and continues to do so. Using the example above, if I start the tape at $5^h\ 00^m$ and the stopwatch at the same time, and I call an event at $7^m\ 12^s.3$ by the stopwatch, the true time is $5^h\ 00^m + 0.9836 \times 7^m\ 12^s.3 = 5^h\ 07^m\ 05^s.2$. If the drift shows random irregularities, the results cannot be trusted. However, I have reduced about one hundred tapes since 1974, and have never encountered a tape that did not drift evenly. Fresh batteries are a must, and keeping the recorder warm under your coat in cold weather is a must also. An external microphone ensures a good recording under a thick coat. It would be a good idea to replace the wristwatch battery frequently. It would not pay to have it die during the graze! It is best not to use any of the special functions of a multi-function watch while you need the stable time base. Accidentally pressing a wrong combination can result in losing the time base.

A final correction must be applied to convert the wristwatch time to UT. As close to the graze as is feasible, synchronize the watch with WWV and record the time and date. Soon after you get back from the graze, see how much the watch has drifted. If it is negligible, use the wristwatch time as UT. If it has drifted, calculate a correction factor to convert the wristwatch time to UT. If

A = the amount of time from synchronizing the wristwatch with WWV until the graze,

B = the amount of time from synchronizing the wristwatch with WWV until rechecking against WWV, and

C = the number of seconds of drift (wristwatch fast = negative, wristwatch slow = positive),

then the factor is $A \times C \div B$, which is added algebraically to the times as determined before (pay attention to the signs). C/B gives the drift rate, which should match the results of your initial checkout of the watch. For example, if A = 1.0 day, B = 2.0 days, and C = -1.0 second (wristwatch ahead 1.0 second when rechecked), the correction factor is

$$\frac{1\overset{d}{.}0 \times -1\overset{s}{.}0}{2\overset{d}{.}0} = -0\overset{s}{.}5$$

which, when added to the previously determined time of $5^h\,07^m\,05\overset{s}{.}2$, gives $5^h\,07^m\,04\overset{s}{.}7$.

This method would work for any field time source as long as its uniformity and accuracy could be trusted. Continued checks of my quartz wristwatch have convinced me that it is more than adequate under any conditions, even large temperature variations.

PLANETARY OCCULTATION PREDICTIONS FOR 1983

This is a continuation of the earlier articles bearing on this subject (see *o.N. 3* (1) 9 and *o.N. 3* (2) 25 and 37). The tables list the occultations of uncatalogued stars found at Lowell Observatory which were not included on p. 26 of the last issue (which included events only through the end of March). The article by Millis, Franz, Wasserman, and Bowell listing these events, "Occultations of Stars by Solar System Objects. III. A Photographic Search for Occultations of Faint Stars by Selected Asteroids," was published recently in *Astronomical Journal 88* (2) 236.

Notes about Individual Events (continued)

Apr. 24: The position of the faint star to be occulted by Pluto on this date is marked "24" at the edge of the A.C.-based finder chart on p. 57.

Apr. 26: The A.C. path crosses Mexico, as shown on the regional chart for this event in this issue. If the shift for this event is similar to those indicated by astrometry for the occultations by Europa on Jan. 19 and Feb. 8, the path probably will be $0\overset{''}{.}9$ S $\pm 0\overset{''}{.}4$, crossing the western and south-central U.S.A. The other rectangles drawn on the *Atlas Coeli* inset for the A.C.-based finder chart for this event are for occultations in February and on March 19 shown in detail on p. 41 of the last issue.

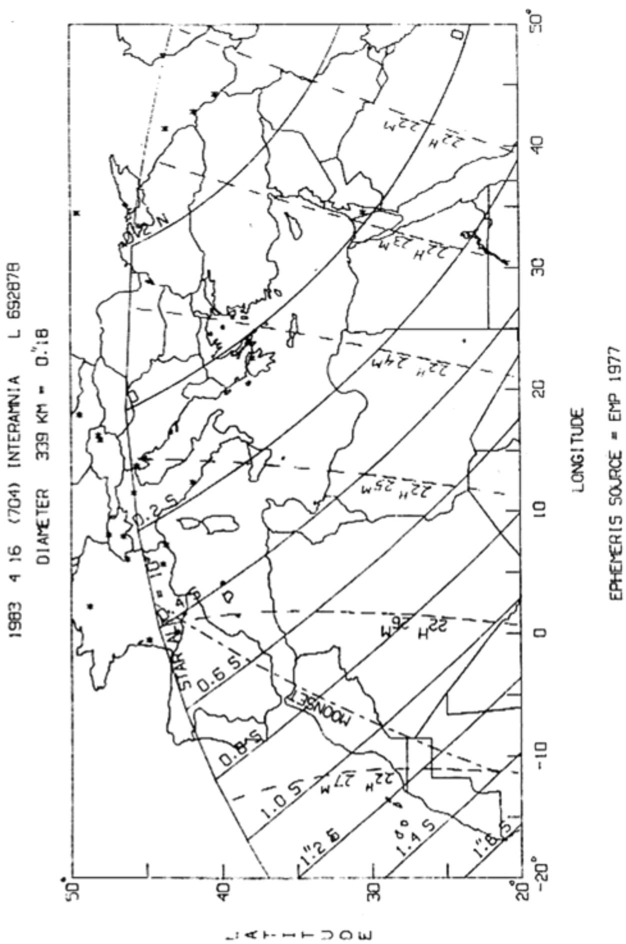
Aug. 1, (511) Davida: The star is in the USNO C-catalog, number C14047, where its magnitude is given as 10.9. The star is on the map of the 1982 July 6th lunar eclipse star field in *o.N. 2* (16) 217, and was occulted by the relatively bright southern part of the moon during the partial phases of the eclipse for observers in the eastern U.S.A.; probably nobody observed that occultation.

Oct. 23: SAO 210091 = ε Sagittarii = FK4 689 = Kaus Australis, the brightest star yet predicted to be occulted by an asteroid, and with the largest occultation Δm. As noted in *o.N. 2* (15), 203, an occultation of a star this bright, or brighter, by an asteroid as large as, or larger than, (804) Hispania, occurs only about once every 141 years. In the *o.N. 2* (15) article, I erred, reversing the paths computed from orbital elements given in EMP 82 and by Herget. Unknown to me then, astrometric observations made at Lowell Observatory last February 21 reported in M.P.C. 6678 clearly favor Herget's orbit. Those observing in daylight might want to offset from the sun, which will be at apparent Decl. -11° 12', R.A. $13^h\,48\overset{m}{.}7$, $4^h\,34\overset{m}{.}4$ less than that of ε Sagittarii, or they can set up their telescopes the night before the occultation, pointing them to a star with nearly the same declination as ε Sgtr. at a time when it will have the same altitude and azimuth (the amount of sidereal time will be the difference in R.A.). Unfortunately, the far southern declination and rather small elongation from the sun preclude Northern-Hemisphere astrometry; during the few months before the event, Hispania will be even farther south. We probably will need to rely on Perth Observatory for the necessary astrometry, which may be difficult due to the large magnitude difference. A trip to the mid-Pacific may be worthwhile for an event much rarer than even a total solar eclipse. Any possible expedition plans will be announced in future issue. Like the other bright stars occulted by asteroids in 1983, this is conveniently a weekend event, occurring on Saturday evening east of the International Date Line.

Nov. 19: See note for Apr. 7, *o.N. 3* (1) 19.

Dec. 1: In his Bulletin 27, Gordon Taylor offers to compute local predictions for this occultation. The bright-limb immersion will not be observable. Even the emersion will be difficult, since the defect of illumination (width of dark crescent in p.a. opposite the sun) will be only $0\overset{''}{.}37$; good atmospheric seeing will be needed.

(Text continues on page 67.)



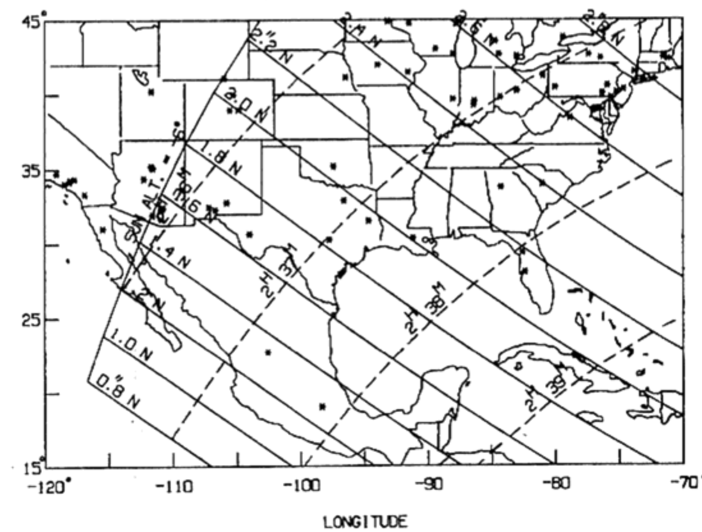
1983 DATE	UNIVERSAL TIME		PLANET NAME	m_v	Δ,AU	STAR Lowell #	m_v	R.A.(1950)	Dec.	OCCULTATION Δm	Dur	df	P	Possible Area	El SUN	MOON El	%Snl	Up	Ephemeris Source
Apr 16	22^h	18^m-24^m	Interamnia	11.5	2.55	692878	10.3	$13^h26^m.2$	-33°27'	1.5	23^s	21	11	India, Mideast,southeast Europe	156°	136°	15+	none	EMP 1977
Apr 26	5	53	Europa	11.5	2.71	679863	10.6	8 12.2	21 42	1.3	15	17	14	central Canada;nw&central USA?s	86	81	99+	all	HERGET78
May 5	1	12	Cybele	12.3	2.79	680214	11.8	20 29.6	-15 58	1.0	24	25	13	southern Africa	98	9	51-	all	EMP 1975
May 10	0	09	Interamnia	11.5	2.57	692719	10	13 08.5	-30 57	2	24	23	11	Antarctica; s. & w. Australia?n	150	152	7-	s 65°S	EMP 1977
May 12	20	06	Hygiea	9.5	1.88	681123	11.7	13 12.5	-13 32	.13	57	35	6	South Africa?n	150	149	0+	none	SCHMADEL
Jun 3	3	56-61	Patientia	11.6	2.34	680969	11.5	18 54.8	-24 27	0.8	26	28	12	SouthAfrica, AntarcticPeninsula	149	51	57-	all	HERGET78
Jun 8	21	08	Davida	11.8	2.82	680743	13.7	19 32.9	-20 00	0.2	30	30	12	western Australia	145	115	7-	el12°E	EMP 1982
Jun 25	18	16	Interamnia	12.0	2.97	692759	14	13 02.1	-25 41	0.2	35	35	13	New Zealand?n; Australia?n	110	73	100-	all	EMP 1977
Jun 29	10	32-44	Cybele	11.5	2.19	680235	14.1	20 33.4	-15 34	.08	38	36	10	western U.S.A.; Hawaii?s	150	17	85-	none	EMP 1975
Jul 1	7	56-63	Davida	11.5	2.68	680759	13.0	19 18.3	-21 30	0.2	21	21	12	cen&w USA or Canada?s; Hawaii?s	170	56	71-	el35°W	EMP 1982
Jul 4	2	00-19	Cybele	11.4	2.16	680239	13.0	20 31.0	-15 44	0.2	34	31	10	cen. Africa, cen. South America	155	72	44-	e 25°W	EMP 1975
Jul 4	4	21-29	Davida	11.5	2.68	680763	11.9	19 16.1	-21 42	0.6	21	20	12	Zaire, se. Brazil?n; Patagonia	174	91	43-	e 55°W	EMP 1982
Jul 19	12	52	Hygiea	10.4	2.58	691242	13.5	13 29.9	-13 05	.06	25	18	8	Indonesia	90	30	74+	all	SCHMADEL
Jul 31	4	51-58	Ceres	7.8	2.00	680439	12.4	22 02.5	-26 20	.02	84	23	3	southern Canada, U.S.A., Mexico	159	52	68-	e 95°W	APAENAXX
Aug 1	8	23-38	Davida	11.6	2.73	680121	10.8	18 54.4	-23 37	1.3	25	24	12	Guatemla;Mex?n;NwZlnd?s;eAustrl	154	107	57-	el35°W	EMP 1982
Aug 13	0	07-21	Cybele	11.4	2.17	681025	13.0	20 03.6	-17 48	0.2	31	29	10	South Africa; Patagonia?n	160	101	24+	w 35°W	EMP 1975
Aug 17	23	58-75	Cybele	11.5	2.20	681030	12.5	20 00.7	-18 03	0.4	34	32	10	southern Africa, Patagonia	154	36	74+	w 32°E	EMP 1975
Sep 3	11	36-70	Davida	12.0	3.04	680142	12.7	18 42.0	-25 11	0.5	101	104	13	China, Indonesia; w.Australia?e	120	171	19-	none	EMP 1982
Sep 14	2	29	Patientia	12.4	2.87	680066	10.8	18 07.7	-29 34	1.8	30	36	15	north-central U.S.A.	101	13	50+	all	HERGET78
Sep 18	17	15-42	Cybele	12.0	2.51	681048	12.8	19 53.4	-19 06	0.4	130	130	12	eastern Africa	122	20	89+	all	EMP 1975
Oct 4	1	31-36	Patientia	12.6	3.14	680090	11.2	18 21.3	-29 46	1.6	16	20	16	nw. South America, West Indies	85	118	8-	none	HERGET78
Oct 25	0	38	Cybele	12.5	3.03	681070	12.8	20 10.6	-18 58	0.6	18	20	14	cen.Chile, n.Argentina, s.Brazil	90	127	90-	e 55°W	EMP 1975
Nov 27	9	52	Ceres	9.1	3.04	680825	11.9	21 47.3	-24 12	.08	44	15	4	eastern Australia	77	166	51-	none	APAENAXX

- - - - - - - - - -Table 1 is above.- - - - - - - - - -Table 2 is below.- - - - - - - - - -

1983 DATE	MINOR PLANET No.	NAME	km-diam.	-"	RSOI	MOTION °/Day	PA	COMPARISON DATA A. C.	Number	Shift	Time	APPARENT R.A.	Dec.
Apr 16	704	Interamnia	339	0.18	2811	0.191	294°					$13^h28^m.1$	-33°37'
Apr 26	52	Europa	291	0.15	1803	0.237	98	+22°	8^h08^m129	-1".37	0.7	8 14.1	21 36
May 5	65	Cybele	311	0.15	2181	0.155	74					20 31.4	-15 52
May 10	704	Interamnia	339	0.18	2801	0.181	314					13 10.3	-31 08
May 12	10	Hygiea	443	0.33	3361	0.138	303					13 14.2	-13 43
Jun 3	451	Patientia	281	0.17	1976	0.152	240					18 56.8	-24 24
Jun 8	511	Davida	335	0.16	2924	0.129	243					19 34.8	-19 55
Jun 25	704	Interamnia	339	0.16	2778	0.108	43					13 03.9	-25 52
Jun 29	65	Cybele	311	0.20	2199	0.122	254					20 35.3	-15 27
Jul 1	511	Davida	335	0.17	2915	0.193	248					19 20.3	-21 26
Jul 4	65	Cybele	311	0.20	2200	0.141	254					20 32.9	-15 38
Jul 4	511	Davida	335	0.17	2914	0.197	249					19 18.1	-21 38
Jul 19	10	Hygiea	443	0.24	3327	0.228	105					13 31.7	-13 16
Jul 31	1	Ceres	1025	0.70	12575	0.201	234					22 04.4	-26 11
Aug 1	511	Davida	335	0.17	2900	0.163	248	-22°	76308	-0.14	4.2	18 56.4	-23 34
Aug 13	65	Cybele	311	0.20	2217	0.155	251					20 05.5	-17 42
Aug 18	65	Cybele	311	0.20	2219	0.137	250					20 02.6	-17 57
Sep 3	511	Davida	335	0.15	2880	0.036	197					18 44.1	-25 09
Sep 14	451	Patientia	281	0.14	1955	0.107	98					18 09.8	-29 34
Sep 18	65	Cybele	311	0.17	2235	0.032	122					19 55.4	-19 01
Oct 4	451	Patientia	281	0.12	1949	0.187	92					18 23.4	-29 45
Oct 25	65	Cybele	311	0.14	2254	0.188	83					20 12.5	-18 52
Nov 27	1	Ceres	1025	0.46	12602	0.251	61					21 49.2	-24 03

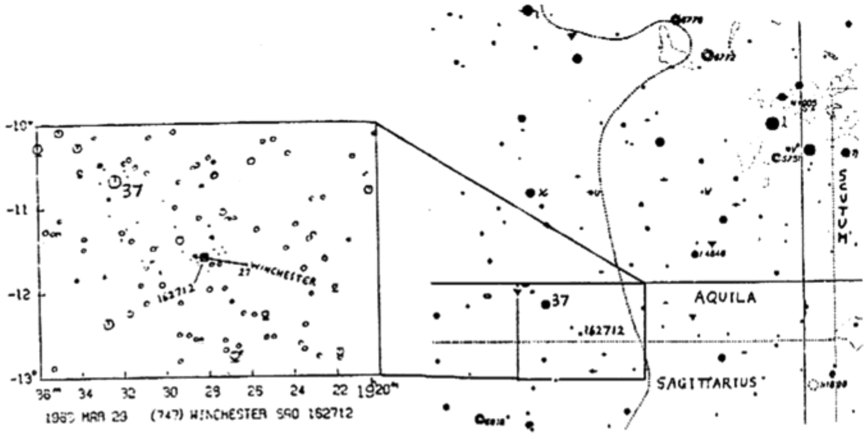
1983 5 6 (71) NIOBE SAO 117178

DIAMETER 106 KM = 0".06

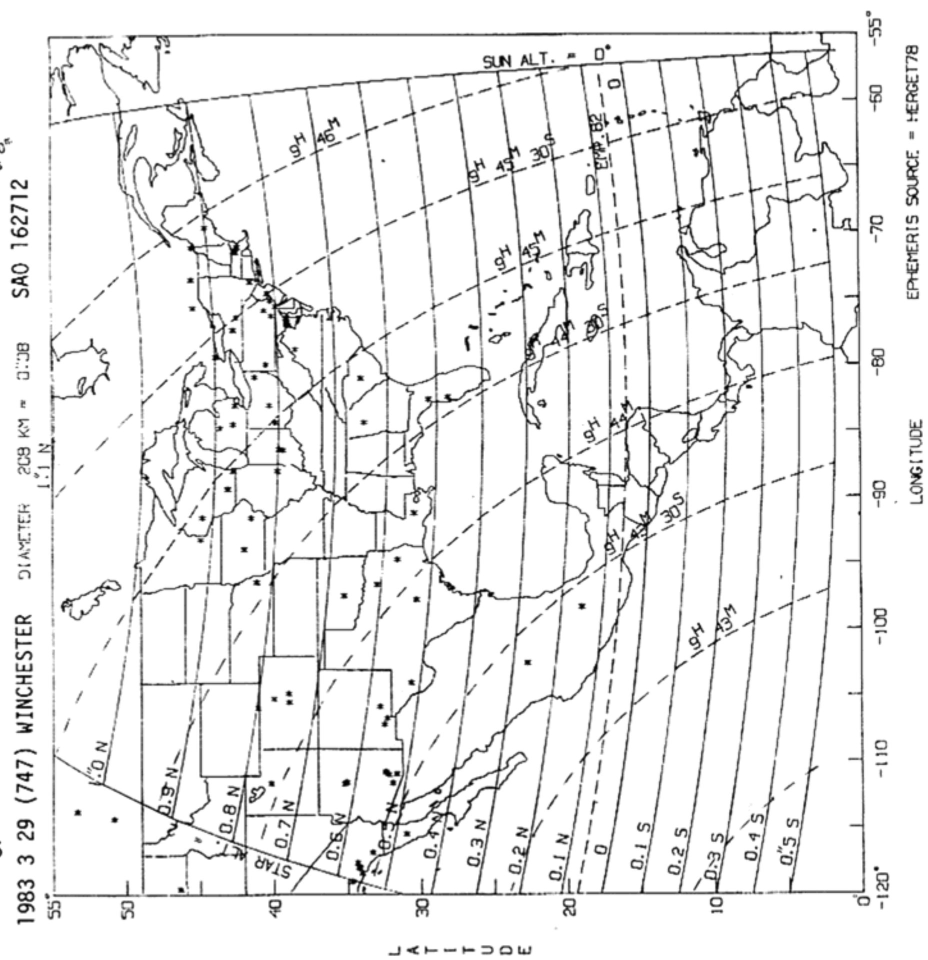


EPHEMERIS SOURCE = HERGET77

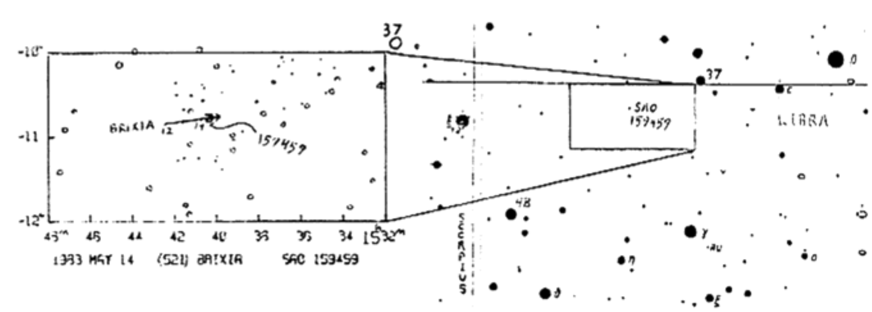
+14° 2256 by Astraea 1983 Mar 24

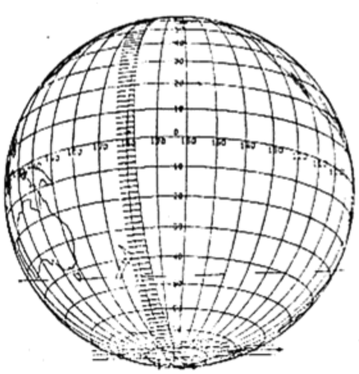


-2164352 by Uranus 1983.Mar 25



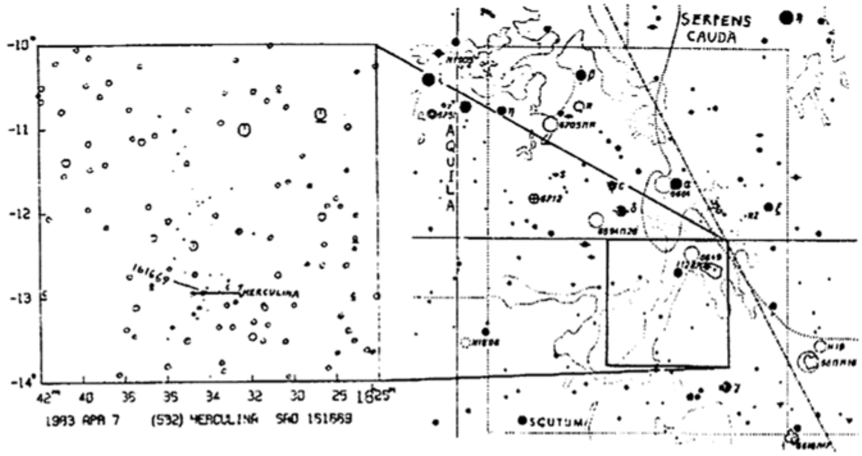
-2164352 by Umbriel 1983 Mar 25



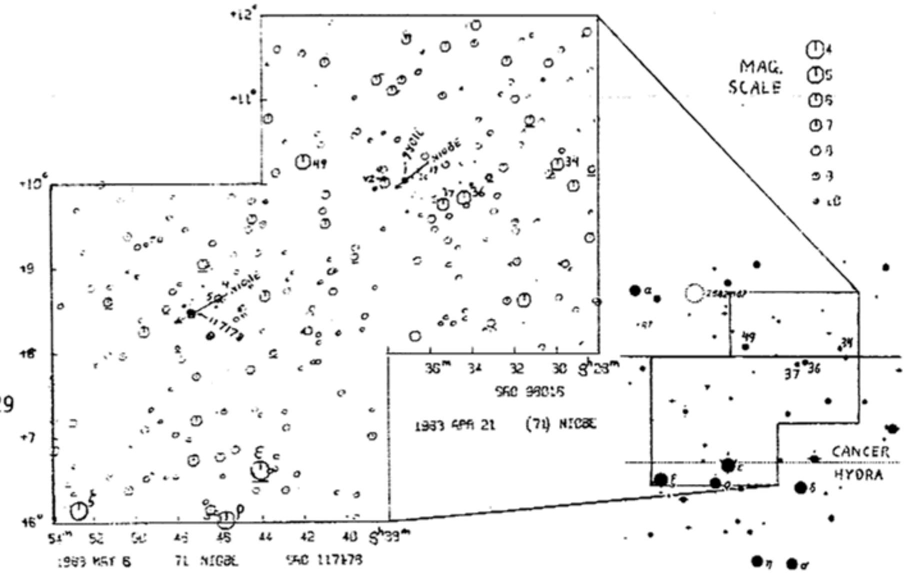


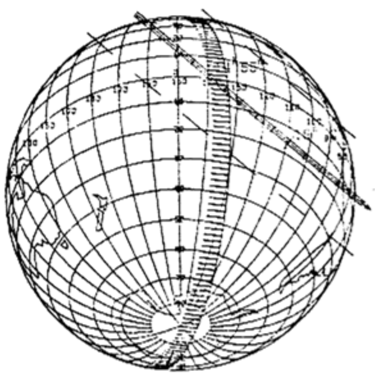
L 680704 by Davida 1983 Mar 27

SAO 104460 by Pallas 1983 Mar 28

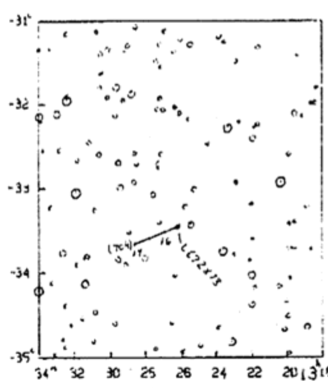


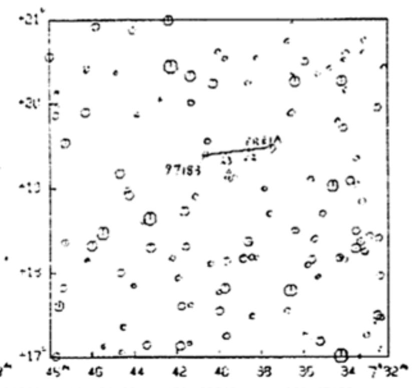
SAO 162712 by Winchester 83 Mar 29





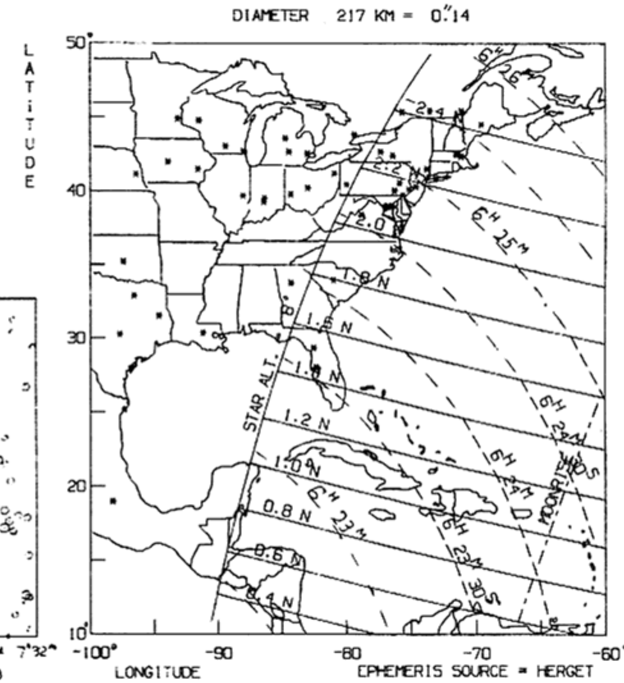
SAO 228439 by Hispania 1983 Apr 4



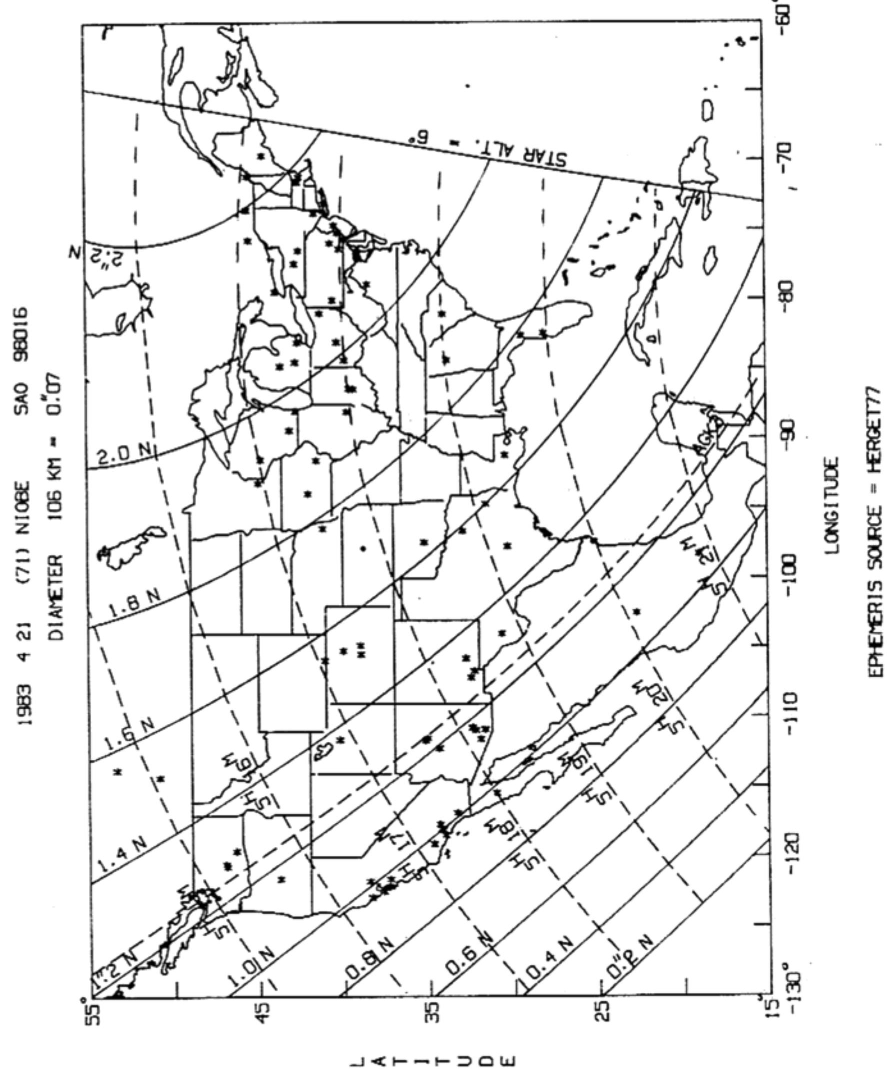


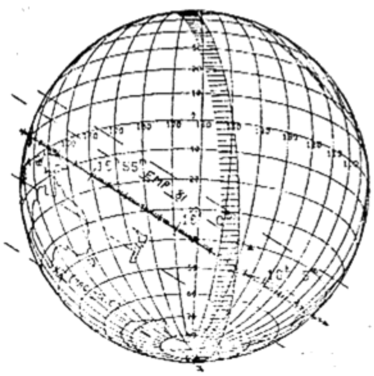
1983 4 7 (532) HERCULINA SAO 161669

DIAMETER 217 KM = 0".14

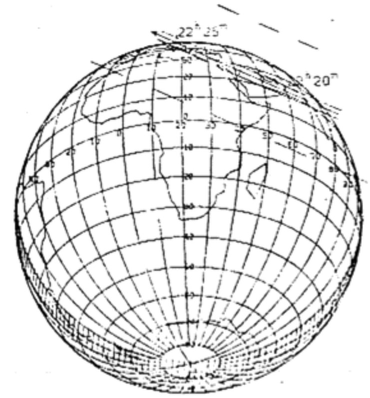


SAO 161669 by Herculina 1983 Apr 7

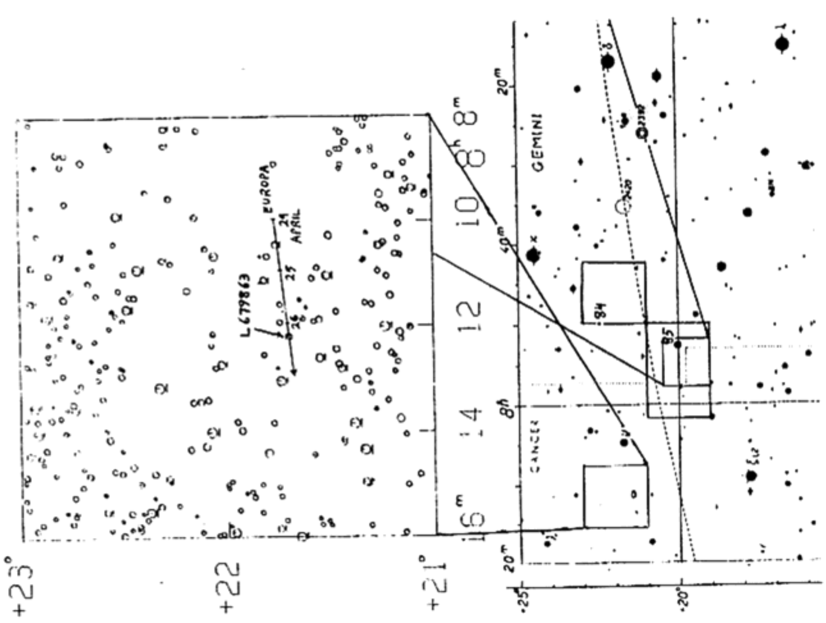


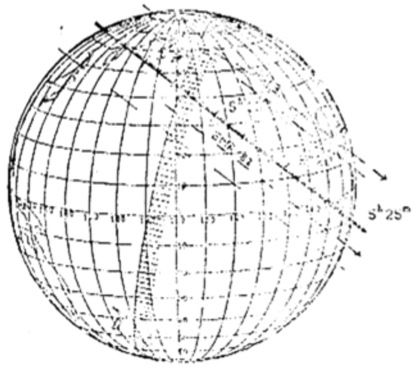


SAO 186949 by Eva 1983 Apr 12



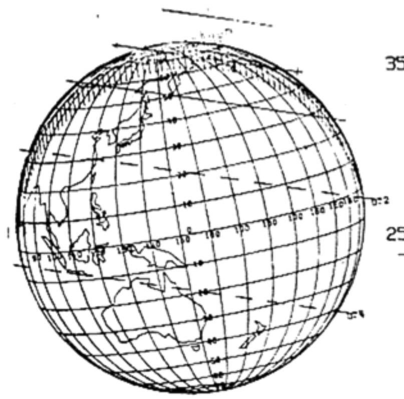
L 692878 by Interamnia 1983 Apr 16





SAO 98016 by Niobe 1983 Apr 21

SAO 97183 by Freia 1983 Apr 23



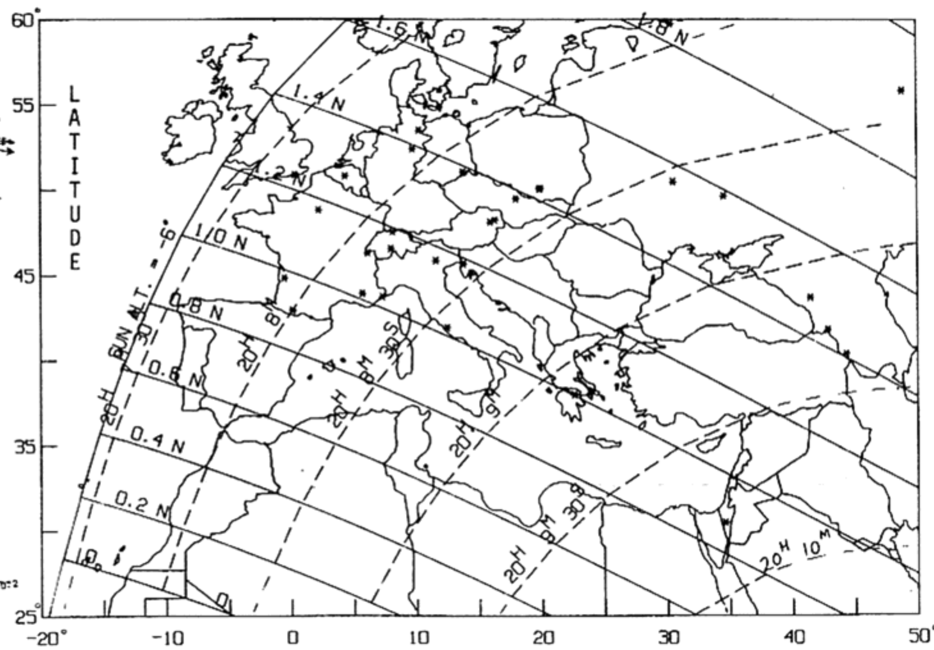
Anonymous by Pluto 1983 Apr 24

L679863 by Europa 1983 Apr 26

SAO 187286 by Beatrix 1983 Apr 28

1983 4 23 (76) FREIA SAO 97183

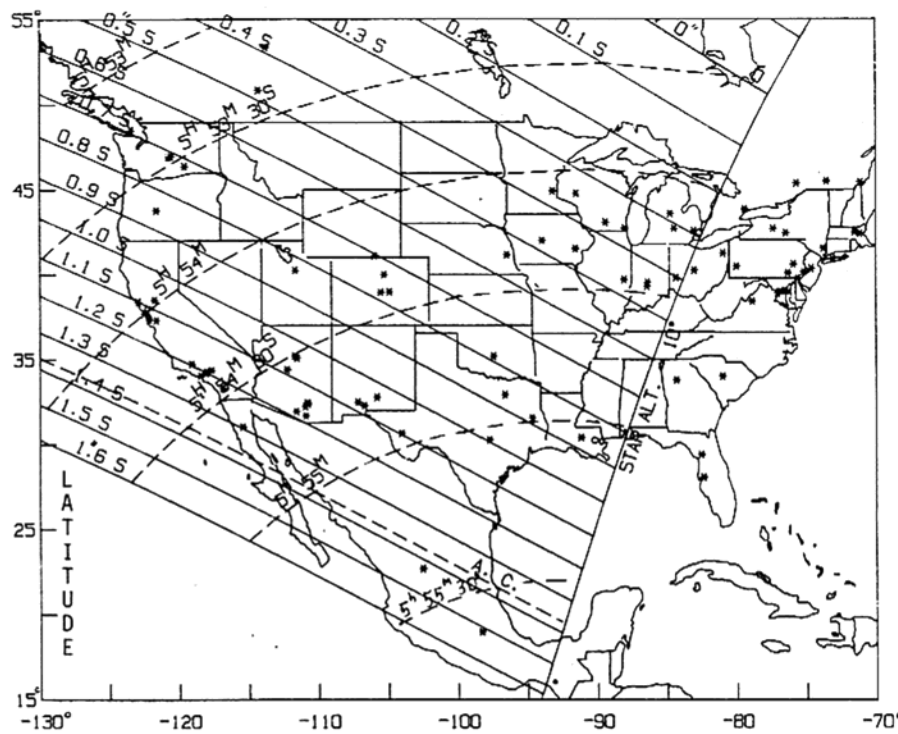
DIAMETER 196 KM = 0."09



EPHEMERIS SOURCE = EMP 1980

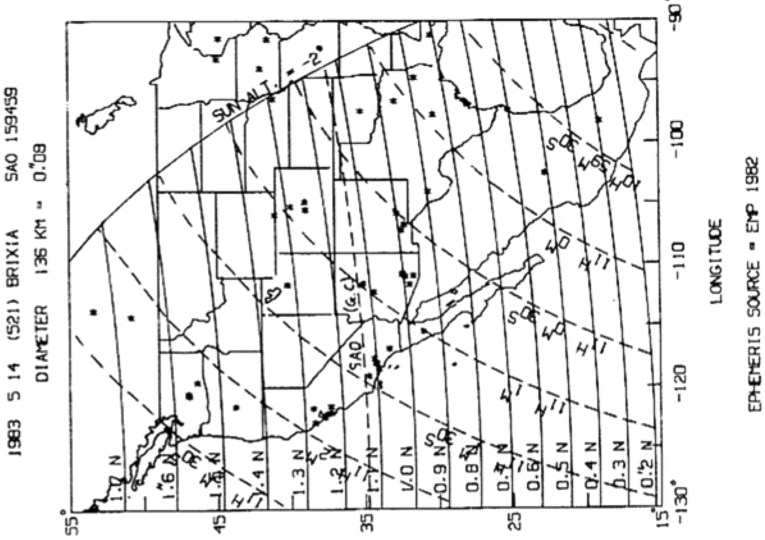
1983 4 26 (52) EUROPA L 679863

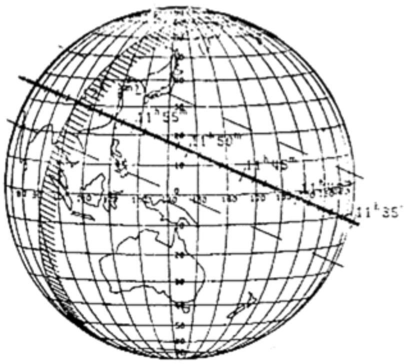
DIAMETER 291 KM = 0."15



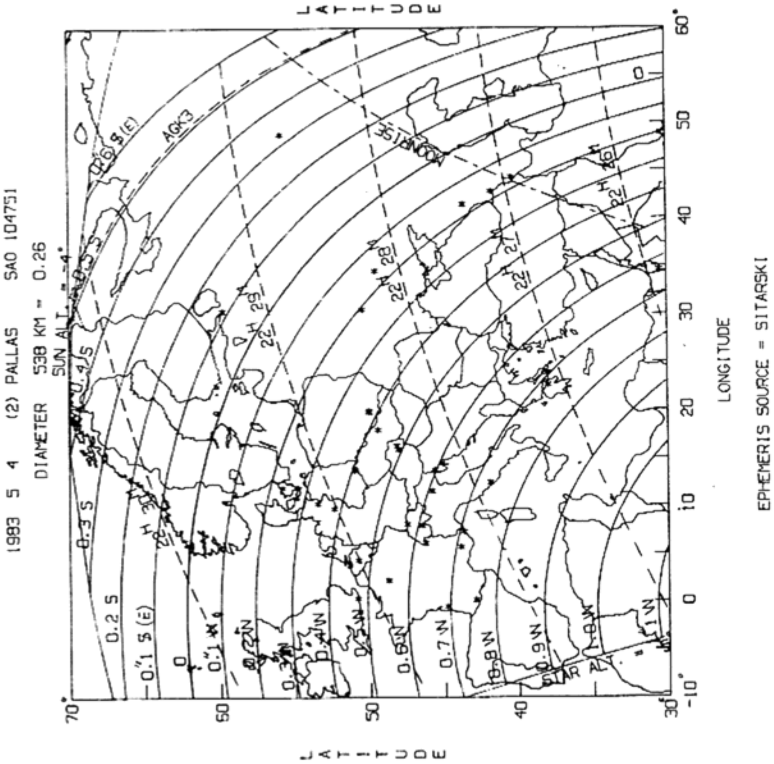
EPHEMERIS SOURCE = HERGET78

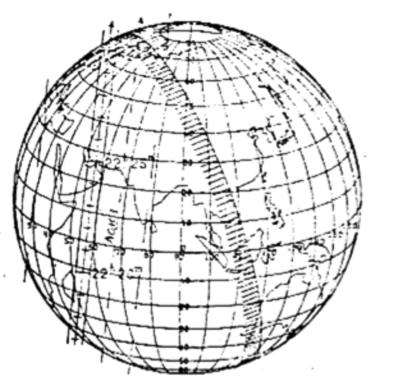
SAO 119287 by Lydia 1983 May 2



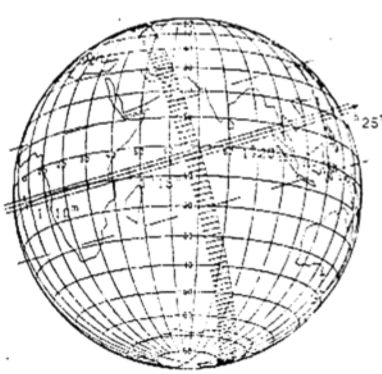


+04° 2579 by Penelope 1983 May 3

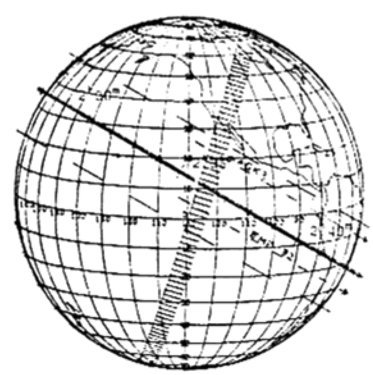




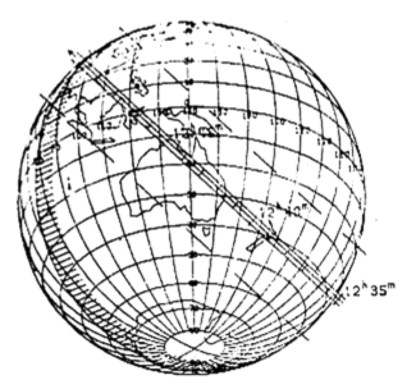
SAO 104751 by Pallas 1983 May 4



L 680214 by Cybele 1983 May 5



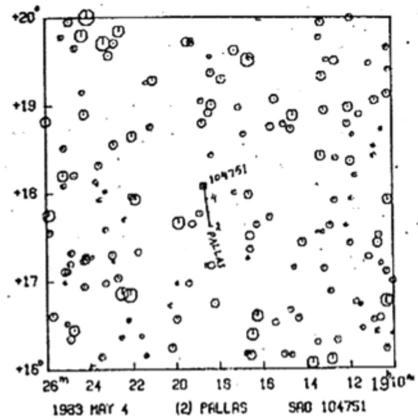
SAO 117178 by Niobe 1983 May 6

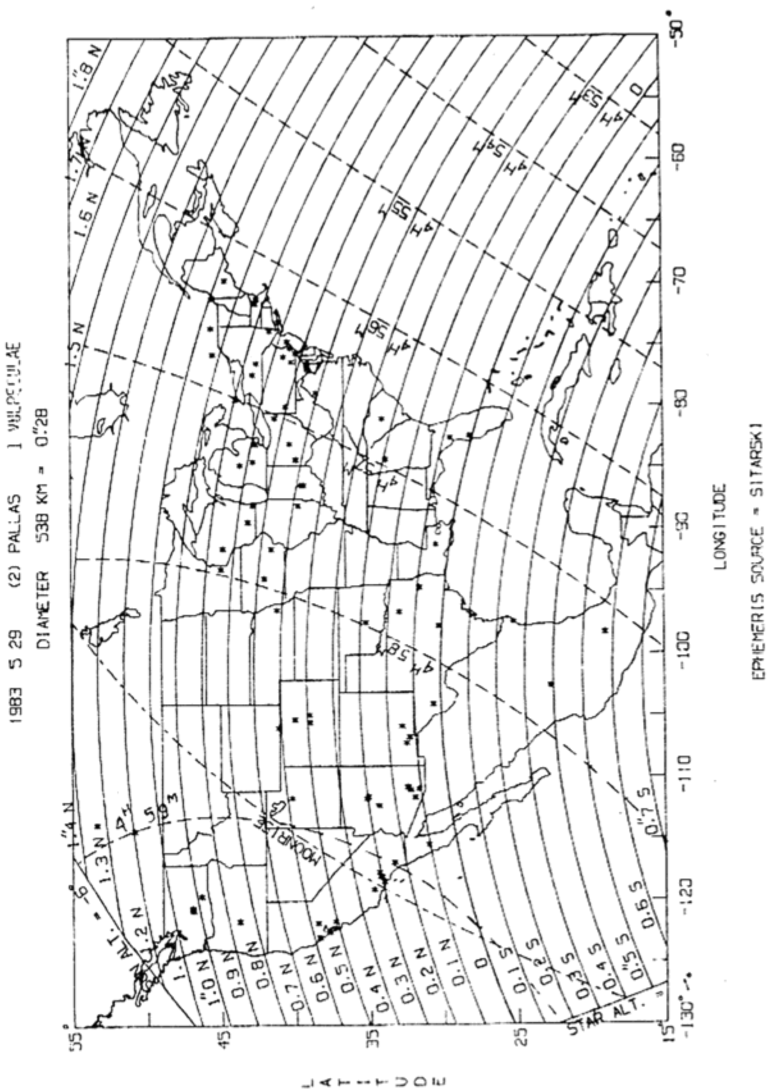


SAO 204221 by Interamnia '83 May 9

Dec 30, (91) Aegina: Astrometry for an unobserved occultation in 1981 April showed a very large correction (mostly in the direction of motion) to the ephemeris, which has not been updated further.

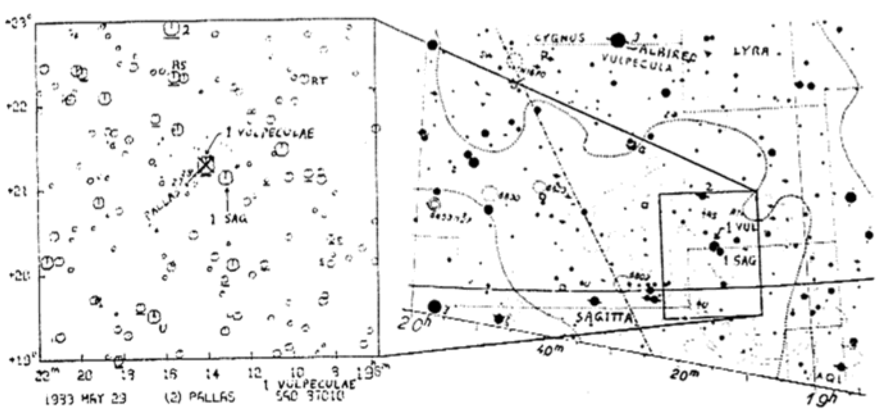
Unfortunately, time did not allow checking four finder charts for potential European events against *Atlas Eclipticalis* or *True Visual Magnitude Atlas*, or for adding *Atlas Coeli*-based large-field charts.

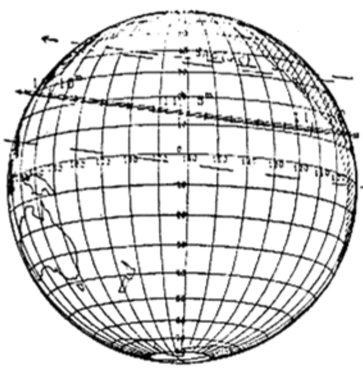




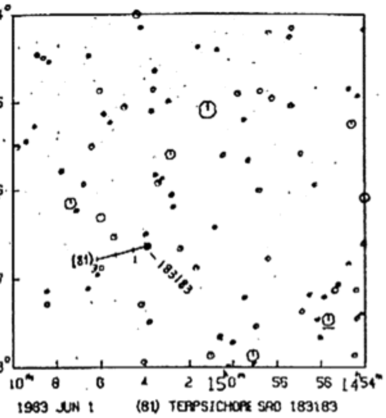
L 692719 by Interamnia 1983 May 10

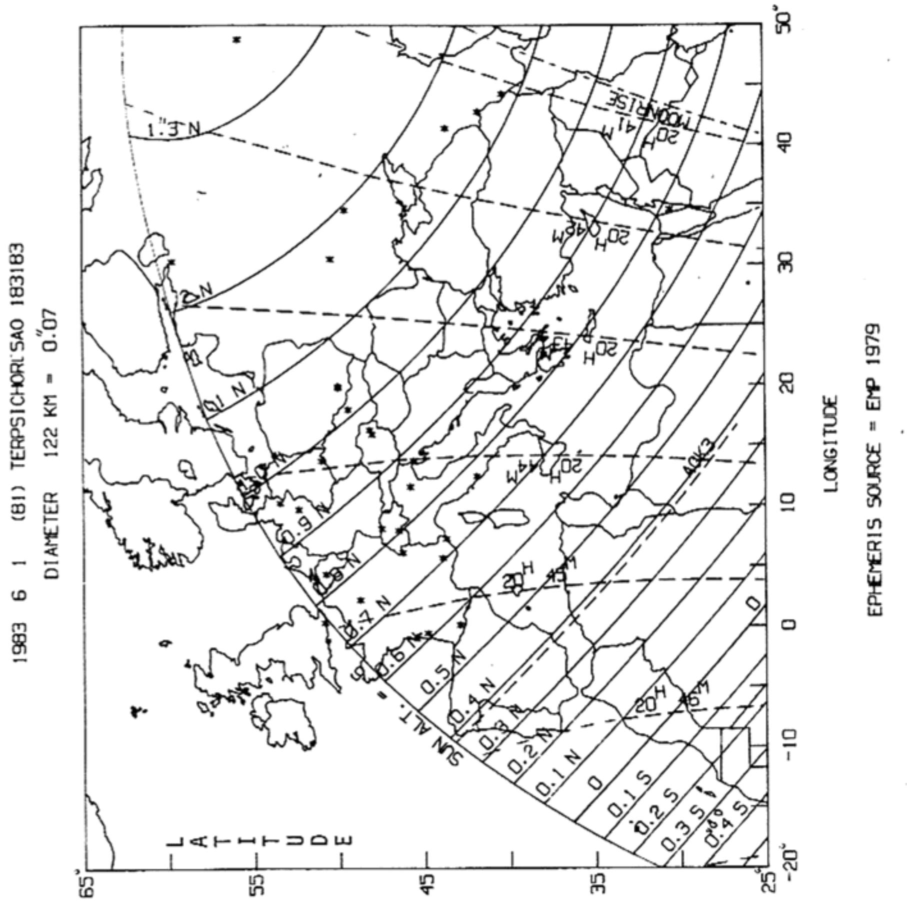
L 681123 by Hygiea 1983 May 12



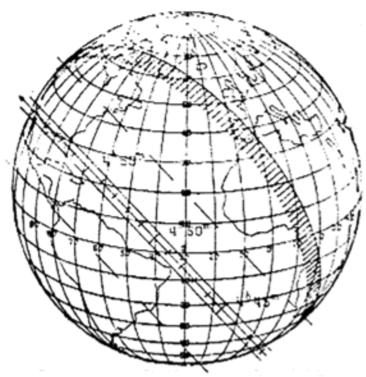


SAO 204221 by Brixia 1983 May 14

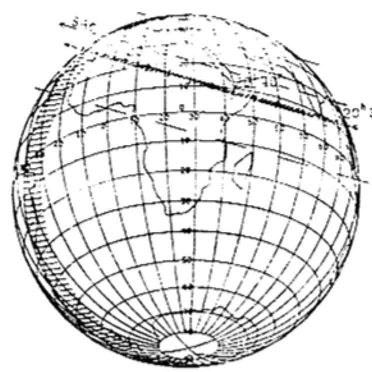




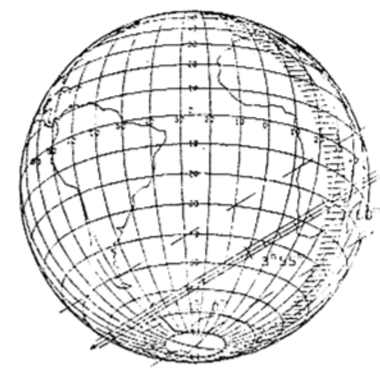
SAO 99225 by Melpomene 1983 May 24



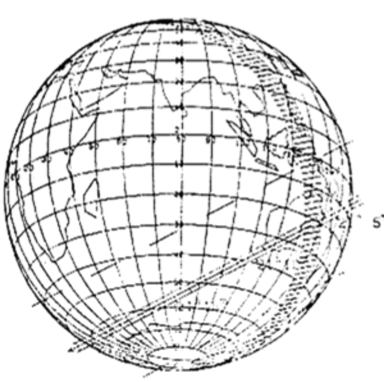
SAO 87010 by Pallas 1983 May 29



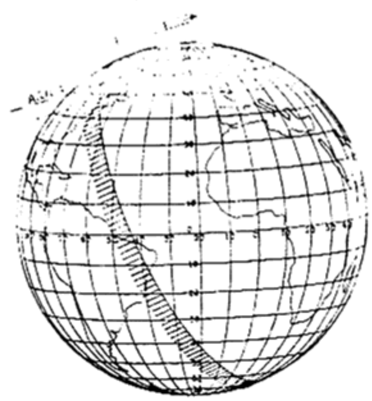
SAO 183183 by Terpsichore 83 Jun 1



L 680969 by Patientia 1983 Jun 3

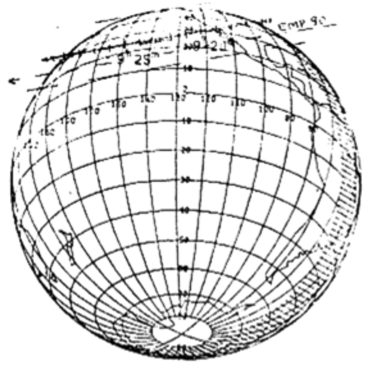


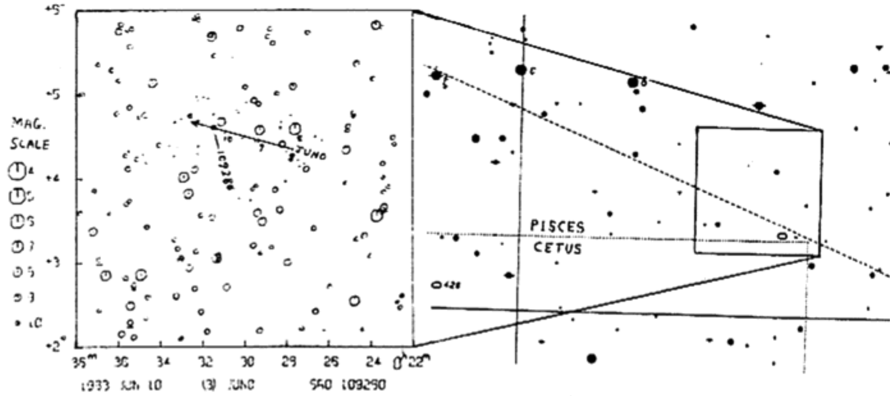
L 680743 by Davida 1983 Jun 8



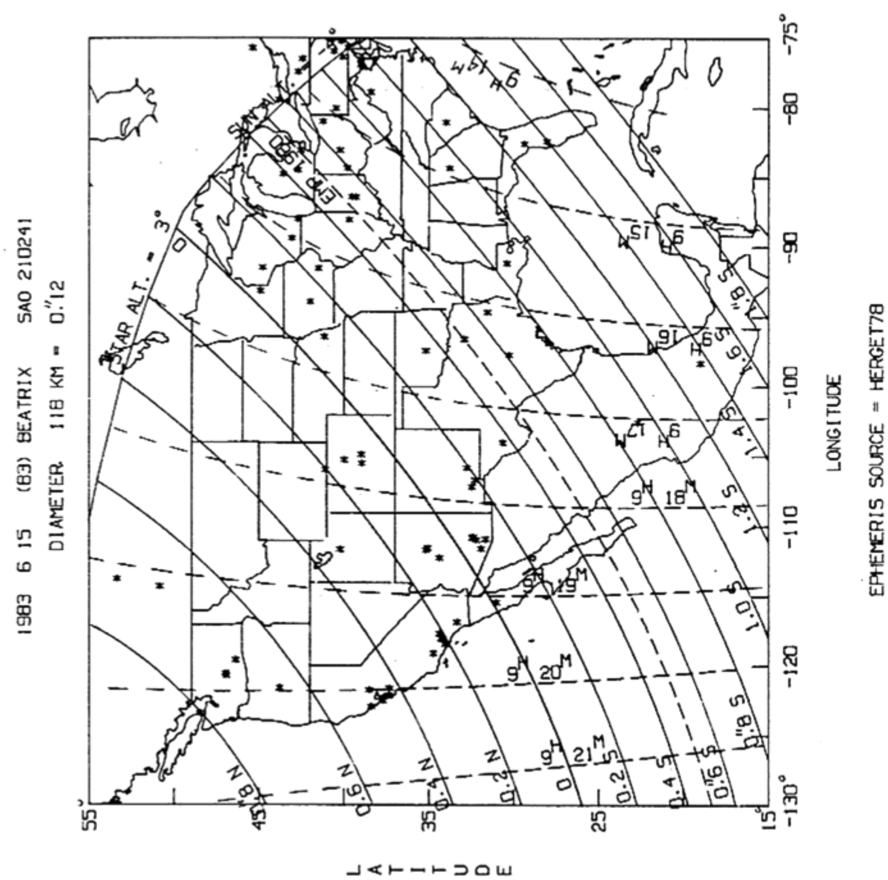
SAO 109280 by Juno 1983 Jun 10

-00°2413 by Germania 1983 Jun 13

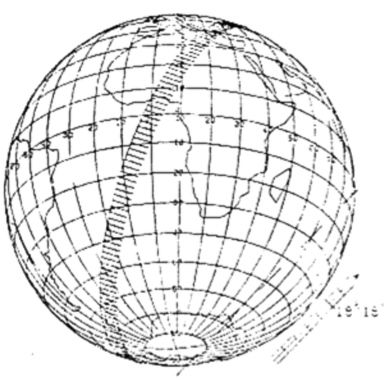




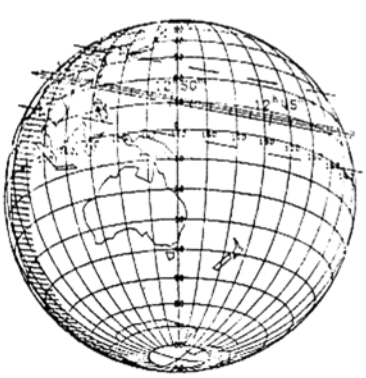
SAO 210241 by Beatrix 1983 Jun 15

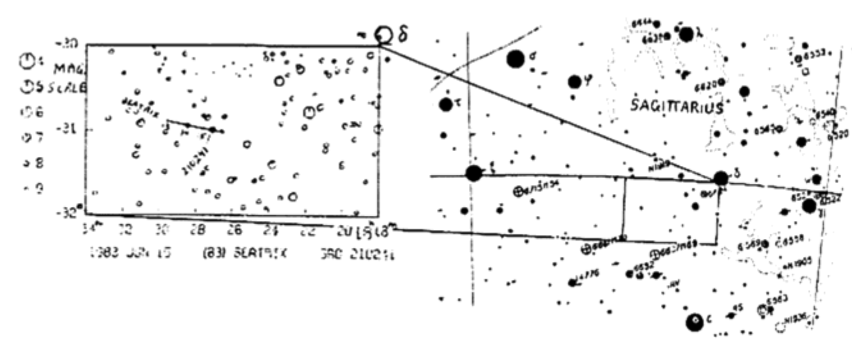


-2258794 by Neptune 1983 Jun 15



L 692759 by Interamnia 1983 Jun 25

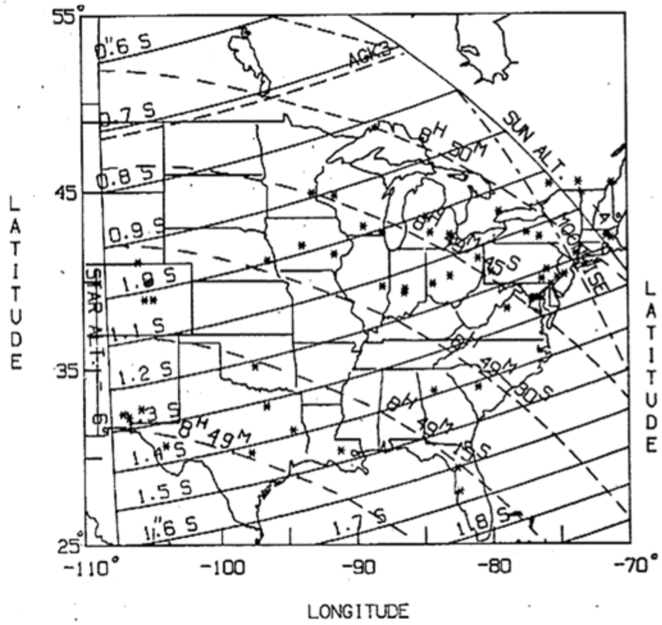




SAO 185215 by Iris 1983 Jun 28

1983 6 10 (3) JUNO SAO 109280

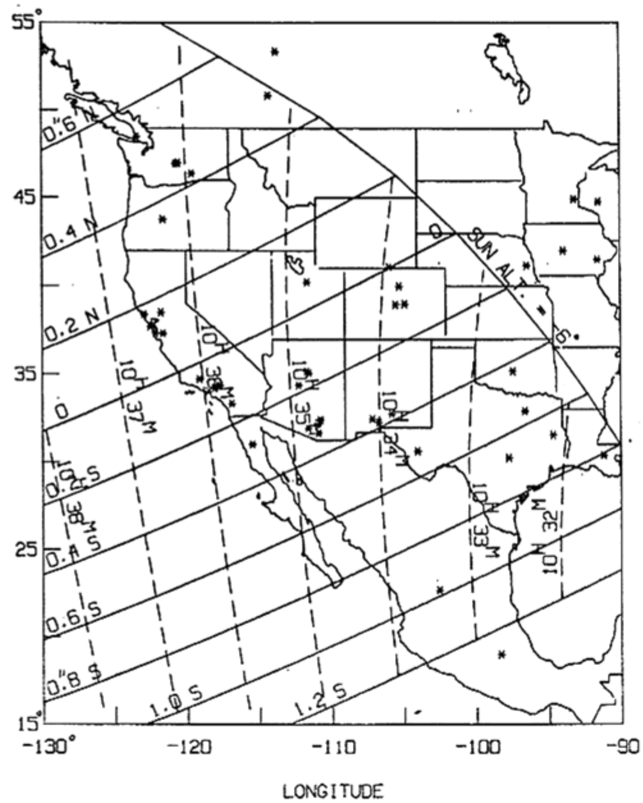
DIAMETER 267 KM = 0".15



EPHEMERIS SOURCE = APAENAXX

1983 6 29 (65) CYBELE L 680235

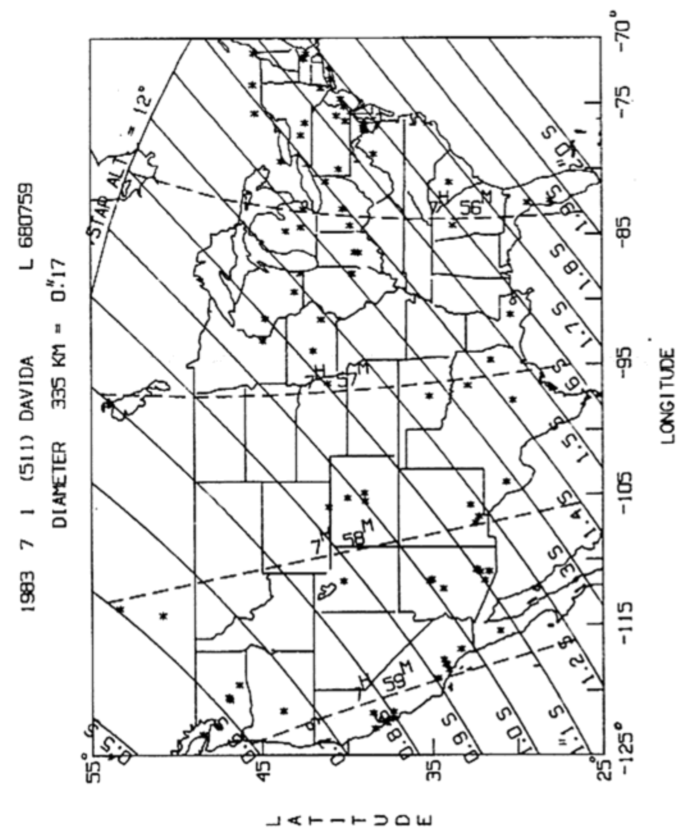
DIAMETER 311 KM = 0".20



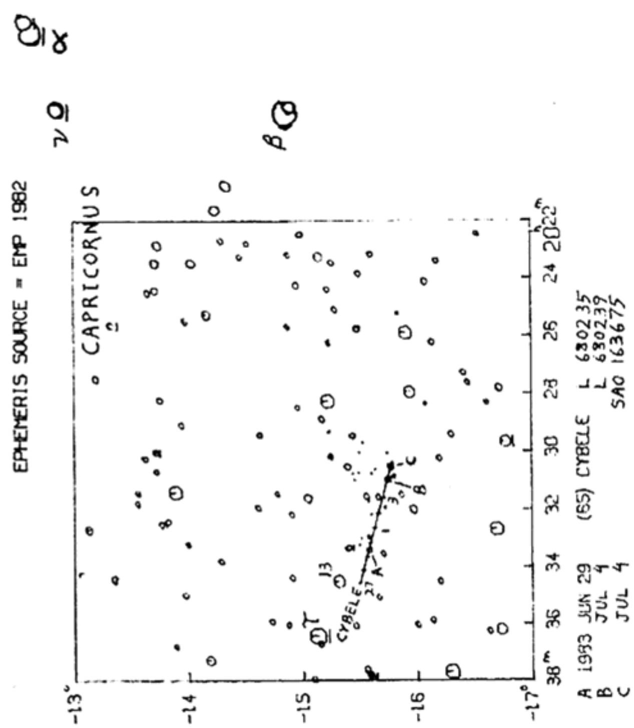
EPHEMERIS SOURCE = EMP 1975

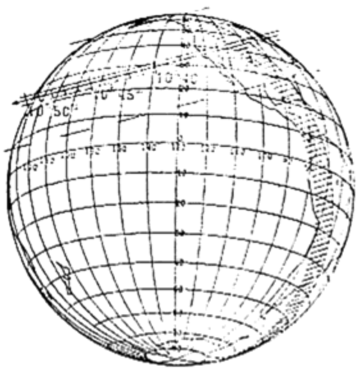
1983 7 1 (511) DAVIDA L 680759

DIAMETER 335 KM = 0".17

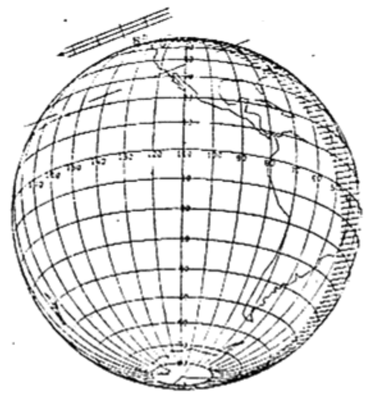


EPHEMERIS SOURCE = EMP 1982



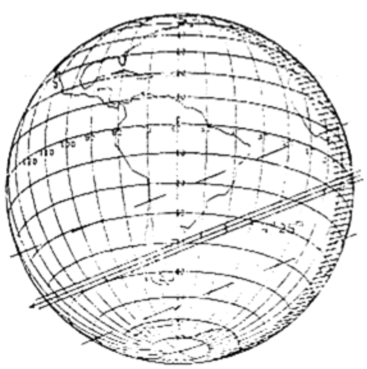


L 680235 by Cybele 1983 Jun 29



L 680759 by Davida 1983 Jul 1

L 680239 by Cybele 1983 Jul 4

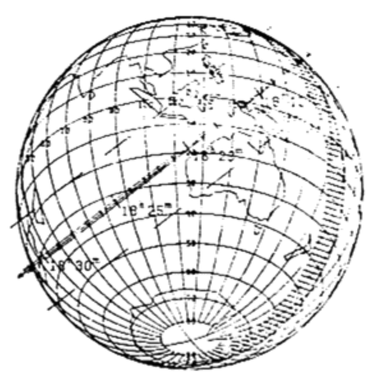


L 680763 by Davida 1983 Jul 4

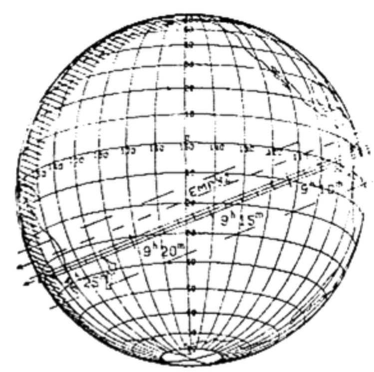
SAO 163675 by Cybele 1983 Jul 4

N 9° 132 by Ligura 1983 Jul 13

L 691242 by Hygiea 1983 Jul 19

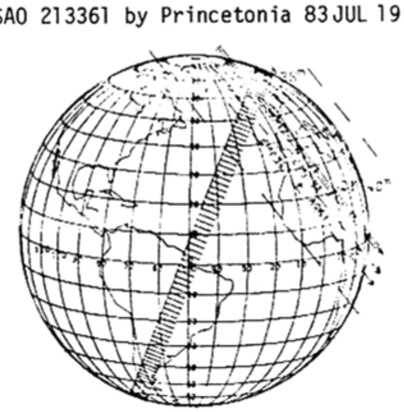


SAO 213361 by Princetonia 83 JUL 19



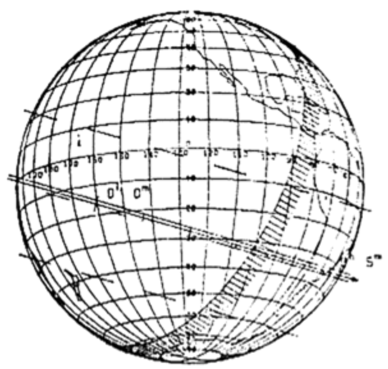
SAO 162591 by Eugenia 1983 Jul 23

+04° 34 by Messalina 1983 Jul 23

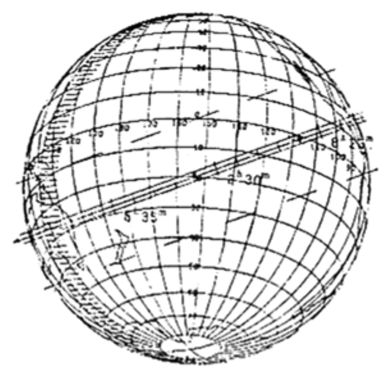


SAO 101045 by Eunike 1983 Jul 23

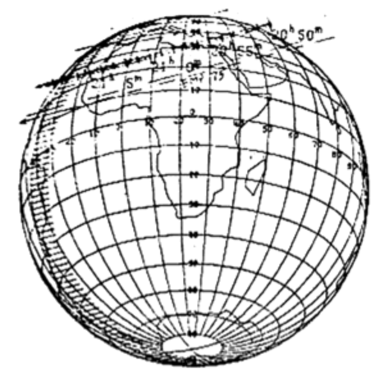
L 680439 by Ceres 1983 Jul 31



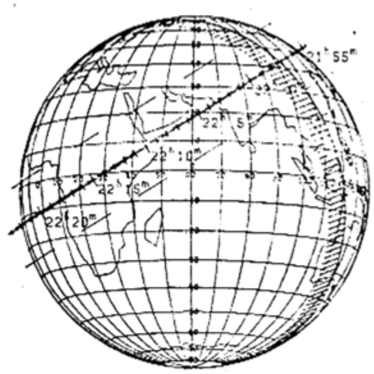
SAO 157161 by Eunomia 1983 Aug 1



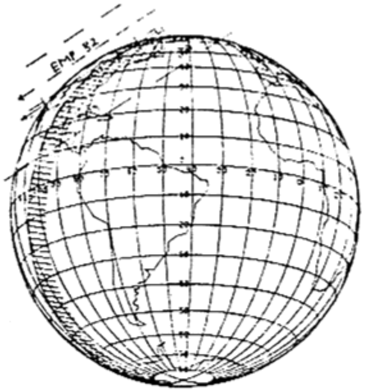
L 680121 by Davida 1983 Aug 1



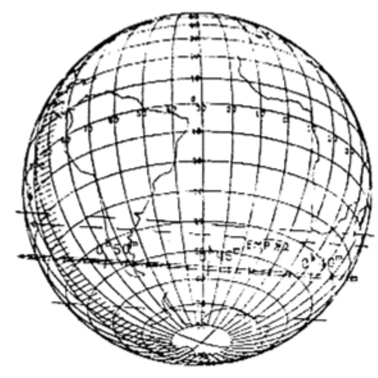
SAO 188145 by Harmonia 1983 Aug 3



SAO 146454 by Hersilia 1983 Aug 3

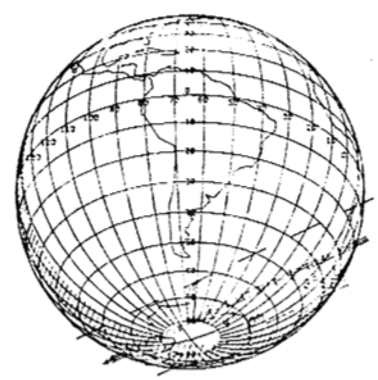


SAO 162242 by Winchester '83 Aug 5



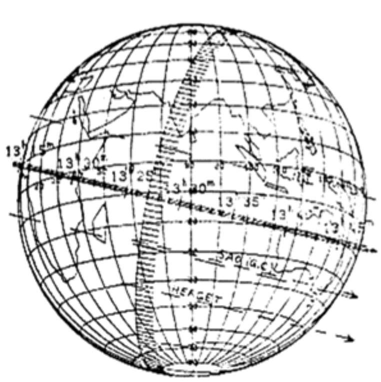
SAO 188283 by Diana 1983 Aug 6

SAO 162357 by Eugenia 1983 Aug 6

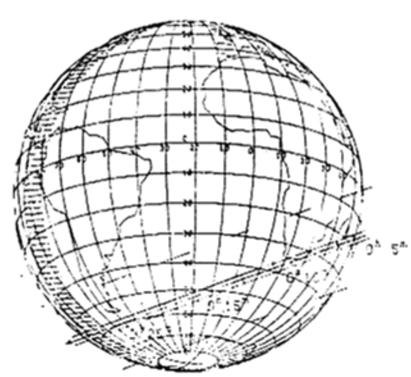


SAO 212325 by Lucina 1983 Aug 7

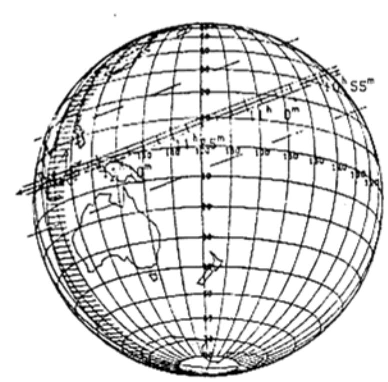
SAO 158213 by Hygiea 1983 Aug 8



SAO 159867 by Boliviana '83 Aug 13

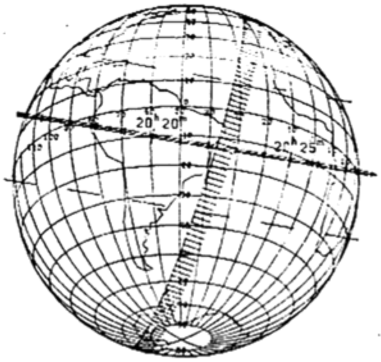


L 681025 by Cybele 1983 Aug 13

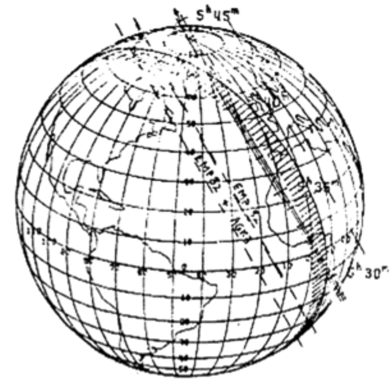


SAO 163239 by Cybele 1983 Aug 15

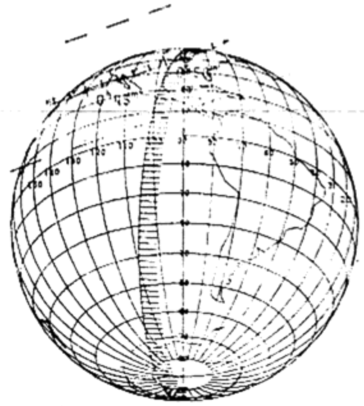
L 681030 by Cybele 1983 Aug 17



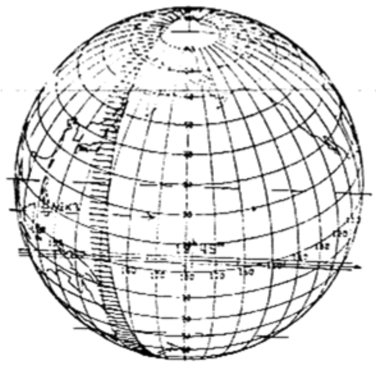
SAO 183178 by Terpsichore 83 Aug 20



SAO 74064 by Palma 1983 Aug 21

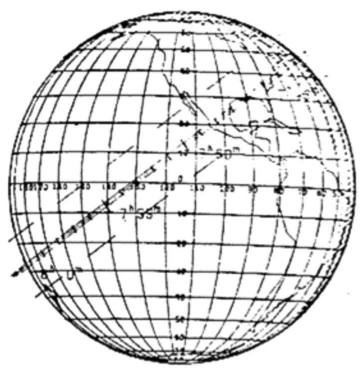


SAO 208888 by Lachesis 1983 Sep 1

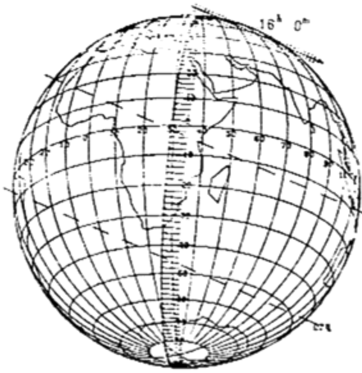


SAO 59132 by Loreley 1983 Sep 1

L 680142 by Davida 1983 Sep 3

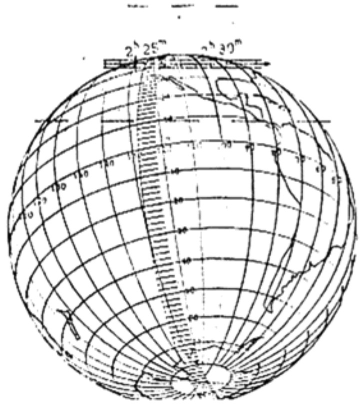


SAO 146780 by Nemausa 1983 Sep 11



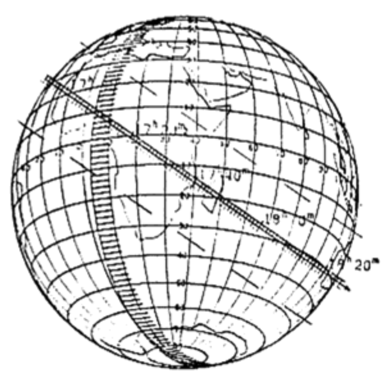
KMN 31 by Neptune 1983 Sep 12

SAO 183331 by Aurora 1983 Sep 13

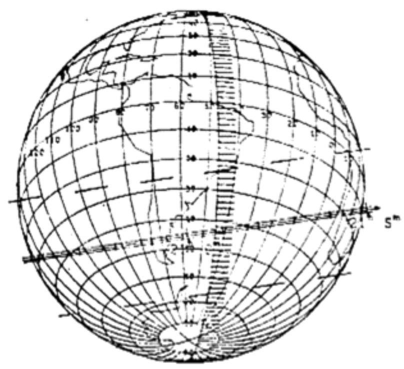


L 680066 by Patientia 1983 Sep 14

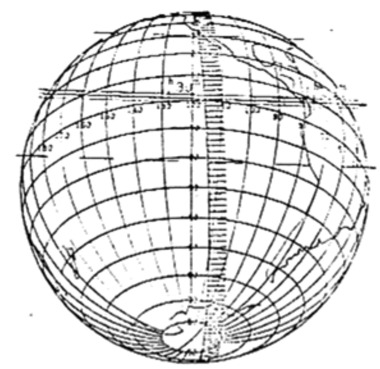
SAO 77803 by Aletheia 1983 Sep 14



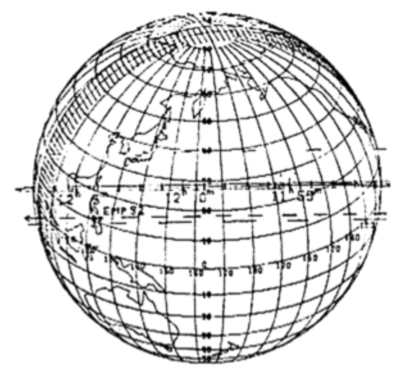
L 681048 by Cybele 1983 Sep 18



SAO 185970 by Lachesis 1983 Oct 1

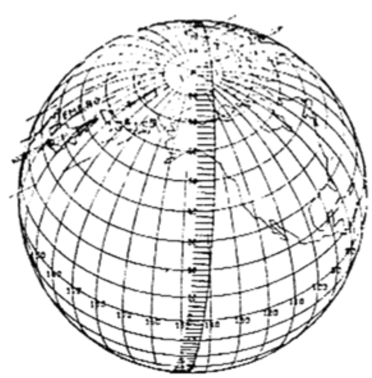


L 680090 by Patientia 1983 Oct 4



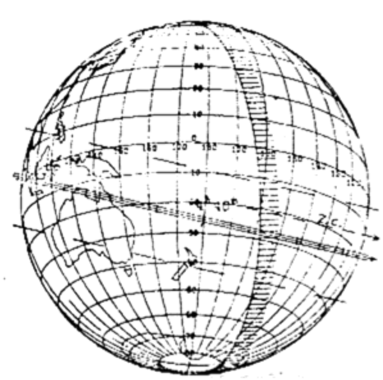
+26°4701 by Palma 1983 Oct 5

SAO 183401 by Hygiea 1983 Oct 8

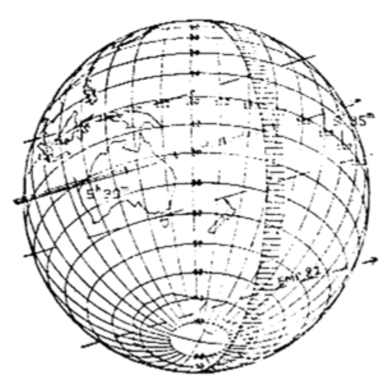


SAO 41289 by Atalante 1983 Oct 9

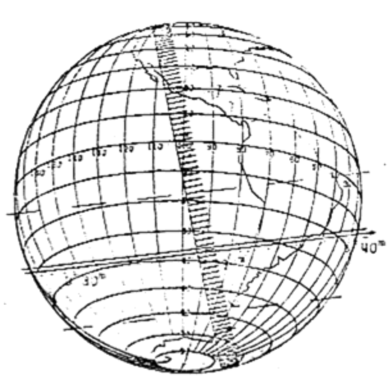
+20°2365 by Pandora 1983 Oct 14



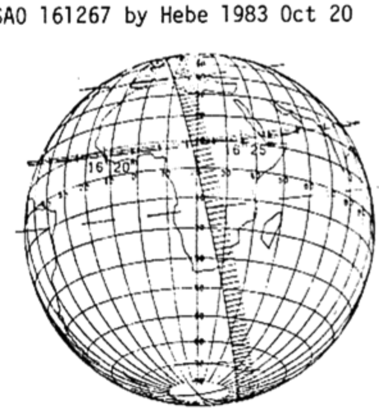
SAO 161267 by Hebe 1983 Oct 20



SAO 210091 by Hispania 1983 Oct 23



L 681070 by Cybele 1983 Oct 25



SAO 188979 by Aemilia 1983 Oct 27

SAO 139084 by Europa 1983 Nov 12

SAO 187978 by Herculina '83 Nov 19