Occultation Newsletter

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FROM THE PUBLISHER

For subscription purposes, this is the fourth and final issue of 1981.

O.N.'s price is $1.40/issue, or $5.50/year (4 issues) including first class surface mailing, and air mail to Mexico. Back issues through *Vol. 2*, No. 13, still are priced at only $1.00/issue. 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.-- (see the first paragraph of IOTA NEWS, below) to Hans-J. Bode, Bartold-Knaust Str. 8, 3000 Hannover 91, German Federal Republic.

IOTA NEWS

David W. Dunham

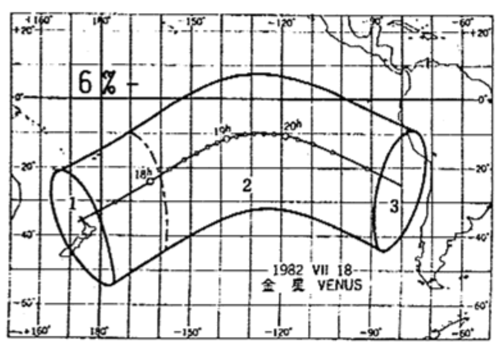
Hans Bode reports that, due to inflation and postal rate increases in the German Federal Republic, the dues for annual membership in the European Section of IOTA must also be increased, to DM 20.--. The main IOTA has not yet incorporated, but we are proceeding with this and it should be accomplished early this year.

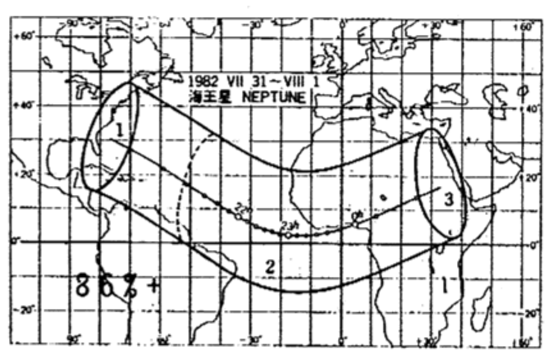
Unfortunately, I was not able to prepare my material for this issue in time for the total lunar eclipse of January 9th, so information about occultations during that event was sent separately, from the U. S. Naval Observatory, during the 3rd and 4th weeks of December. More information is in my article on extended USNO total occultation predictions on p. 188. Since we are rushed to include information about asteroidal occultations during early 1982 in this issue, information about new double stars, and about observed grazing occultations and asteroidal occultation attempts will be published in the next issue, either late in February or during March.

Our trip to Somalia to observe the occultation of Nunki by Venus on November 17th was partly successful. The sky was clear, but we had some problems with tracking which caused us to lose part of the immersion record, and the central flash was not evident at our site. More information will appear in the 1982 February issue of *Sky and Telescope* and in the next *O.N.* Since returning, we have used our video equipment to record part of a graze of 7.0-magnitude SAO 164948 at Wicomico, VA, using a 35-cm Schmidt-Cass loaned by Robert McCracken, on 1981 December 31, UT. On January 4, I recorded the disappearance of 4.3-mag. ZC 364 = ξ^2 Ceti from our home in Silver Spring, MD, using a 20-cm Schmidt-Cass, the first lunar total occultation we have recorded with our equipment. Last-minute equipment problems prevented our obtaining a video record of a graze of ZC 3529, mag. 6.8, under partly cloudy skies at only 8° altitude near Hagerstown, MD, on January 2 UT, but some visual timings were made at 9 stations, perhaps the first graze observed during 1982.

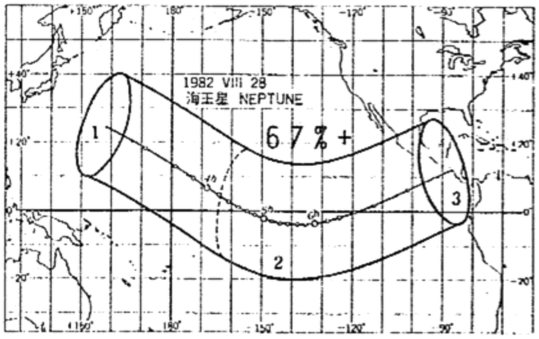
LUNAR OCCULTATIONS OF PLANETS

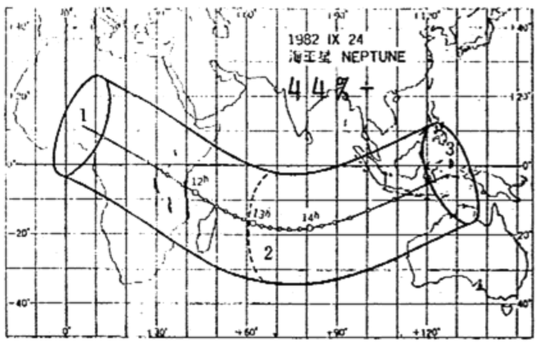
The maps showing the regions of visibility of lunar occultations of planets are reprinted by permission, from the Japanese Ephemeris for 1982, published by the Hydrographic Department of the Maritime Safety Agency of Japan. In region 1, only the reappearance is visible; in region 3, only disappearance may be seen. Reappearance occurs at sunset along a dashed

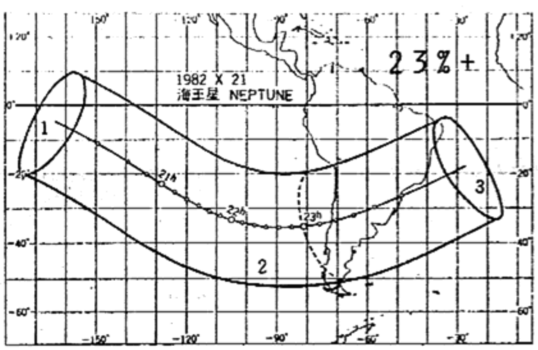




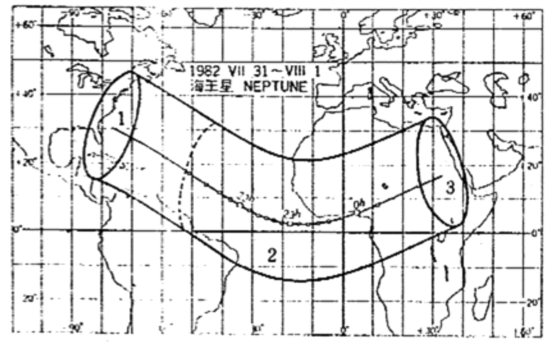
curve, while disappearance is at sunrise along a curve of alternating dots and dashes.

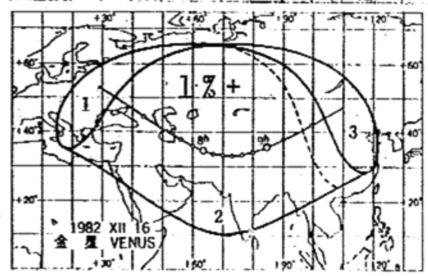




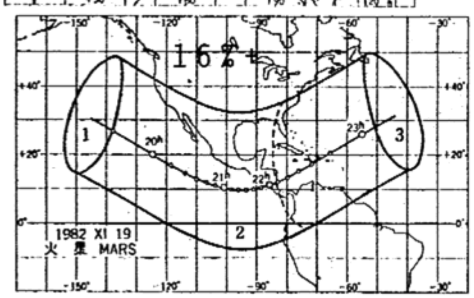


Observers interested in observing partial occultations should request predictions at least three months in advance, from Joseph Senne; P.O. Box 643; Rolla, MO 65401; U.S.A.; telephone 314,364-6233. For further details, see *O.N.* *2* (6), 54-56.





See page 194 for Neptune 1982 Nov 18



EXTENDED USNO TOTAL OCCULTATION PREDICTIONS FOR EARLY 1982, INCLUDING THE TOTAL LUNAR ECLIPSE OF 1982 JANUARY 9

David W. Dunham

Last month, I created a new star catalog, the C-catalog, at the U. S. Naval Observatory for computing extended-coverage total occultation predictions for the first half of 1982. The C-catalog was produced from Astrographic Catalog data to cover the January 9th lunar eclipse star field, as well as the field for the December 30th eclipse and the vicinity of M35, down to the A.C. limit of about magnitude 12½. The C-catalog also contains the Praesepe cluster to mag. 11.5 and the Milky Way region from equinox 1950 declination +20° to +26° and right ascension 5^h to 7^h to mag. 10.5 (and some fainter XZ stars). The C-catalog has been cross-referenced with the XZ catalog, with appropriate X, ZC, or AGK3 ("N") numbers given in the DM REF NO column. The prediction tape for the C-catalog was merged with one for the J-catalog, since the latter is needed for the Hyades, part of which is still being occulted (the proper motion error for the fainter J Hyades stars is still present). The C-catalog was not cross-referenced with the K-catalog. The C-stars with "N" given in the DM REF NO column should be in the K-catalog, and the K-number (obtainable from your regular USNO occultation predictions) should be reported rather than the C-number, if the former is available. *N.B.* Unfortunately, due to a computer program error, the letter prefixes to the USNO REF NO in the chronological lists are sometimes in error — sometimes J when they should be C, and vice versa; the number part is correct. The correct prefix letter is given in the main list preceding the chronological list. Some stars very close to declination +20° between 5^h and 7^h right ascension are in both the C- and J-catalogs, in which case, two predictions will occur for the same star, one from each catalog.

Extended-coverage predictions have been computed only for those with USNO observability-code limits less than 5, since the standard XZ and K USNO coverage is complete for O-codes higher than 4. For many Eastern Hemisphere observers, only predictions during the January 9th eclipse were sent. For others, C- and J-catalog predictions for the first half of 1982 were computed. With very few exceptions, predictions have been sent only to those Western Hemisphere observers who are both IOTA members and who are in USNO's active list. Non-eclipse occultations with the moon more than 72% sunlit, or less than 3% sunlit, have been removed, since virtually all observable events at those phases are included in the regular XZ-K USNO predictions. For this reason, there are no occultations predicted in the extended coverage during January for Western Hemisphere observers, who are being sent their extended predictions at about the same time that this issue is being mailed. If you were not sent extended-coverage predictions, or if you have only Jan. 9th eclipse predictions and want data through June, or if you would like a set of predictions not limited to the phases described above, or if you want data for another station(s), additional predictions are available upon request to me at P.O. Box 7488, Silver Spring, MD 20907, U.S.A. The 2nd half of 1982 extended-coverage predictions will not be computed until another catalog, to include Southern Astrographic Catalog data (at least that part covering the 1982 July 6 Lunar eclipse field), is operational for occultation predictions.

Star charts of the January 9th eclipse field, showing the paths of the Moon's center for 24 cities, were sent to Eastern Hemisphere observers along with their extended-coverage predictions. Also, detailed predictions, including profiles, were distributed for grazing occultations of ZC 1110 (δ Geminorum = Wasat), ZC 1125, and ZC 1129 (63 Geminorum). The value of lunar eclipse occultation timings for solar eclipse studies of changes in the solar diameter is described in my 1982 Occultation Highlights article on pages 100 and 101 of this month's issue of *Sky and Telescope*, which was referenced in the distributed material. The value of timings of grazing occultations during the eclipse was stressed. Also emphasized was the value of accurate timings of occultations at the following Watts angles, where contacts during total solar eclipses have been timed: 8.8, 11.4, 15.2, 19.0, 20.0, 156.0, 156.6, 161.0, 162.6, 170.8, 177.0, 181.4, 185.4, 186.2, 189.0, 190.6, 192.4, 194.4, 195.8, 198.2, 198.8, 204.8, 205.4, 331.0, and 357.4, all in degrees. Most of these would be visible from locations many kilometers inside predicted graze limits. A formula to calculate the distance from the limit for a particular feature is:

$$D = \frac{932''.6}{VPS}[1.000 - \cos(WA - WAG)],$$

where WA is the Watts angle of the solar eclipse contact feature (valley bottom) from the list above, WAG is the Watts angle of central graze given at the top center of the predicted ACLPPP profile for the graze, and VPS is the vertical profile scale in arc seconds per mile (or per kilometer) given in the lower central part of the information below the profile. The result D will be in miles or kilometers, depending on the units of VPS. If you observe from near a point in the predicted occultation limit rather far from the place for which the profile was computed, use WAG = WAGP + PAG - PAGP, where WAGP is the Watts angle of central graze from the profile, PAGP is the position angle ("POS ANGLE") of graze given in the lower right side of the profile, and PAG is the actual position angle of graze given for your intended longitude in the graze limit predictions. The formula should be accurate for distances of nearly 200 km from the limit. The values of timings of occultations observed at these Watts angles are not limited to lunar eclipses, but are useful whenever the latitude libration is between -1°.0 and +1°.0. Unfortunately, we have found that grazing occultation observations by themselves are not very useful for analyses of solar eclipse observations, due to the small range of Watts angle usually covered during grazes. The scale of total solar eclipse phenomena is compressed relative to that for occultations, since the paths of total solar eclipses are typically 200 km wide, while the width of occultation zones exceed 3000 km. Hence, if a total solar eclipse is timed from a location 2 km inside the edge of the path of totality, the equivalent lunar occultation phenomena would occur more than 30 km from the occultation limit. Of course, the actual distances vary depending on the Watts angle of central graze and need to be computed with the above formula. The most useful data would be obtained by both observing the grazing occultation in the usual manner, and accurately timing the total occultation (including some emersions) from a few locations far inside the occultation zone to cover some of the Watts angles listed above for previous solar eclipse observations.

SHUTTLE BACKUP NAVIGATION

Don Stockbauer

An interesting application of occultations is being considered by NASA — the Shuttle Backup Navigation, or Shuttle Autonomous Navigation. It is a method of navigation for situations in which there is a complete loss of radio frequency communications to the spacecraft. The current technique being considered involves the measurement of atmospheric refraction of stars' lines-of-sight with the Star Tracker during several nighttime passes. The actual occultation by the earth's limb will not be observed due to interference with cloud cover; what will be observed is the refraction of the light rays to a point somewhere above the cloud tops. Three star settings would be observed during each of 12 nighttime passes; 36 observations are accepted by NASA as being practical for obtaining a solution. However, this system is in direct competition with TACAN (Tactical Air Control and Navigation); it may never see the light of day. Keep your fingers crossed that we'll never lose RF communications with the Shuttle!

ESOP I ABSTRACTS

[The First European Symposium on Occultation Projects was held in Hannover, German Federal Republic, on 1981 November 7, sponsored by the International Occultation Timing Association/European Section (IOTA)/ES) and the Astronomischer Arbeitskreis Hannover E.V. (AAH), in cooperation with the Institut fuer Theoretische Geodaesie, Universitaet Hannover. Abstracts of papers presented are given here.]

Calculation of Occultations, J. Meeus, Belgium. Description of a new developed program that is able to calculate occultations of stars by the moon for a given star, year, and place of observation.

First part of the program is to analyze the orbit of the moon (variation of node, etc.): Is it possible (in general) that a given star will be occulted by the moon?

Second part consists of the determination of the local circumstances. The program is running on a CDC computer.

Determination of Personal Equation — a New Method, Jean Bourgeois, Belgium.
The personal equation to deduct when timing lunar occultations is subject to various factors of human and physical origins, whose influences are difficult to estimate.

A simulated occultation created in the field of the telescope, just after an occultation timing, may be considered as rebuilding the observational conditions of the actual occultation. A series of repeated simulations, with an artificial star of the same brightness as the actual one, can give the best possible value for the personal equation, and also the observation's accuracy.

An apparatus permitting such simulations is described, and first results are represented, as a function of the "observability code" given in the U.S. Naval Observatory's lunar occultation predictions.

Prediction Programs, Kyril W. Fabrin, Denmark.
Two prediction programs will be mentioned: the well-known USNO EVANS Total Occultation Prediction Programs (called USNOSP) and the prediction program of the author (called OKKU).

The problems in transferring the USNOSP from an IBM machine in Washington, D.C., to a CDC machine in Aalborg, Denmark, will be covered in detail. The basis of OKKU also will be discussed thoroughly and the differences of the programs will be stressed and their accuracies compared.

Theory and Observation Possibilities of the Central Flash, W. Beisker, Astronomischer Arbeitskreis Hannover.
During the occultations of stars by planets with atmospheres a very rare phenomenon can be observed by an observer who is very close to the central point of the occultation, the so-called 'central flash'. Due to the refraction of light in the planetary atmosphere the observer can register an intensity increase. This can be calculated as done by P. J. Young.[1] The central flash has been observed only once in the history of astronomy, at the occultation of ε Geminorum by Mars in 1976, observed photoelectrically from the KAO.[2]

The occultation of Nunki (σ Sagittarii) by Venus (1981 Nov 17) is the next possibility to observe the phenomenon. The central line of this occultation will path through Somalia and Ethiopia. Using the atmospheric data as determined by different spacecraft (Pioneer and Venera) a minimum distance of 82 km to the surface of Venus for light rays contributing to the light intensity increase of the central flash could be calculated. So the light eventually may path through the upper parts of the Cytherian clouds. [Note added by D.W.D.: The height of 100 km above the (solid) surface of Venus which I reported on *O.N., 2* (12) 163 is incorrect. The bending of the star's light required by Venus, due to its larger size, is greater than that for Mars. For Venus, more scale heights consequently are required, and Beisker's 82 km is correct.]

1. Young, P. J.: "Theory of the Occultation of ε Gem by Mars," *Astron. Journ., 82* (1977) 75.
2. Elliot, J. L.; French, R. G.; Dunham, E.; Gierasch, P. J.; Veverka, J.; Chuch, C.; and Sagan, C.: "Occultation of ε Geminorum by Mars, II. The Structure and Extinction of the Martian Upper Atmosphere," *Astrph. Journ., 217* (1977) 661-679.

Fundamental Concepts in Microprocessor-controlled Photometric Systems, N. Kordts, Germany.
Discussion of the possibilities and instrumental arrangements of an automatic photometric system based on a Z80 microprocessor.

Invitation to coordinate amateur efforts to create a processor system to be used by amateurs.

Photometric Occultation Work at Valasske Mezirici, B. Malacek, C.S.S.R.
An up-to-date historical review of photoelectric occultation work: Demonstration of its results.

Reduction of Occultation Data, H.-J. Bode and W. Beisker, Astronomischer Arbeitskreis Hannover.
The data of occultation of stars can be analyzed in different ways. In a recent period of several years, the bright star Aldebaran (α Tauri) was occulted many times by the moon. Grazing as well as total occultations of this star could be observed in Europe. With high-speed photometry, the diameter of Aldebaran was determined to be 0".021 at 550 nm wavelength. The timing of a total occultation can have an accuracy better than 0s003. This is equivalent to a station location accuracy of about three meters.

With a microcomputer system, the data of the grazing occultation of 1981 February 12 were analyzed to calculate the profile of the moon's limb. More than 80 contacts (from 10 stations of a team in the Netherlands and from 5 stations of the Astronomischer Arbeitskreis Hannover) were analyzed.

With a Super-8 movie camera, a total occultation was filmed with an electronic controlled exposure and interval timing circuit.

Principles of One-Dimensional Image Analysis, H.-J. Bode and W. Beisker, A.A. Hannover.
Ordinary direct photometry can be regarded, in general, as zero-dimensional light intensity registration. Photography is the classic system for getting two-dimensional information, whereas video systems deliver modern high-speed sampling rates.

One-dimensional data can be obtained using a moving slit for scanning the desired celestial object.

Design of a Portable Photometric Unit for Occultation Applications, W. Beisker, H.-J. Bode, and C. Bittner, Astronomischer Arbeitskreis Hannover, Volkssternwarte Hannover.
The great importance of photoelectric timing of occultations of stars forced us to develop a portable photometric system. Independence of the mains supply, high-speed recording (about 1000 samples/sec.) on magnetic tape, and a compact design, are the highlights of this system. It includes a high-voltage supply for the photomultiplier tube with a long-time stability better than 0.05% and a short-time stability (frequency range >0.05 Hz) better than 0.005%. The photometer uses a 12V DC power supply p.e. an accumulator as used in cars. The signal from the multiplier is amplified by a preamplifier in the photomultiplier case and by a main amplifier. Variable gain factors and offset adjustment, as well as different time-averaging possibilities, are included in the main amplifier.

Data recording on a magnetic tape is done by a voltage/frequency converter. With the complementary frequency/voltage converter, the data can be read back from the magnetic data tape. With an additional electronic circuit, a microcomputer link can be added, to analyze and plot the stored data.

Possibilities of Occultation Observations in Finland, Jukka Piironen, Finland. Aarne Karjaleinen Observatory (University of Oulu) and Tuorla Observatory (University of Turku) are willing to participate in observations of asteroidal occultations. At Oulu, we have a 40-cm Cassegrain telescope with photoelectric photometer (with strip-chart recorder), and at Turku, there is a 60-cm Cassegrain with photon-counting photometer. For the observations, both observatories have the future potential of using time signals directly. Thus, the errors of manual calibration will be eliminated in the future.

As observing sites, both Oulu and Turku are excellent, considering their high northern latitudes. However, because of the unsteady weather conditions, the participation of other Scandinavian countries is of great importance. Sweden and Norway are especially needed, to cover northern latitudes as well as possible.

[The following were also on the agenda:] Discussion and coffee break, including TV show (Grazing Occultation of Aldebaran); National Occultation Work -Belgium (R. Laureys) -West Germany (H.-J. Bode) --Hannover (H.-J. Bode) --Luebeck (I. Reimann); IOTA/ES, General Situation; Demonstrations of Grazing Occultation of Venus (movie) and Grazing Occultation of Aldebaran, M. Knitsch, W. Germany.

[The next opportunity for European photoelectric observers to meet will be during an I.A.P.P.P. session of a meeting of the International Union of Amateur Astronomers in Bologna, Italy, in August, 1982, just before the I.A.U. General Assembly in Greece. The next ESOP meeting is tentatively planned for November, 1982, probably in Czechoslovakia, to encourage attendance by more eastern Europeans.]

PLANETARY OCCULTATION PREDICTIONS FOR 1982

David W. Dunham

This is a continuation of the article which started on p. 178 of the last issue, which includes tables of all of the planetary and asteroidal occultations predicted to occur during 1982. Finder charts and maps of occultations visible from the Eastern Hemisphere during January were distributed with information and predictions of lunar occultations during the lunar eclipse of January 9th mentioned on page 188. A map showing the predicted paths of occultations of stars by asteroids crossing well-populated parts of North America during 1982 (not 1981, as stated in the caption) was published with my article on 1982 planetary occultations starting on p. 62 of this month's issue of *Sky and Telescope*. The rest of this article consists of notes, finder charts, and maps for specific occultations which will occur during the first few months of 1982.

Notes about Individual Events

Jan. 24: An astrometric update based on last-minute astrometry at Lick Observatory is planned for this occultation, which will only be detectible with photoelectric photometers. Either Larry Wasserman or Bob Millis at Lowell Observatory, Flagstaff, AZ, telephone 602,774-3358, will compute the final prediction and coordinate the efforts of portable photoelectric observers to cover this occultation. But wherever the occultation path is predicted to be, photoelectric observers at fixed sites throughout North America are urged to monitor the appulse, to give the best possible coverage of the space around Herculina to try to detect the probable satellites which produced the secondary occultations reported during the 1978 June occultation by Herculina. This path is nearly perpendicular to the one for the 1978 event, so the presumed satellite orbital plane will almost certainly not be in line with Herculina's motion this time, and secondary occultations will be possible for observers at least 5 diameters (or more) from the primary occultation path. I expect to be out of town from late Jan. 19 - 24, and probably will be unavailable to help with the last-minute predictions for this occultation.

Feb. 8: This prediction can be improved considerably with some recent astrometry, as can the predictions for the other occultations by (344) Desiderata this year. The ephemeris is rather uncertain, and most of Europe and eastern North America are about halfway between the occultation paths predicted using Ephemeris of Minor Planets (E.M.P.) 1981 and Herget data. I plan to coordinate a possible North American effort for this event, depending on the astrometric results.

Feb. 28: (201) Penelope has a large-amplitude light curve, indicating an unusual shape, possibly being two asteroids which have crushed together to a dumbbell shape.

Mar. 9: A large satellite of (18) Melpomene is suspected from the 1978 December 11th secondary occultation recorded photoelectrically at Atlanta, GA.

Mar. 15: An ephemeris supplied by Leif K. Kristensen, Institute of Physics, University of Aarhus, Denmark, has been used for my prediction. From analysis of photoelectric observations of the 1979 August 17th occultation of SAO 144417 by (51) Nemausa published in *Astron. Astrophys. Suppl. Ser. 44*, p. 375 (1981), Kristensen determined a mean diameter of 153 ±15 km. The observations were made at Alma-Ata and Gissar Observatory in the southern U.S.S.R.; I did not previously know about the Alma-Ata observation. The EMP 81 path for this year's occultation just misses the Earth's surface, passing 3" east of the path using Kristensen's data. The EMP 81 orbit satisfies published 1979 and 1980 observations within 1", but Kristensen has done a more thorough study of Nemausa's orbit, so his prediction should be more accurate. Since I do not have Kristensen's orbital elements, I can not compute how well they satisfy the 1979 and 1980 observations, and some recent astrometry is recommended. A shift of only a short distance to the east will put the path entirely in daylight, or twilight too strong for observation.

Mar. 20, (344) Desiderata: The ephemeris is quite uncertain, with all the U.S.A. except AK and HI between the predicted paths; see the note for Feb. 8. The Herget path misses the Earth's surface to the east.

Mar. 20, (250) Bettina: The diameter of Bettina may be smaller than the value I have used (from TRIAD) since its type and albedo are poorly determined.

Radiometric and/or polarimetric observations to measure the albedo as soon as possible are urged for this important occultation. SAO 58636 is θ Aurigae, the brightest star yet predicted to be occulted by an asteroid. There is some spectroscopic evidence for close stellar duplicity. The star is also a visual double, ADS 4566, with a 7.2-mag. companion 3".5 in p.a. 304° which will just miss being occulted. The occultation will occur after sunset only from part of eastern Brazil. Paul Maley, 15807 Brookvilla, Houston, TX 77059, is planning to join Brazilian observers for an expedition; others interested in joining this effort should contact him. I may join the effort to attempt a video observation. Jorge Polman, Clube Estudantil de Astronomia, Colegio Sao Joao, Rua Francisco Lacerda, 455-Varzea, 50.000 Recife - PE - Brazil, telephones 0812,271864 or 270094, will coordinate the efforts of amateurs at the national level. The star is bright enough, and the altitude high enough, that the occultation might be observed in daylight from western South America, or from southern North America if astrometry shows a large north shift, which is possible.

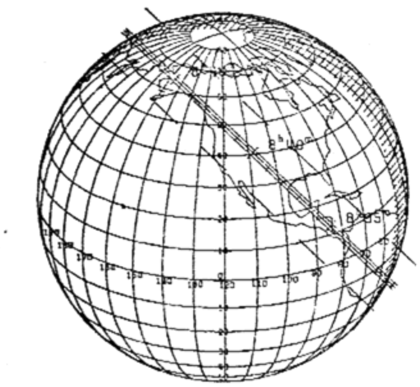
Mar. 23: If I travel to Brazil for the occultation by Bettina discussed above, I will be unavailable for last-minute coordination in North America for this occultation, and the one by Desiderata on Mar. 20; the situation probably will be clarified, with possible alternate arrangements made, in time for the next issue, which probably will be distributed in time for the Mar. 20 events. A plate was taken at the Royal Greenwich Observatory a few days before the 1981 Nov. 22 occultation by (386) Siegena. The prediction based on measurements of this plate put the path for the primary component of SAO 135010 across central Europe in daylight, while the path for the secondary component was predicted to cross New Hampshire; the astrometric accuracy was "poor." The prediction was telexed to Jim Elliot at the Massachusetts Institute of Technology, but since it was a weekend, he did not receive it until 2 days after the event. Telex can not be relied upon near weekends, when urgent updates should be telephoned instead. The prediction, though poor, indicated a shift at least 2/3 of the way from the Herget path to the EMP 81 path. If a similar shift occurs on Mar. 23, the path will be at nearly 1" north, crossing northern CA and MN. So again the event could occur in just about any part of the U.S.A., and more astrometry is needed to improve the prediction.

Apr. 18: The possible area for this event in the table on p. 179 of the last issue should be changed to central Asia and southern Europe, and 4 minutes should be subtracted from the times. Sôma's world map was produced using an ephemeris based on an old I.T.A. orbit, but the path computed from EMP 81 data is preferred. My regional map was computed from the preferred EMP 81 data. Herget did not compute an orbit for (146) Lucina.

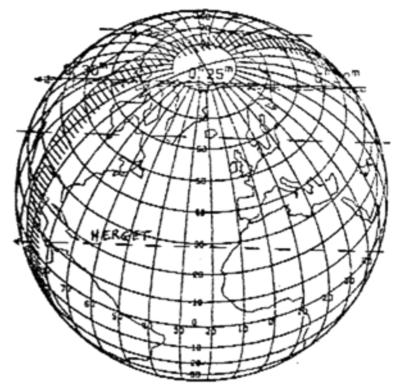
Apr. 22 and May 1: The Astrographic Catalog, Hyderabad Zone, number of the star is given in the DM No. column; neither star is in the B.D. Prospective photoelectric observers of these occultations should contact Jim Elliot, Dept. of Earth and Planetary Sciences, Bldg. 54-612, Mass. Institute of Technology, Cambridge, MA 02139, U.S.A., for standardization of filters. Uranus and its rings should occult the star for all in the region of visibility.

Apr. 27: See the note for Jan. 24, but in this case the occultation Δm will be large enough for visual observation.

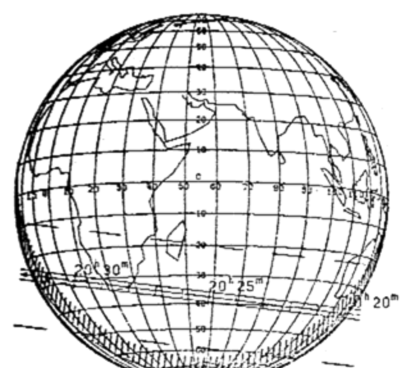
May 28, (40) Harmonia: The star is 46 Leonis or ZC 1544.



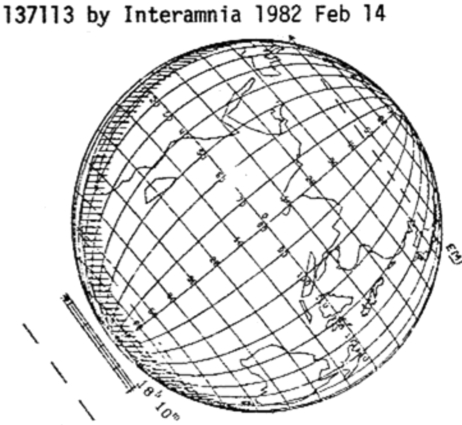
+27° 1688 by Herculina 1982 Jan 24



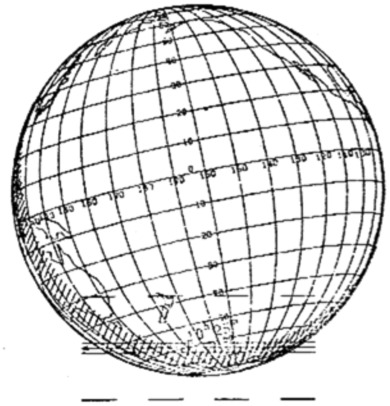
+45° 1520 by Desiderata 1982 Feb 8



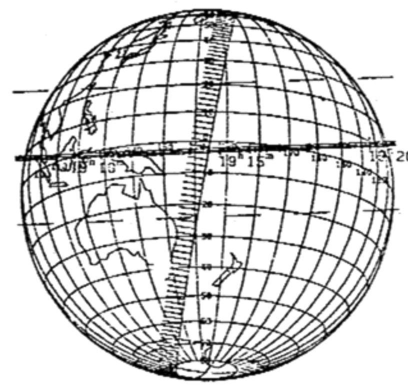
137113 by Interamnia 1982 Feb 14



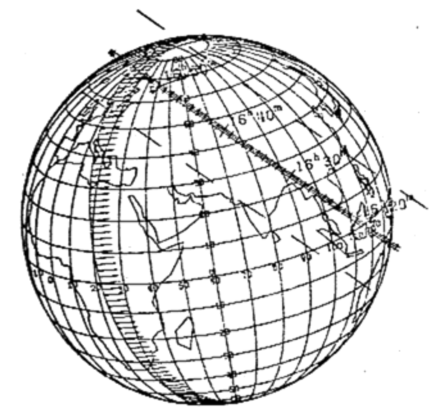
-02° 2859 by Alauda 1982 Feb 18



137038 by Interamnia 1982 Feb 22



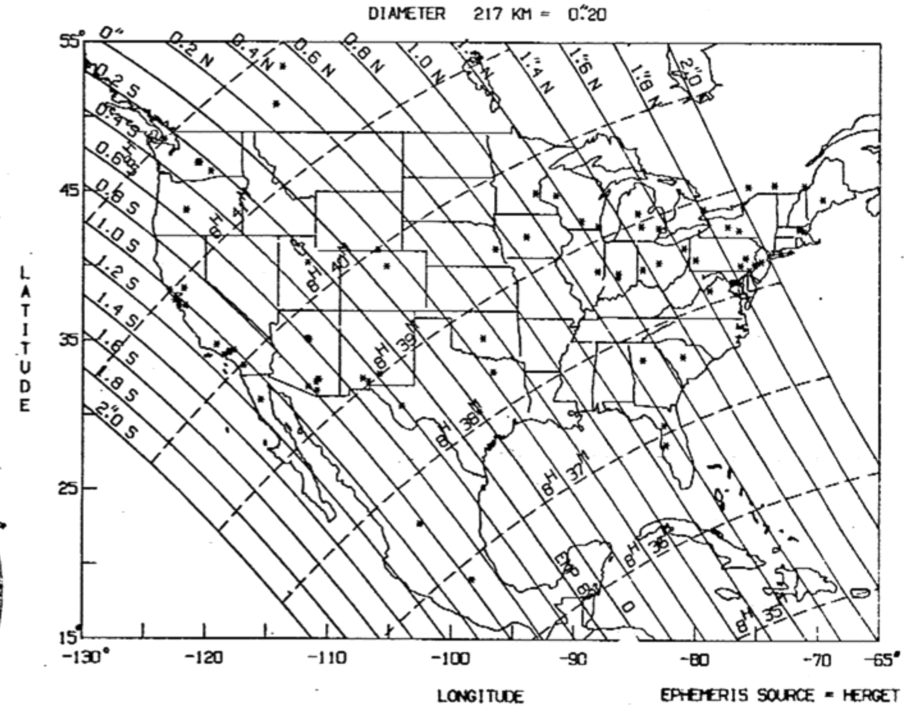
159986 by Doris 1982 Feb 25

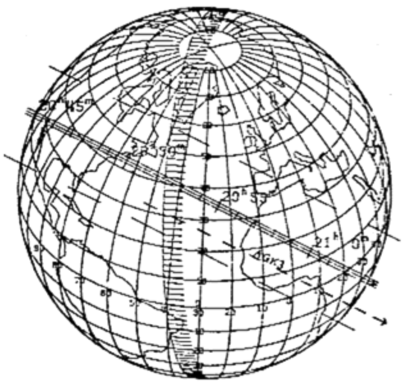


+18° 1579 by Penelope 1982 Feb 28

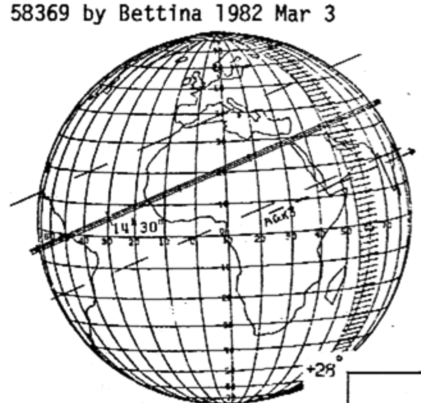
1982 I 24 (532) HERCULINA BD +27 1688

DIAMETER 217 KM = 0.″20

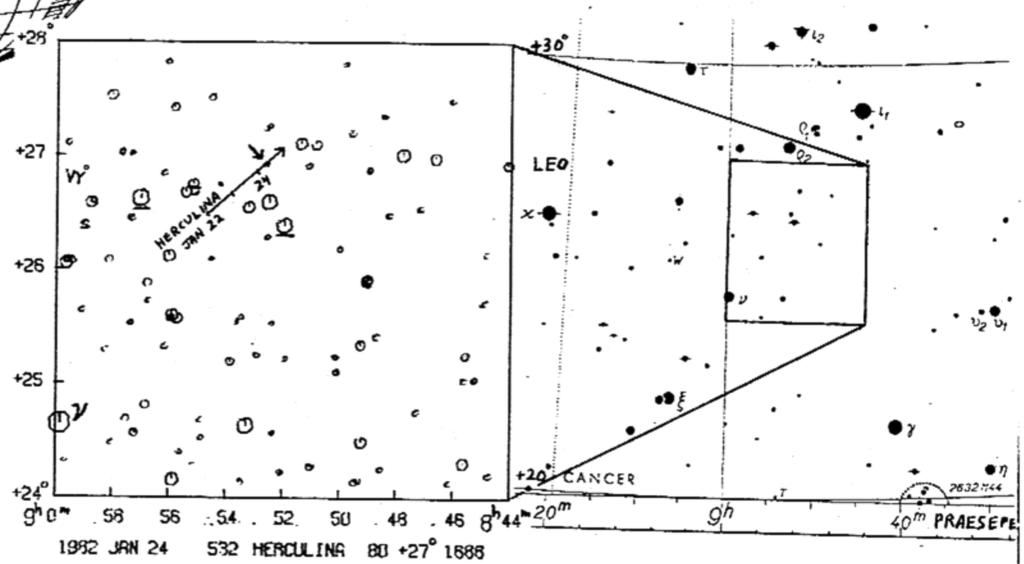




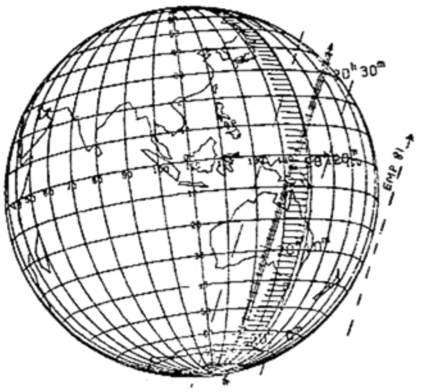
58369 by Bettina 1982 Mar 3



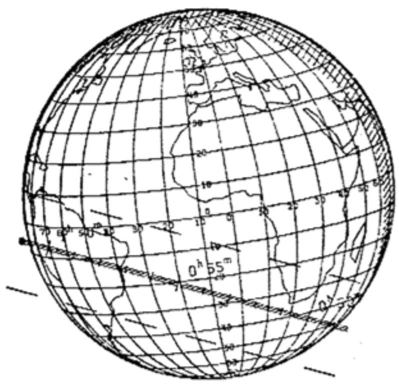
110454 by Melpomene
1982 Mar 9



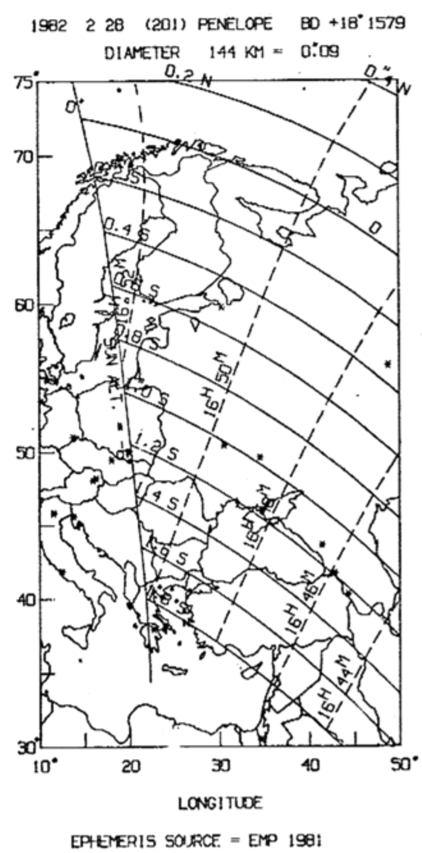
1982 JAN 24 532 HERCULINA BD +27° 1686

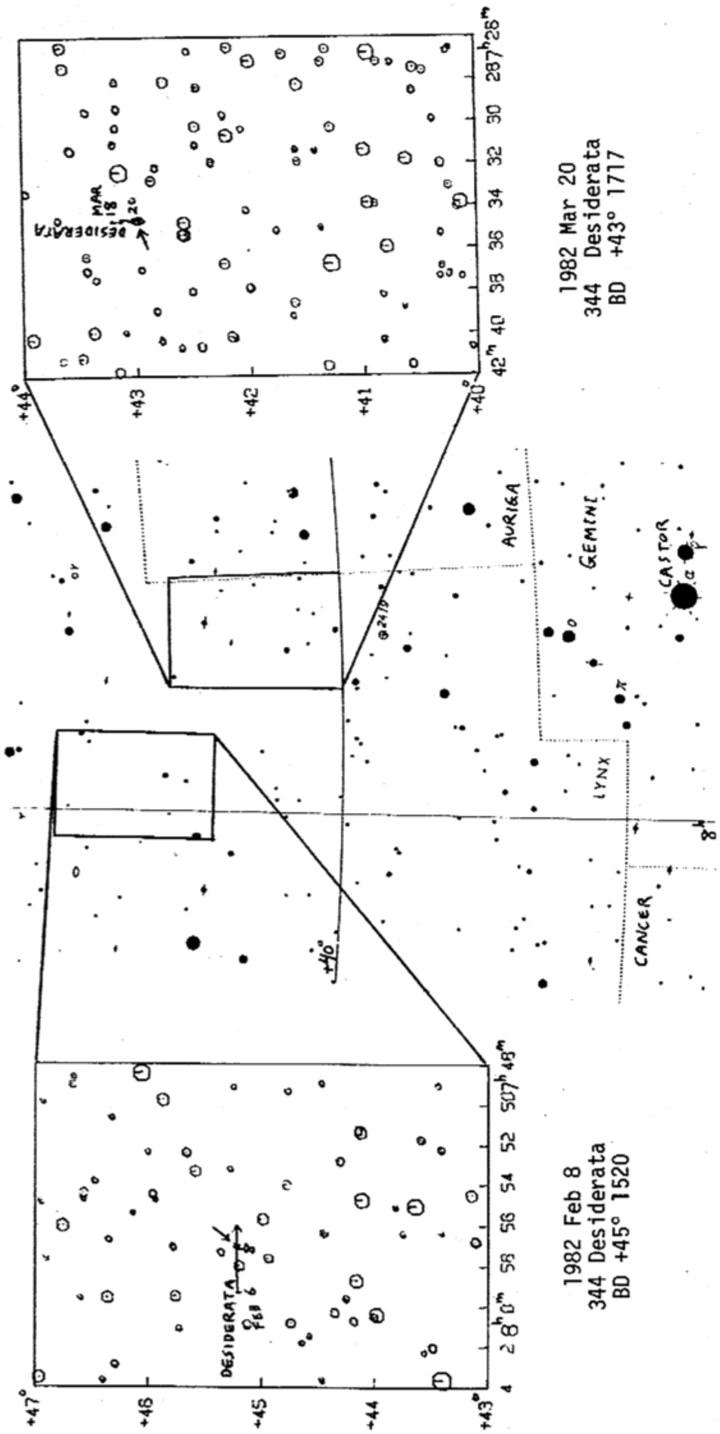


140321 by Nemausa 1982 Mar 15

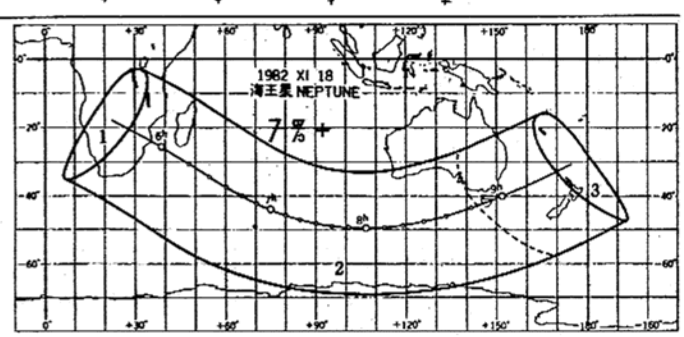


+07° 2512 by Vibilia 1982 Mar 17

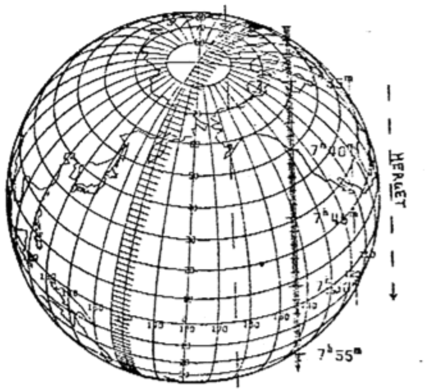




Continued from page 188



77304 by Eunomia 1982 Mar 19



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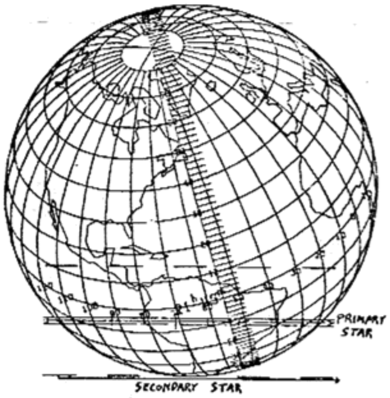
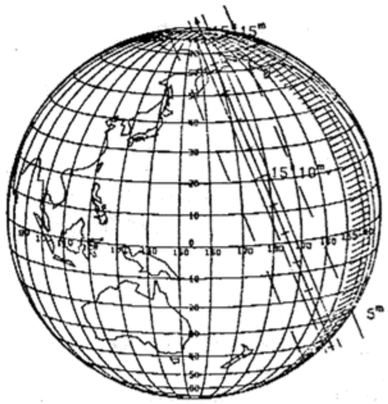
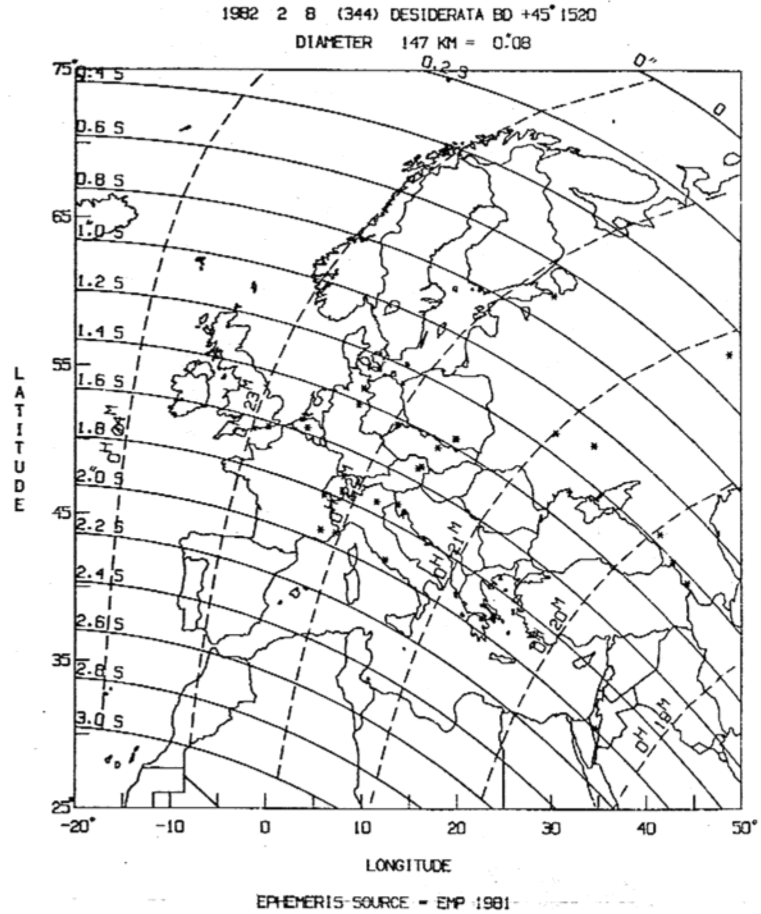
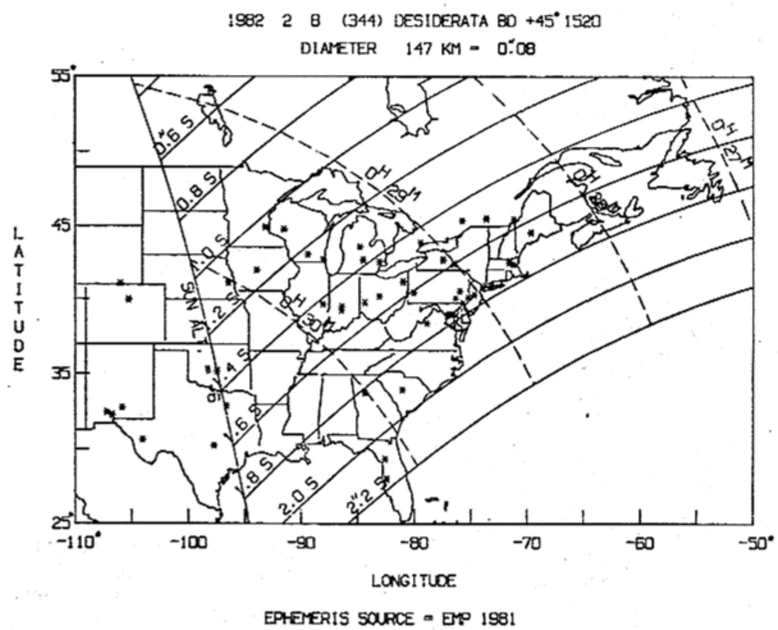


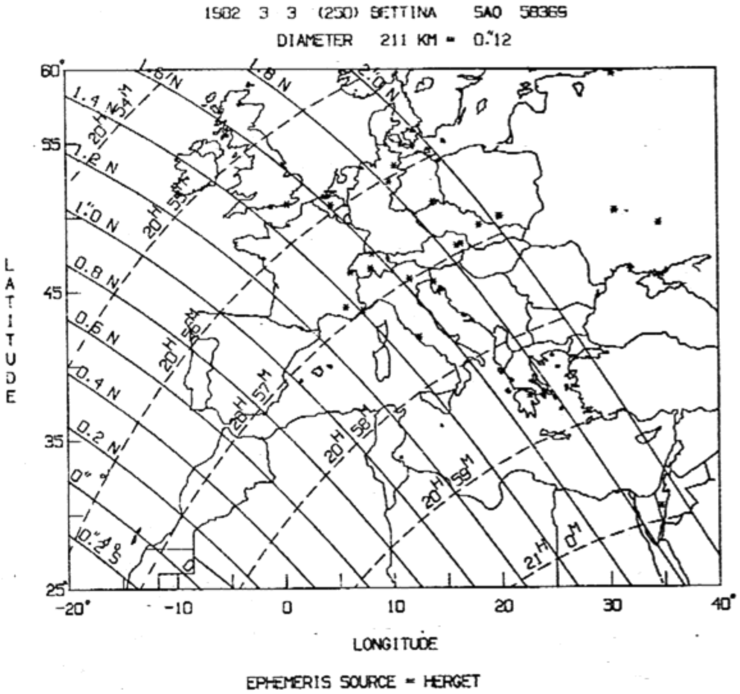
θ Aurigae by Bettina 1982 Mar 20

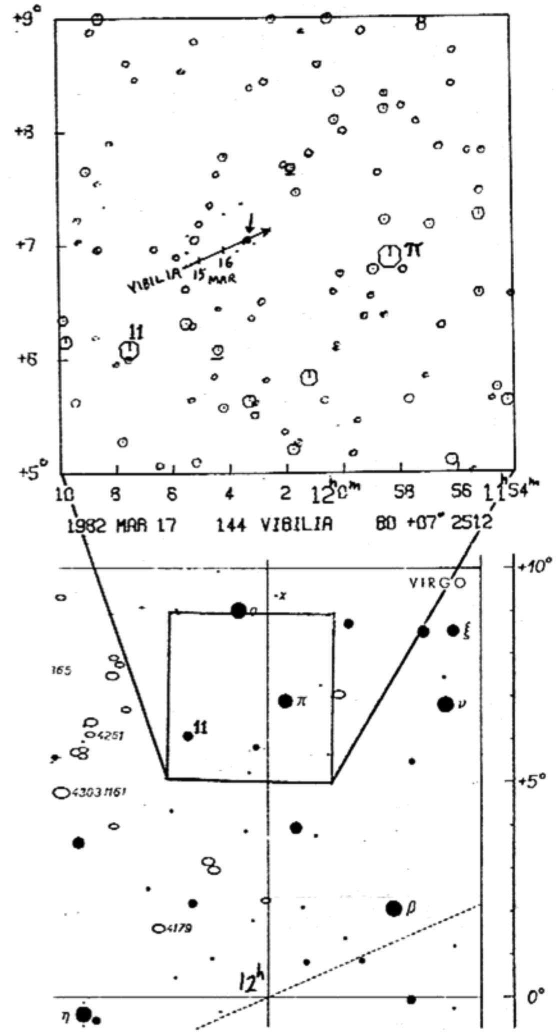


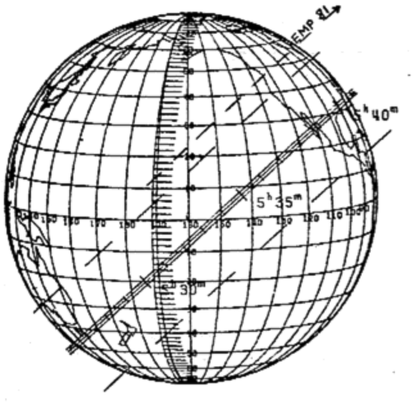
+11° 2562 by Pallas 1982 Mar 21



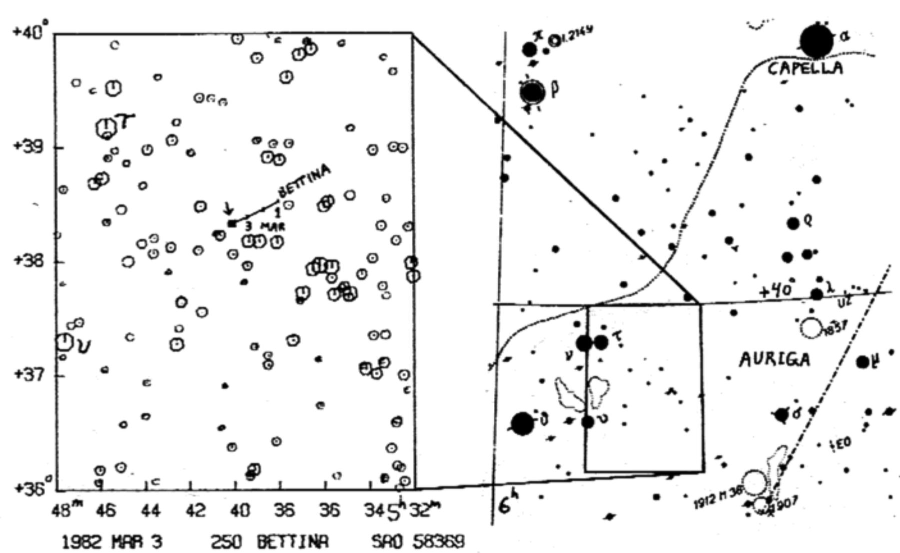


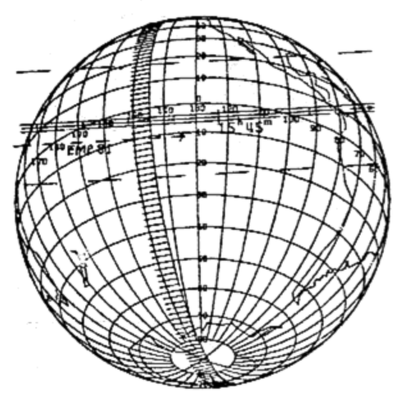






+06° 1468 by Siegena 1982 Mar 23





211211 by Bamberga 1982 Mar 24

[A last-minute (January 10) phone message from David Dunham indicates that his office will be moved at about the time this issue is published. The phone number will remain the same (301,589-1545), but the extension will be changed, probably to either 242 or 326.]