Occultation Newsletter

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FROM THE PUBLISHER

This is the first issue of 1989. It is the eleventh issue of Volume 4.

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Although they are available to IOTA members without charge, non-members must pay for these items:

Local circumstance (asteroidal appulse) predictions (entire current list for your location)	1.00
Graze limit and profile prediction (each graze)	1.50
Papers explaining the use of the predictions	2.50

Asteroidal occultation supplements will be available at extra cost: for South America through Ignacio Ferrin (Apartado 700; Merida 5101-A; Venezuela), for Europe through Roland Boninsegna (Rue de Mariembourg, 33; B-6381 DOURBES; Belgium) or IOTA/ES (see below), for southern Africa through M. D. Overbeek (Box 212; Edenvale 1610; Republic of South Africa), for Australia and New Zealand through Graham Blow (P.O. Box 2241; Wellington, New Zealand), and for Japan through Toshio Hirose (1-13 Shimomaruko 1-chome; Ota-ku, Tokyo 146, Japan). Supplements for all ather areas will be available from Jim Stamm (11781 N. Joi Drive; Tucson, AZ 85737; U.S.A.) by surface mail at the low price of 1.18
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Observers from Europe and the British Isles should join IOTA/ES, sending DM 40.-- to the account IOTA/ES; Bartold-Knaust Strasse 8; 3000 Hannover 91; Postgiro Hannover 555 829 - 303; bank-code-number (Bankleitzahl) 250 100 30. Full membership in IOTA/ES includes the supplement for European observers (total and grazing occultations) and minor planet occultation data, including last-minute predictions, when available.

[1] Single issue at ¼ of price shown
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[5] Area "B" includes the rest of South America, Mediterranean Africa, and Europe (except Estonia, Latvia, Lithuania, and U.S.S.R.).

BRIEF ANNOUNCEMENTS

Please do not send diskettes to Mr. DaBoll (Editor, Secretary-Treasurer) as he has no way to read them.

MacPherson Morgan will accept for conversion to diskette form only occultation timing data which have been entered on the current standard IOTA/ILOC forms.

Those planning to observe the 1990 July 22 total solar eclipse in Finland should write for the English-language information leaflet from Ursa Astronomical Association; Laivanvarustajankatu 3; SF-00140 Helsinki; Finland.

IOTA NEWS

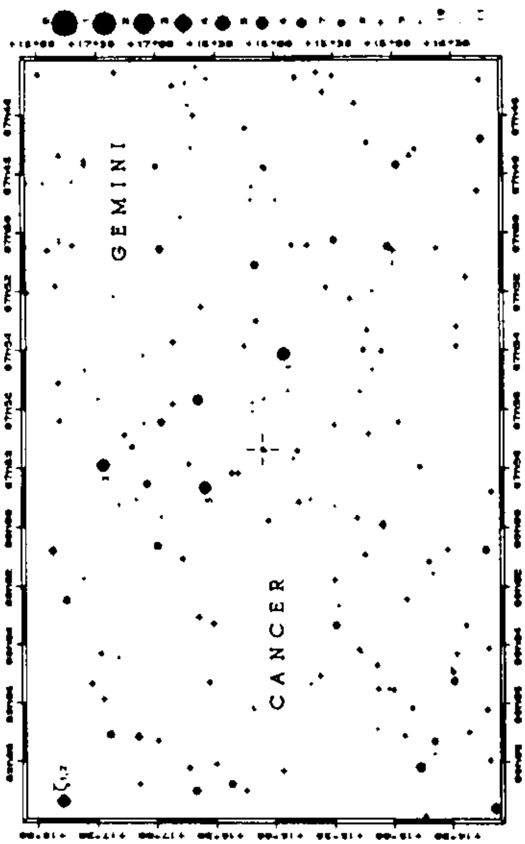
David W. Dunham

A special *o.n.* supplement about occultations during the lunar eclipse on February 20th was distributed only to the minority of subscribers and IOTA members who live in areas where occultations of faint stars during that eclipse could be seen. This made it unnecessary to mail this issue before the eclipse. Consequently, this issue is being distributed about a month later than I suggested in the last issue, which allowed time to create the extensive L-catalog needed to compute predictions of faint stars during the February lunar eclipse. This required more effort than I anticipated, occupying much of my time during late January and early February; see p. 263.

IOTA/ES Meeting. As noted in the last issue, I attended a Giotto Science Working Team meeting that was held in Darmstadt, German Federal Republic, on February 20th. On February 18th, upon first arriving in Germany, I travelled to Hannover, where a small meeting of IOTA/European Section members was held. Besides me, the only other foreigner attending the meeting was Bohumil Maleček from Czechoslovakia. This was the first time that I had seen Maleček since 1967, when I met him during the first International Astronomical Union General Assembly that I attended, in Prague. Hans-Joachim Bode led the discussions. The late distribution of *o.n.* to IOTA/ES members was a major concern. I explained that the bulk mailings within and from the U.S.A. inevitably cause considerable delays. Quicker alternatives that would not be too expensive for IOTA/ES were discussed, and a decision on implementing one of these will be made after the costs are assessed.

I gave a magnetic tape containing 6 star catalogs, as well as solar eclipse Baily's bead analysis software and sample data, to Mr. Bode. The latest version of the XZ (XZ80JA) and the New L-catalog were included. Mr. Büchner's software, which prepares ILOC disk files and calculates residuals for lunar occultation timings, was briefly described. Brown's improved lunar theory was being used for the lunar ephemeris. I suggested that Chapront's laser-ranging-fitted theory would be better, and suggested that they contact Jean Meeus, who has successfully implemented an abbreviated version of Chapront's theory that is quite accurate for occultation work. Since Büchner's software might be useful for other IOTA members, IOTA standards for exchanging software were discussed. Since programs might be run on minicomputers and mainframes as well as PCs, we agreed that Basic would not be a good standard, and suggested FORTRAN 77 as a standard programming language. I apologized that most of my programs were written in FORTRAN before the 77 standard was established, and also for the paucity of comment statements, since most of my programs were written when I did not expect others to use them. IOTA/ES did recently adapt my Planetary appulse/local circumstances (LOCM) program to run on one of their computers, and they now have supplied these predictions to IOTA/ES members. IOTA/ES has also developed software to plot finder charts for stars occulted by asteroids, to supplement those produced by E. Goffin. An example, "Bedeckung von SAO 97455 durch Kalypso" (Occultation of SAO 97455 by Kalypso) is shown below. The SAO catalog is used, but later

Bedeckung von SAO 97455 durch Kalypso
13. Januar 1989, 3h 09.8m MEZ
α· 7h 57m 22.4s, δ· +16° 06' 38" (1950)



they plan to add AGK3 stars. I have not yet learned whether the the writing of Bayer Greek letter and Flamsteed number designations, and constellation names, is automatic (to get the designations and plot them in places to avoid writing over stars); if so, at least these aspects of the program would be of interest to me and to others producing finder charts automatically.

Future observing trips were briefly discussed. I gave predictions for the bright-limb graze of 4.5-mag. 136 Tauri on March 14th to E. Bredner, which he had requested earlier, but I warned him that the bright-limb conditions may make it impossible to get useful timings of the event (for this reason, predictions of stars of this brightness on the bright limb are not included in IOTA's usual graze prediction coverage). Hans Bode hopes to observe the March 19th daytime northern-limit graze of Regulus from Italy. I said that I hoped to observe the June 7th Praesepe passage from southern Italy or southwestern Greece, depending on a trade-off between twilight and low Moon altitude, and some of the others expressed some interest in this. Hans Bode and Wolfgang Beisker plan to come to the U.S.A. to observe the July 3rd occultation by Saturn with a CCD camera, and I said that I would find an observatory where they could make these observations, probably in California. An international campaign to observe the Aug. 17th total lunar eclipse grazes of 42 and 44 Capricorni was proposed. Paul Maley, and perhaps other IOTA members to observe the northern-limit graze of 44 Cap. from England, while IOTA members from southern Africa would try to cover 42 Cap.'s southern limit in Kenya. Hans Bode and E. Bredner expressed an interest in observing both of these occultations from the other limits, both of which cross northern Egypt, as shown in the Eastern Hemisphere Grazing Occultation Supplement for 1989. Hans said that a relative living near Cairo could help with the local arrangements there. More observers are sought to help with the effort in Egypt, and I suggested that Bode might contact Helwan Observatory to see whether they could provide some manpower for the effort. Several IOTA/ES members are interested in observing the upcoming total solar eclipses, in Finland in 1990 and in Mexico in 1991. Hans discussed the possibility of taking a GPS receiver to Indonesia to refine the positions where observations of the 1984 November and 1988 March eclipses were observed, but he wants to do a preliminary analysis of the timings first to see if this effort is justified.

Hans showed me the 40-cm Cassegrain telescope which he now has in an observatory on his roof. It is partially controlled by a portable PC, and later he plans to have it fully computer-controlled, for photoelectrically monitoring variable stars. He recently observed an occultation of a 10½-mag. star, which appeared "quite bright" with this telescope. On the same mount, he is working to add a 15-cm long-focal-length astrograph, to use for last-minute asteroid occultation astrometry; the field of view will be nearly 3 degrees, and he expects 0".2 accuracy. Finally, he gave me a copy of the videotape that he made of the Regulus graze in Denmark last November 3rd, with a portable 20-cm telescope. It is the best graze video that I have seen, including about 18 events. Counting the events is difficult due to the many brightness variations that took place due to Fresnel diffraction. When I get a chance, I will have this copy converted from PAL format to American-format video, so that I can include it in the video sequences that I distribute.

Trip to Soviet Union. I plan to visit the U.S.S.R. for the first time in early April, to attend meetings at the Space Research Institute in Moscow. During the last week of March, I also hope to visit astronomers in Leningrad, Kiev, and perhaps Dushanbe, if the appropriate arrangements can be made. In particular, I want to talk to Dr. Tel'nyuk-Adamchuck, Director, Astronomical Observatory of the Kiev State University. He is organizing Soviet efforts to observe the 1990 July solar eclipse from near the edges of the path of totality, and has already had correspondence with Paul Maley indicating a willingness for collaborative efforts with IOTA. If by the time of the eclipse, commercial air service between Alaska and eastern Siberia has been established, that might be an interesting way for Americans to get to this eclipse path.

European Asteroidal Occultation Network. Roland Boninsegna informs me that EAON's policy is to supply asteroidal occultation prediction information to all active observers in Europe. However, if anyone (including IOTA and IOTA/ES members) on their mailing list does not report any observations in a two-year period, they will be sent a letter asking whether they are still interested in receiving EAON's material. If they do not reply affirmatively to this letter they are removed from EAON's mailing list.

Praesepe Passages, especially June 7th. Occultations of the Praesepe cluster (M44, or the Beehive) that will occur this year are listed on page 68 of the January issue of *Sky and Telescope*. Perhaps the best passage will be the one on June 7th, when the Moon will be only 18% sunlit and waxing. The Moon is then far enough from the Sun that most of the passage can take place high enough above the horizon in a relatively dark sky for easy observing with little interference from lunar glare. A special supplement about this event will be sent to IOTA and IOTA/ES members in Europe. It will include charts similar to those for Pleiades passages, such as the one on p. 261. Detailed predictions of occultations of faint stars in the Praesepe are included in the L-catalog USNO predictions; see p. 263. The Moon will be too bright on April 14th to observe much more than occultations of XZ stars included in the USNO predictions for 1989 distributed last year, so L-catalog data and a chart will not be essential for it; besides, the Moon will only nick the northern part of the cluster, missing most of it. The May 11th event occurs in bright twilight in Hokkaido, and the Moon will be very low in Alaska. The Moon will be too close to the Sun (poor altitude-twilight combination) to see much more than XZ-star occultations on August 28th. I will produce another supplement for the September 24th event, also quite good, but in an area with few IOTA members. Articles (with charts) for the somewhat less favorable October and November passages will be included in future issues of *Occultation Newsletter*.

Hubble Space Telescope Observing Proposals. In a letter sent from the Space Telescope Science Institute to all amateurs working on Phase II proposals, the deadline for receipt of these proposals was set at February 24th. I received two proposals, Paul Maley's on imaging asteroids to search for satellites, and Tony Murray's on discovering stars during lunar occultations.

Pallas Paper Schedule and Other Analyses. Unfortunately, the star catalog and prediction work mentioned elsewhere in this issue have again delayed work on the 1983 Pallas occultation paper. We did recive more data on some of the observations made in Florida from Terry Oswalt. These data have been incorporated into the database and a new analysis performed, with results that differ very little from the previous solution. Paul Maley and I provided Don Stotz with data about a discrepancy between the northernmost occultation and southernmost miss observations, and Don said that he would visit the sites to refine the positions (Don is the IOTA member who lives closest to these locations). I will work to finish the Pallas manuscript as soon as possible (probably within 10 to 11 days) after I return from the Soviet Union, and with some luck, it may be done just before that trip. For the 1987 September solar eclipse in China, Pat Trueblood has typed the rest of the IOTA Baily's bead timings into a file that is ready for processing at the U. S. Naval Observatory. Some more *local* help like this would be very helpful for completing important IOTA analyses whose completion and publication are long overdue!

The next issue of *O.N.* will probably appear in June or early July, at least in time for the good July 27th Pleiades passage in western North America.

GRAZING OCCULTATIONS

Don Stockbauer

My goals as coordinator of IOTA's lunar grazing occultation section are:

1. To provide a forum for the exchange of information through these articles;
2. To quality check the reports received and to request any needed clarifications;
3. To publish tabular summaries of each expedition's results; and
4. To maintain an independent repository of the reports.

In order to help IOTA accomplish these goals, please send a copy of your graze report to me at 2846 Mayflower Landing; Webster, TX 77598; U.S.A. (make a copy for yourself, of course)). Sending a copy to ILOC in addition is very helpful; their address is: International Lunar Occultation Centre; Geodesy and Geophysics Division; Hydrographic Department; Tsukiji-5, Chuo-ku; Tokyo, 104 Japan. Data on diskette should be sent to ILOC; if you prefer this medium, please send me a printout of your data file only. Total occultation data in any format should only be sent to ILOC, as I do not need it to produce this article.

I have been asked for references on occultation fundamentals. The "papers explaining the use of the predictions" listed on the front page of each *O.N.* issue is the preliminary version of IOTA's observer's manual; it is the basic reference. I have a paper available upon request titled "How to Calculate a Lunar Grazing Occultation Shadow Shift"; it contains information not in the observer's manual. I will be more than happy to answer any questions directed to me at the above address.

One of our members asked me for the following general interest information.

1. In ordinary English, the graze shift is a measure of how much the prediction was in error. If

you observe a southern-limit graze, and the star was seen to be occulted for much too long (say, for 10 minutes), then the actual shadow must have passed far south of your site; you observed a large south shift of the actual shadow from the predicted shadow. Shifts will occur as long as there are any inaccuracies in our predictions (either star position errors, or lunar profile errors). One must be prepared for shifts of zero to several tenths of an arc second at best, to perhaps ½ to 1 second (rare) at the very worst. Previously observed shifts published in *O.N.* for a star may be applied to one's own expedition for that star (assuming the observations were of high quality and the same prediction version was used), but the Watts angle (WA) and latitude libration should be similar for best results. A difference of over a degree in WA and/or latitude libration between expeditions lessens the validity of the comparison greatly.

2. A graze shift results from the combined effects of error in the star's position and error in the predicted profile. The basic definition of the shift is the distance (in arc seconds as subtended at the Moon's distance, the scale on the left side of the profile) and direction (north or south) that the predicted profile must be moved to match the actual observations. It does not measure absolute positions; it is a measure of the relative positions of the Moon and the star.

3. Graze observations do not usually match the predicted profile in detail. The observations will, in general, resolve finer detail than the profiles show, since the Watts data base upon which they are based is relatively coarse. In such situations one just fits the data as well as can be done by hand and eye. It is permissible (and advisable) to move all contacts as a group freely either earlier or later in time (i.e., right or left) to obtain the best fit, since it is the vertical component that we are interested in. Someday, when all observations are applied to the Watts data base, the resolution of predicted profiles will dramatically improve.

Tom Campbell, 5405 98th Ave.; Temple terrace, FL 33617 has a utility to convert Radio Shack TRS-80 formatted files to IBM-compatible files. He is willing to either provide interested parties with the utility itself, or to do the conversion for them. For someone with access to a TRS-80 who would like to generate ILOC machine-readable occultation report files, this would be an essential piece of software as the ILOC format is IBM-compatible.

Date	V/P	Star #	Mag	% Snl	CA	Location	# Sta	# Tm	S S	Ap Cm	Organizer	C	St	WA	b
1987															
0306		0560	3.8	37+	N	Jollyville, OK	5	16			Carl Schweers				
0817		0696	7.4	35-	15N	Stawell, Austrl.	1	7	2	15	Jim Blanksby	3	S	347	-70
1012		0810	1.8	72-	2N	Garland, AL	2	13	1	15	Povenmire/O'Sullivan				
1988															
0408		2660	6.1	62-	7S	Kilmore, Austrl.	5	14	2	15	Jim Blanksby	3	S	189	63
0410		189391	8.4	38-	2N	Wangaratta, Austrl	1	1	1	15	Jim Blanksby	2	N	356	49
0411		3153	8.4	27-	7N	Bulla, Australia	4	16	1	15	Jim Blanksby	0		351	35
0413		146621	8.5	9-	6N	Benalla, Australia	1	8	1	15	Jim Blanksby	2	S	352	3
0421		078095	7.4	26+	15N	Colac, Australia	1	2	1	15	Jim Blanksby	9	S	12	-74
0627		2263	4.8	91+		Flint, MI	1	6	2	25	Richard Walker				72
0905	V	1035	6.8	27-	8N	Pine City, MN	4	24	1	15	James Fox			355	-58
1001		0810	1.8	64-	8N	St. Lucie Inlet, FL	19	182	1	7	Harold Povenmire	3	N	351	-66
1007		1600	5.1	7-	7S	Lucknow, India	1	2	1	6	Col. J. E. S. Singh	7	N	188	0
1021		3313	6.7	81+		Bredgo, Australia	6	28			David Herald	10	N	162	4
1103	V	1487	1.3	35-	2S	Cumbria, England	1	6	2	20	Jean Bourgeois			184	-9
1114		2784	3.4	20+	19S	Bentonia, MS	2	23	1	15	Benny Roberts	1	S	164	61
1119		3500	7.3	74+	17S	Sulphur Spgs, FL	1	4	1	20	Tom Campbell	3	S	162	-16
1130		1487	1.3	58-	8S	Crow's Landing, CA	4	24	1	8	James Van Nuland	0		190	-10
1130		1487	1.3	58-	10S	Dry Lake, NV	9	47	1	6	David Werner	0		193	-10
1130		1487	1.3	58-	18S	Smithville, TX	1	8	1	15	John West				-10
1130		1487	1.3	58-	19S	Boling, TX	25	143	1	6	Stockbauer/Frenzel	0		201	-10
1212		3031	5.9	16+	20S	South Amherst, OH	5	25	1	9	B.Modic/D.Rothstein			163	40
1219		0317	6.4	81+	6S	Washington, GA	1	10	3	40	Roger Venable			177	-55
1220		0440	4.6	88+	20S	Atlanta, GA	2	16	1	20	Mike Kazmierzak			165	-59
1220		0440	4.6	88+	21S	Sandy Cross, GA	1	12	1	40	Roger Venable			166	-59
1231		1815	4.8	48-	11S	Hiawatha, KS	10	63	1	6	Richard P. Wilds	1	S	193	41
1231		1815	4.8	48-	12S	Lawson, MO	5	36	1	7	Robert Sandy	2	S	193	41
1989															
0117		0538	5.6	77+	1S	Brandon, FL	3	4	2	20	Tom Campbell	0		182	-67
0211		0233	6.2	29+	2N	Conyers, GA	2	14	1	20	Mike Kazmierzak			359	-53
0211		0233	6.2	29+	2N	Augusta, GA	1	3	3	15	Roger Venable	10	N	359	-53

David Dunham summarized the results of the November 30th, 1988 Regulus expeditions in the last issue of *O.N.* The current table contains entries for those expeditions for which I have received final reports; others will continue to come in.

If a zero shift was observed for a graze (i.e., the prediction was essentially exact), please enter a 0.″0 on the form rather than leaving the space blank. A blank entry is interpreted as "the shift was not determined and is therefore not being reported."

Sometimes reports are received which have no cover letter and no comments specified on the back. It forms a much-more-complete record in our files if at least some description is given of what occurred during the graze rather than dry numbers. A copy of the limit and predicted profile (with the plotted observations, I hope; my paper mentioned earlier shows how) also helps me to visualize what occurred during your expedition.

Thanks for the reports received; we appreciate your efforts.

THE 1988 DECEMBER 31 GRAZE OF CHI VIRGINIS

Robert L. Sandy

As far as we know, 15 observers from the great states of Kansas and Missouri were very successful in accumulating 96 timings of this very interesting occultation, making this one of the three best-observed grazing occultations in the Midwest. The others were for ZC 1089 on 1966 September 10 at Black Creek, WI (96 timings) and for SAO 97580 on

1977 April 26 at St. Paul, MN and Union Church, WI (110 timings); I hope we don't have to wait until 1999 for the next similarly successful Midwestern graze. The Chi Virginis success was largely due to the efforts of Richard Wilds and me, yet all observers should be complimented for a job well done.

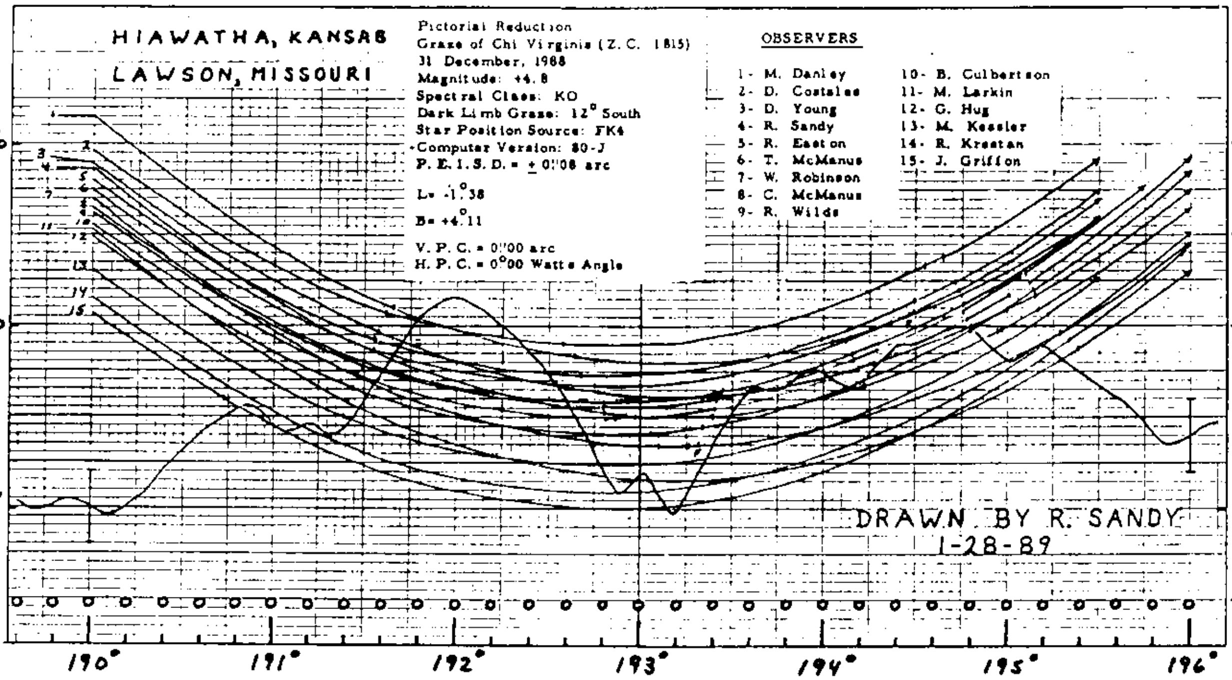
The Moon's predicted profile for the graze pictorial reduction shown below was derived from the C. B. Watts "The Marginal Zone of the Moon." The accuracy of each plotted point (every 0°2 WA interval on the predicted profile) is code=0. Code 0 is defined by Dr. Dunham as "excellent limb correction; typically good to ± 0"2 vertically." In other words, an error bar with an overall length of 0"4 arc vertically. A few error bars are shown on the reduction. A 0-code is the best-possible profile accuracy at the present time.

As can be seen, there are several interesting things to note about this graze.

a. There was a south shift of the Moon's shadow on the Earth's surface of about 0"2 arc. This is intersting considering that the star's predicted position was taken (for prediction purposes) from the FK4 star catalog (i.e., the best star positional catalog available at present). Also, the computer version 80-J (the most recent one) was used in drawing the reduction.

b. Secondly, through our actual observations, some higher features than shown by Watts occurred along the plateau between WA 194°5 and 195°4. Also, the Watts valley at 194°25 was observed to be deeper. It is well known that the Watts datum (as good as it is) tends to smooth out minor elevation changes, as shown by our observations. Yet, overall, Watts data along the plateau did indicate the highs and lows of the features we observed there.

An exciting serendipitous result from our observing efforts was the very probable discovery of an 8.8-magnitude secondary star by Wilds and me. This non-fluctuating star was visible for several seconds while the primary was occulted. Wilds observed this star between WA 192°65 and 192°78, 193°93 and 194°16, and 194°51 and 194°75. I saw it between 194°84 and 194°94. Since the moon speed for the graze was 1° WA/35§2 of time, this can be applied to the above angles to determine how long each of us observed the faint star.



SHIFTS STILL NEED TO BE REQUESTED FOR SOME GRAZES, TO CORRECT ERRORS FOUND IN THE XZ CATALOG

David W. Dunham

In some cases for stars south of declination -25°, when the prediction source in the graze prediction heading is given as SAO, YALE, ZC, or GC, and when the star's Zodiacal Catalog (ZC) number is between 2515 and 2743 (inclusive), or its USNO X number is between 23541 and 26023, a better position for the star is available from the Lick Uranus catalog. More frequently, for double or triple stars, when the position source is any of the above, or XZ or XZGC, with no restriction on the star's number, an improved position is often available from the preliminary Zodiacal Zone (ZZ87) Catalog. In these cases (and only in these cases), you should contact me preferably a month or more in advance at 7006 Megan Lane; Greenbelt, MD 20770; U.S.A.; telephone 301, 474-4722, providing me with the star's X or ZC number, and the date and position angle of the graze. I will then calculate the difference (path shift) for the event you requested, or tell you that the star is actually not in one of the new catalogs, so that its position can not be updated.

Probably the first graze observed in 1989 (and therefore the first one utilizing the 80J version of the XZ catalog) fell into the second category. Fortunately, Harold Povenmire was astute enough to realize that the large error of the star's declination, given in his predictions for the graze of 7.5-mag. X19329 (SAO 157895) on January 1st, indicated that something might be wrong. The star's position source was G.C. It also turned out to be double, with a 10.5-mag. (magnitude difference 3.0) companion 19" away. The star is in ZZ87, which predicted a 0".6 south shift. The graze was successfully observed by Povenmire's expedition in Florida, and the expected ZZ87 south shift did occur. This indicated to me that the rejection of the new photographic catalog data for doubles with magnitude differences this large for XZ80J was not a good idea, and that a smaller rejection limit of 2.0 would be better.

Early Monday morning, February 13th, a favorable northern-limit graze of 5.9-mag. ZC 518 (7 Tauri) was predicted to cross New York City. The star is a close double, with equally bright components separated by only 0".6; the position source was ZC. We had planned an expedition from DC to observe it from Andover, NJ, about 40 miles northwest of N.Y.C. But Andover is over 250 miles from our area and I was behind in my work, so I decided not to undertake the arduous trip, and only videorecorded the total occultation from my home. However, one of my coworkers, James Hernstein, was planning to spend the weekend in New York City, so I loaned him a telescope, timing equipment, and detailed maps of the Andover area. He went to Andover, where he met Roger Tuthill from Mountainside, NJ. They both observed the graze (Jim's first success), but each of them only had one long occultation of each component, indicating a sizable north shift, but it seems to be in good agreement with ZZ87, which indicated a 0".5 north shift. The mean epoch of the ZC position was 1915, so in retrospect it is not surprising that the recent ZZ87 position is better, in spite of the star's duplicity. Again, the rejection of new photographic data from XZ80J for very close doubles (regardless of the magnitude difference), when the previous positional data have an early mean epoch, was the wrong choice.

In early February, I created a modified version of the XZ80J catalog, which I call XZ80JA and have distributed to a few observers. This new catalog includes Lick data for the several southern stars in XZ80J where the old data were not replaced in XZ80J. Also, the new catalog rejection for double stars in XZ80J was changed from 3.0 to 2.0, so that most doubles in this range have ZZ87 data in XZ80JA. But the close doubles in XZ80J with magnitude differences smaller than 2.0, such as ZC 518, still do not utilize ZZ87 data in XZ80JA. This correction will be made in a future version of the XZ, such as XZ80K, which I plan to use for the 1990 graze prediction calculations several months from now. Other bigger improvements can probably be made for XZ80K, including addition of the new (not yet released) PPM data for all AGK3 stars and of final ZZ data for the southern ZZ87 stars. Also, I plan to fix the AGK3 magnitudes, which are photographic. I will convert them to visual magnitudes by using the spectral type, since spectral type K stars are over a magnitude brighter than the photographic magnitude would indicate, and type M stars can be two magnitudes brighter. Also, Kenneth Kelly, Detroit, MI, has found some errors in Isao Sato's J2000 version of the ZC, mainly many variable stars whose variability is not indicated. Many of these are also not indicated in any versions of the XZ, so I plan to add them.

Two individual magnitude errors have been corrected in XZ80JA. On January 14th, Eberhard Bredner and some other observers tried to observe a graze of 7.1-magnitude X 2285 (SAO 92548) near Hamm, German Federal Republic, but they had much difficulty in seeing the star. Wayne Warren found that the Yale (and SAO and XZ) magnitude for this star is wrong; the HD catalog gives the visual magnitude as 8.2, which agrees with the B.D., so I have used this for XZ80JA. Similarly, Alfred Kruijshoop, observing total occultations at Clayton, Victoria, Australia, was able to observe some occultations of 9th-magnitude stars on January 18th, in spite of the Moon being 88% sunlit, but he never saw 7.7-mag. X6548 (B.D. +28° 749), also predicted to disappear at his site. Again, Warren believes that the AGK3 magnitude (7.7) for this star is wrong; the B.D. gives 9.2, which I have used for XZ80JA.

Since XZ80J has already been used for all 1989 graze profiles calculated so far, I plan to keep using it for all of this year's predictions. In spite of the errors noted above, this will provide a uniform standard for 1989.

ANOTHER ELECTRONIC STOPWATCH TECHNIQUE

Robert L. Sandy

Until it broke down in February of this year, I had routinely used a mechanical stopwatch for timing total occultations for the better part of three decades. While waiting for it to be repaired, I started using an $8 electronic digital stopwatch, and my experience with the latter has been so favorable that I expect to continue using it.

After starting the electronic stopwatch at the occultation event, I depress the "freeze" plunger on the watch at five seconds after the WWV tone return and immediately write down the elapsed time shown. I then hit the freeze plunger again to display the running time. I repeat this process twice more at five seconds after the tone return, and write the times shown. I then average the three readings to be subtracted from WWV (of course, taking into account the five-second delay and my personal equation) to get the actual event time.

I let the tone return, and then "beat" my arm (the one holding the watch) in synchrony with the second pulses, and am somewhat surprised that I have been able to come up with exactly the same hundredth-second reading on all three freezes, on several occasions.

The freeze action does not always operate, but as this has no effect on the running time, it simply means having to wait an extra minute for another reading.

JEAN MEEUS CALCULATES 2 CENTURIES OF OCCULTATIONS OF BRIGHT STARS

David W. Dunham

I thank Jean Meeus for sending me a 195-page computer-produced book entitled *Occultations of Bright Stars by the Moon 1900-2099*. It contains Besselian elements of lunar occultations of all (18) stars of magnitude 3.0 and brighter that occur during the current and next centuries. The Besselian elements are in the same format as those given in Part 5 of

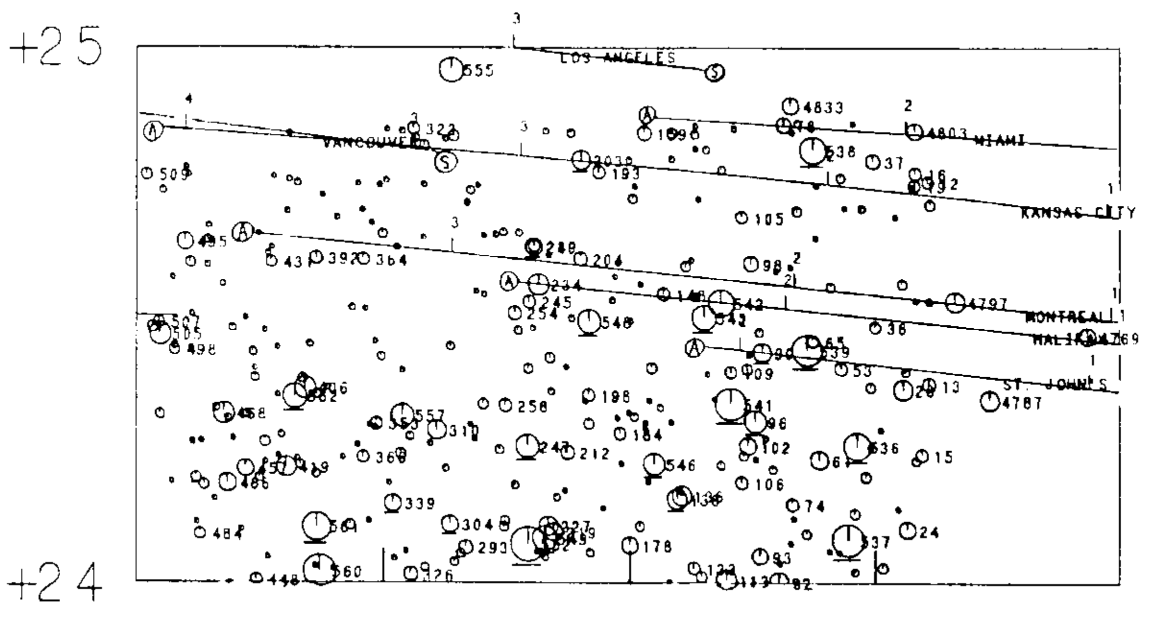
Meeus' *Astronomical Tables of the Sun, Moon and Planets*, published by Willmann-Bell, Richmond (1983). Their use is also described in that book. Meeus also discusses the special cases of Pollux, which was last occulted in the year -116, and Delta Sagittarii, which was last occulted in 1987, will next be occulted in 2006, and will not be occulted at all after 2359. The book is very useful to see when various bright stars are occulted. No publisher or price is listed on the book, so I do not know how many copies he produced, or its availability; interested *O.N.* readers might write to him at Heuvestraat 31 ; B-3071 Erps-Kwerps, Belgium. A next step might be to put the contents of these tables for some years (perhaps just the rest of this century) on floppy disk, and program the formulae given in Meeus' *Astronomical Tables*, so that the data could be used on a PC to calculate limits of the occultations, and times and other circumstances at specified locations.

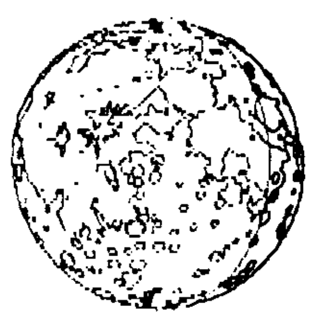
THE PLEIADES PASSAGE OF 1989 APRIL 8-9

David W. Dunham

Around 2^h U.T. of April 9 (Saturday evening, April 8th, local time), the 12% sunlit Moon will occult the northernmost part of the Pleiades cluster as seen from most of North America. The eastern $^2/_3$rds of Canada, and the midwestern and northeastern states, will be favored with an occultation of Taygeta (ZC 539) and some of the bright stars nearby. Much information about this passage, including predicted Universal Times of disappearances of stars down to mag. 8.7 and graze information will be included in my article about the passage in the April issue of *Sky and Telescope*.

The apparent-place chart of the Pleiades shows the topocentric paths of the Moon's center for several cities, like the one described in *O.N.* 4 (7), 158. The Moon diagram, produced by Bob Bolster using a modified version of John Westfall's MOONVIEW program, is oriented with north up. The position angle of the north cusp will be 341° and the P.A. of the center of the bright limb will be 251°. Since the Moon passes so far north this time, the southern parts of the Pleiades are not shown in the chart.





PLEIADES PASSAGE OF 1988 AUGUST 5-6 AT PIC DU MIDI

Henk J. J. Bulder

During the night of August 5-6 an occultation of the Pleiades cluster could be observed in Europe. Because weather conditions in the Netherlands tend to be bad, it seemed a good opportunity to take advantage of an opportunity to observe at the Pic du Midi Observatory in France. This professional observatory, with more than 13 domes, is situated at a height of nearly 3000 meters, near the Spanish border. This would be my first chance to see a Pleiades passage, and predictions showed no less than 121 occultations, mainly reappearances at the dark limb, and only 5 disappearances at the bright limb. Of course, not all of them would be observable because often there were very short intervals between two successive events, but even so, here was an excellent opportunity to break records. The faintest stars would be of magnitude 12.9, which I expected to be visible at the earthlit dark limb with the 60-cm Newtonian telescope available for serious amateurs, and maintained by "L'Association T60."

Of the 7 days I spent at Pic du Midi, 4 were crisp and clear, whereas the other 3 were clouded, with heavy thunderstorms. These thunderstorms were a real spectacle, with lightning striking the main antenna every few minutes. With every strike, there was a crackling of static electricity throughout the buildings. On clear days, sunsets are unforgettable at Pic du Midi, and in fact, I saw the green flash there for the first time in my life.

On August 5, the seeing was perfect, and the waning Moon would be 37% sunlit when it rose from the horizon. The main part of the Pleiades cluster would be occulted at that time. My first disappointment came about at that very moment, for in spite of all assurances by Jean Bourgeois, the Moon was not visible from the dome of the T60, being hidden behind one of the other domes! I was able to use a 7×50 binocular of questionable quality to observe Electra reappearing as a faint star. There was nothing to do but wait, and it was not until the Moon reached a height of 11° before I was able to see it with the T60. So I lost the first 18 occultations, of mainly bright stars, as can be seen from Table 1.

Table 1. Occultations of Pleiades stars during passage of 1988 August 5-6.

magnitude	<6	6	7	8	9	10	11	12	total
number	7	6	9	7	9	15	27	41	121
moon height <11°	5	1	1	4	2	3	2		18
observed by Henk	2	5	8	3	6	9	11	2	46
observed by Jean	6	5	9	5	6	5	3		39

Soon it became clear to me that the faintest stars wouldn't be visible at all, probably due to a combination of bright earthshine and bad optics (the mirror showed some coma). In fact, I was only able to observe 2 12th-magnitude stars (12.0 and 12.1) and the limiting magnitude was rather in the vicinity of 11.7. Because of this, another 52 stars were lost. Finally, only 49 reappearances were timed, including 3 non-Pleiades stars, besides 2 events of a grazing occultation of a star of magnitude 9.7. Jean Bourgeois, who observed at a distance of only 50m with a portable 25-cm Newtonian was able to observe 42 occultations. From these stars, 31 were observed by both of us, so that a total of 60 different stars were observed. Although I was not completely satisfied, it was a tremendous experience to see so many stars reappear in so short a time.

Later, we heard that the 49 reappearances in one night seems to be a record, after all, since earlier records mainly involved disappearances.

Table 2. Preliminary reduction of overlapping SAO stars.

1		2	3	4	5	6	7	8	9	10	11	12
nr	star	mag	Henk		Jean		rem	sec	red	O-C"	O-C"	O-C"
			PE	ACC	PE	ACC		H-J	H-J	Henk	Jean	H-J
1	P 49	3.6	0.6	0.2	0.3	0.1		0.2	0.25	0.49	0.34	0.15
2	P 96	7.1	0.4	0.1	0.3	0.1		-0.1	-0.07	0.32	0.36	-0.04
3	P 136	7.5	0.3	0.1	0.4	0.1	*	-0.6	-0.55	-0.51	-0.19	-0.32
4	P 138	7.9	0.4	0.1	0.4	0.1		-0.1	-0.05	-1.06	-1.03	-0.03
5	P 151	7.3	0.3	0.1	0.3	0.1		0.0	0.04	0.08	0.06	0.02
6	P 248	2.8	0.4	0.1	0.3	0.1		-0.2	-0.12	-0.16	-0.13	-0.03
7	P 231	6.2	0.3	0.1	0.3	0.1		-0.1	-0.06	-0.32	-0.30	-0.02
8	P 219	8.6	0.3	0.1	0.3	0.1	*	-0.4	-0.33	-0.61	-0.48	-0.13
9	P 227	8.3	0.3	0.1	0.3	0.1		-0.2	-0.15	-1.34	-1.28	-0.06
10	P 304	9.2	0.4	0.1	0.5	0.2	*	-0.7	-0.58	-1.24	-1.14	-0.10
11	P 234	7.7	0.4	0.1	0.3	0.1		-0.1	-0.11	-0.39	-0.36	-0.03
12	P 247	6.8	0.2	0.1	0.3	0.1		0.0	0.04	-0.31	-0.33	0.02
13	P 310	8.2	0.4	0.2	0.3	0.1		-0.2	-0.17	-1.90	-1.81	-0.09
14	P 330	6.9	0.3	0.1	0.3	0.1		-0.1	-0.06	-0.14	-0.11	-0.03
15	P 406	7.5	0.4	0.1	0.3	0.1		-0.2	-0.14	-0.52	-0.45	-0.07
16	P 413	6.5	0.4	0.1	0.3	0.1		-0.2	-0.15	0.49	0.56	-0.07
17	P 468	7.5	0.5	0.2	0.3	0.1		-0.3	-0.23	-0.23	-0.16	-0.07
18	P 505	7.4	0.3	0.1	0.3	0.1		-0.1	-0.05	-0.04	-0.02	-0.02
19	P 495	9.3	0.4	0.1	0.3	0.1	*	-0.4	-0.37	-0.51	-0.33	-0.18
20	S 76292	8.8	0.4	0.1	?	0.1		-0.1	-0.05	-0.23	-0.21	-0.02
21	S 76306	9.1	0.5	0.2	?	0.1		0.0	-0.13	-0.19	-0.17	-0.02
mean			0.38		0.32			-0.19	-0.14	-0.40	-0.34	-0.05
standard dev.			0.09		0.05			0.21	0.19	0.59	0.57	0.09

* Result outside common accuracy interval

Perhaps you will wonder about the value of two observers observing the same stars at the same place. In general, the value is limited. But because it involves observations of two experienced observers, it provides an opportunity to compare the results to see what the effect of personal equations is on the overall O-C, since all other effects like limb corrections, faults in star positions, and faults in observer coordinates are the same for both.

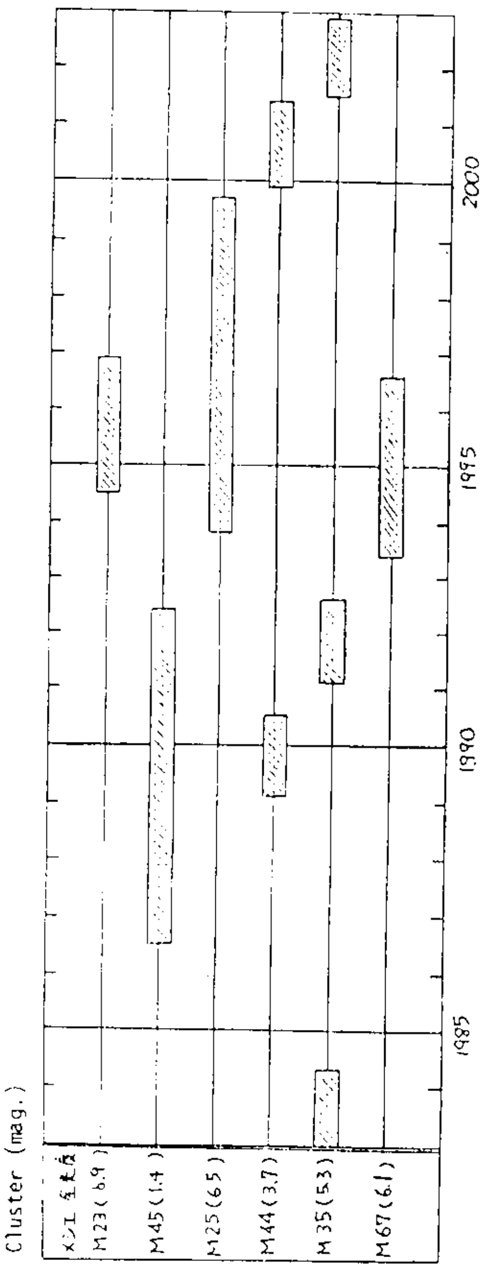
From the 31 overlap stars, 21 were SAO stars for which Adri Gerritsen calculated preliminary O-Cs. The results are in Table 2. The largest difference for an individual star is 0.7 seconds (line 10), which after reduction leaves 0.58 time seconds. There seems to be a systematic difference of 0.14 seconds between the two observers, which corresponds with 0.05 arc seconds. The mean PE of Jean Bourgeois is 0.06 seconds smaller than the PE of Henk Bulder, whereas reaction timing tests show Henk to be 0.03 seconds faster than

Jean. This explains 0.09 of the 0.14 seconds. The remaining 0.05 seconds could be explained by the fact that the stars must have seemed fainter in Jean's 25-cm Newtonian, which in general contributes to even slower reaction times, as we have proven with the same reaction tests. I hope to publish a paper on these reaction tests in a later issue.

In general, we can conclude that the mean difference in arc seconds (0.05) between experienced observers is not large in relation to the absolute O-C" (-0.40 and -0.34), which proves to be the result of deflections in SAO star positions. Even in cases of very high absolute O-Cs (like 1.90 in line 13) the difference between the two is only 0.09 arc seconds. This makes a strong argument against rejecting observations on the basis of absolute preliminary O-Cs which seems to be common practice in some countries. Often, a limit of 2.00 arc seconds is used for such a practice. I resent this practice, but if used, I would most certainly raise this limit to 3.00 arc seconds, or even more.

YEARS OF LUNAR OCCULTATIONS OF MAJOR ZODIACAL CLUSTERS

Isao Sato



L-CATALOG TOTAL LUNAR OCCULTATION PREDICTIONS FOR 1989

David W. Dunham

In January and early February, I created the L-catalog primarily from the Lick Voyager catalogs and from Astrographic Catalog data for regions that will be occulted by the eclipsed Moon during 1989 and 1990, and for the Praesepe cluster. In early February, I installed it in the OCC account disk files at the U. S. Naval Observatory (USNO), and calculated predictions for all observers on USNO's active mailing list and for all IOTA members, provided that they live in areas where the eclipsed Moon on February 20th was high enough that there might be observable occultations of non-XZ stars (that is, stars not included in the regular predictions distributed from the USNO last year). These predictions were calculated for the remainder of 1989. For some dates, chronologically ordered lists of abridged data were generated, like those produced for the Pleiades (P-catalog.).

Distribution of Predictions. The L-catalog is not yet complete, but predictions were calculated at USNO and distributed to the above-mentioned observers on February 10th so that some of them might have received the data in time for the total lunar eclipse on February 20th. Pat Trueblood, Joan Dunham, and Marie Lukac helped with this distribution. The eclipse was described in more detail (with 2 star charts) in my *o.n.* supplement "Occultations During the Total Lunar Eclipse of 1989 February 20," which was either enclosed with the predictions or was sent separately to IOTA members and *o.n.* subscribers in the regions of visibility of that eclipse.

In a month or two, I will complete the L-catalog by adding the high right ascension data for stars that will be occulted during the total lunar eclipses of 1989 August 17 and 1990 August 6 to the end of the current catalog (David Herald, Woden, A.C.T., Australia, provided me with the 1989 August and 1990 August eclipse star field data, which he calculated from Astrographic Catalog data). Then, I will generate predictions for the rest of 1989 for at least those IOTA members and *o.n.* subscribers who are also on USNO's active list, for those who were not in areas where the February 20th eclipse was visible under favorable conditions (that is, for those who were not included in the February mailing, including most of the Americas, Europe, and Africa).

Marie Lukac has sent USNO station, address, and active status data to Derald Nye, who will enter USNO address and station codes into IOTA's master address and station file. This will facilitate crossreferencing, which I had to do manually for the February eclipse. If you are an IOTA member and not on USNO's active list, I will probably make some effort to generate predictions, also, but you may want to contact me to be sure, especially if you want predictions for a location (such as as point in a predicted graze path) not in IOTA's file. Also, if you are not in USNO's active list, and are either only an *o.n.* subscriber, or joined IOTA recently and have not returned your completed observer information form (so that we do not have your current station coordinates), you also need to contact me if you want L-catalog predictions for your site. Send coordinates of your site, and the aperture of the telescope that you plan to use, to me at 7006 Megan Lane; Greenbelt, MD 20770; U.S.A. If you need to reach me quickly, you can either telephone me at 301,474-4722; send me a fax at 301,794-4377; send a telex to 7108259636 CSC SS MD; or send a telex to Wayne Warren at Goddard Space Flight Center (specify code 633, and ask operator to phone him at 286-8310), telex number 89675 NASCOM GBLT.

Reporting Observations. Occultation timings of L-catalog stars should be reported on the International Lunar Occultation Centre (ILOC) lunar occultation report forms, or the equivalent IOTA/ILOC graze report forms or in an ASCII file on MSDOS-compatible diskette (for the latter, see p. 237 of the last issue of *O.N.*, and *O.N. 4* (5), pp. 92-97). For the star number, use the ZC number and catalog code (column 16) "R." If the star is not in the ZC, give its SAO number and put "S" in col. 16. If it is in neither the ZC nor the SAO, give its XZ number with an "X" in col. 16; the XZ (or X) number is given in the DM REF NO column of the predictions (5-digit number with "X" prefix) if the star is in the XZ and is not a ZC star. If the star is in neither of these catalogs, give the star's L-catalog number, if you have predictions that give this number, and put "L" in col. 16. If you do not know the L-catalog number for a non-ZC, non-XZ star, leave the star number blank, and give the BD number in the comments on the back, if it has a BD number. If not, include a copy of the star chart (these will be published in later issues for future lunar eclipse fields and for the Praesepe) with your report marking these fainter stars whose occultations you time (this would need to be done in any case if you time occultations of any stars not shown on the charts). Since I have sent ILOC a copy of the L-catalog, you can report these stars by their L-numbers on the ILOC report forms, along with other (ZC, X, and P) stars that you time, and ILOC can reduce any timings of these stars that you report to them. For all occultations that occur during lunar eclipses, please also send a copy to David Herald; P.O. Box 254; Woden, A.C.T. 2606; Australia; since he will analyze all timings made during the eclipse and publish his results in *Occultation Newsletter*.

L-Catalog Number Errors for ZC Stars. In the USNO predictions, the star's L-catalog number (L-number) is usually given under "USNO REF NO" in the main list. However, if the star is not in the Zodiacal Catalog (ZC), the 4-digit ZC number is given under this column with no prefix, similar to the procedure for USNO's regular XZ-catalog predictions. The ZC number is repeated (with prefix "ZC") in the DM REF NO field. However, in the abridged chronological lists, the ZC number is also given in the USNO REF NO field, but with an "L" prefix. This is wrong because it is a ZC number, not an L-number. In the DM NUMBER column, ZC stars are correctly identified as such with a "ZC" prefix. I hope to correct this error before computing any more L-catalog predictions, but it is of course too late for those who were sent predictions on February 10th. Another change that I plan to make is to add an option to suppress the daily paging for the chronological lists, to make them more compact (easier to mail and wastes less paper).

Construction and Description of the L-Catalog and its Predictions. The occultation Besselian elements file used to generate the L-catalog predictions includes only stars that are occulted during lunar eclipses, or at times when the Moon is 70% or less sunlit. Also, events occurring when the Moon is less than 3% sunlit were eliminated. I have compared only the February 20th eclipse field with the True Visual Magnitude Atlas (TVMA). As a result, I have adjusted the photographic Astrographic Catalog magnitudes for many stars in that field to reflect their relative visual brightness better, and have indicated that this has been done with a "T" for the spectral type. "TN" means that the star is not visible on TVMA (whose limit is near 13th mag.), "TF" means that it was fainter in TVMA, "TVF" means that it was very faint on TVMA, and "TB" means that it was brighter in TVMA. "MNW" and "MNE" were used for the "spectral" types for two stars that were clearly in different positions on TVMA, but the positions of these stars in the L-catalog were not altered. "MNW" means "moved northwest" and "MNE" means "moved northeast."

Wayne Warren provided me with a tape copy of his preliminary machine-readable version of the appropriate Bonner Durchmusterung (BD) zones, which I precessed to equinox 1950 to identify all BD stars with AC counterparts. I decreased the magnitudes of several of these BD stars from their large (faint) AC values, usually to 10.5, since fainter stars would likely not have been observed by the visual compilers of the BD. Most of these are probably red and orange (spectral type K and M) stars that were faint on the blue-sensitive AC photographic plates.

The equinox 1950 boundaries for the regions covered by the L-catalog are given in the table on the facing page. Under Source, "Lick" means a Lick-Voyager catalog, with the flyby planet for which the catalog was constructed given. "FAC" means "Fresneau Astrographic Catalog" data. "AC" means Astrographic Catalog data provided by David Herald. For some of the Lick catalogs, the boundaries extend more than 6° 40' from the ecliptic, beyond which the Moon can never occult a star as seen from the Earth. No stars outside this Zodiacal boundary are included in the L-Catalog.

The numbers are not entirely consecutive. This is because the catalog search part of the OCC program requires a "star" within each hour of right ascension. So where needed, I have added some fake "spacer" stars with appropriate R.A.s, but with Dec. -90 degrees and Mag. 50.0, which of course will never appear in predictions. Also, there is one star, L11319 = 8.1-mag. B.D. -21° 4104, a close double star that is not in the SAO catalog, and in neither the XZ nor the K catalog. Yale catalog data have been used for it.

On p. 234 of the last issue, I said that I would use the C-Catalog for the Praesepe cluster. But operationally, it is simpler to use one catalog, and the C-Catalog included Praesepe data only to mag. 11.5. Therefore, I included the Praesepe area in the L-Catalog, using all A.C. data (down to about mag. 13). Note that the Praesepe R.A. range overlaps part of the Lick-Jupiter catalog, but does not overlap it in declination.

L-No. Range	R.A.-low h m	R.A.-high h m	Dec.-S.	Dec.-N.	Source
7 - 2708	6:00	7:00	+16.0	+24.0	Lick - Jupiter
2709 - 6168	7:00	8:00	+13.5	+26.2	Lick - Uranus Gemini (post):
6169 - 6383	8:00	8:05	+13.5	+26.2	Lick - Jupiter
6384 - 7285	8:31	8:57	+8.0	+15.0	Lick - Jupiter
6397 - 7017	8:32	8:42	+19.0	+21.0	FAC - Praesepe
7286 - 7748	9:23	9:37	+13.0	+16.0	FAC - 1990 Feb. 9 lunar eclipse
7749 - 8403	10:06	10:20	+9.8	+12.7	FAC - 1989 Feb. 20 lunar eclipse
8406 - 11317	12:40	14:01	-9.5	+3.0	Lick - Saturn
11321 - 11922	17:24	17:50	-30.2	-25.0	Lick - Uranus Sagittarius (pre)
11923 - 12686	17:50	17:58	-30.2	-19.0	Lick - Uranus Sagittarius (pre)
12687 - 17558	17:58	18:25	-30.2	-15.0	Lick - Uranus Sagittarius (pre)
17559 - 19695	18:25	18:50	-30.2	-18.0	Lick - Uranus Sagittarius (pre)
19696 - 23079	19:30	20:20	-22.0	-13.0	Lick - Neptune
23080 - 24200	20:20	20:46	-25.1	-13.0	Lick - Neptune
Not yet in L	20:56	21:09	-18.0	-15.3	AC - 1990 Aug. 6 lunar eclipse
Not yet in L	21:36	21:52	-15.3	-12.2	AC - 1989 Aug. 17 lunar eclipse

New Merged Lick Catalog. I received the final Jet Propulsion Laboratory (JPL) version of the Lick Neptune catalog in January. This allowed creation of a final version of the merged Lick Voyager catalogs; I had created a preliminary version in 1986 when Arnold Klemola provided me with the basic data for the Neptune catalog. The preliminary version had been used only for asteroid occultation searches, by me and by workers at Lowell Observatory, which had been provided a copy. In the course of creating the final version in January, I eliminated several duplicate entries (mostly Jupiter and Uranus-Gemini stars that had not been matched originally, and several pairs in the Saturn catalog). During the work, I discovered a bug in my calculations for the E-terms in the preliminary version; these terms had to be added to the Uranus catalog data. My computed values were too small, so that errors of as much as 0".35, mostly in right ascension, existed. Since the star positions themselves are hardly more accurate than this, the error was not obvious. It has been corrected in the new version of the catalog. I have sent a copy of the new version on magnetic tape to Larry Wasserman at Lowell Observatory.

For creation of the L-Catalog, the Lick and AC data were compared with XZ80J, which already included ZZ87 and Lick data, where appropriate; see p. 255. The XZ80J data were preferred, and used to replace AC and (often) Lick data. But one star posed a problem. The epoch 1950 position for S Virginis = X19474 in the XZ and SAO catalog disagreed with the Lick Saturn (L 2 2558 or LS 2558) position by over 5" in right ascension. G.C. data had been used by XZ and SAO. The Lick-Saturn catalog simply used the SAO (G.C.) proper motion. I assumed that there was an error in the R.A. proper motion, and rederived it by combining the SAO (G.C.) position at its recent epoch. The result was a smaller proper motion, which I adopted with the Lick position. In addition to the merged Lick catalog, I have also used this new positional data in the XZ80JA catalog, as well as the L-Catalog (the star is L10578). S Virginis is a Mira variable with magnitude range of 6.0 to 13. Also in the Lick Saturn Catalog, I found that 13.4-mag. LS 3672 was incorrectly designated SAO 139637. This star is not in the SAO. 8.9-mag. LS 3828 is actually SAO 139637, and this has been fixed in the new merged Lick and L-Catalogs. The star LS 3286, mag. 8.0, is identified as SAO 139527, whereas it is actually SAO 139537.

Catalog Discrepancies. For the February 20th eclipse field, I found some discrepancies when comparing the FAC data with the B.D. and the TVMA. One star, L07992, has been given a V? in the DM zone field. It may be a variable, since its mag. is given as 9.5 in AC, yet it is very faint on Atlas Stellarum (AS) and is not shown at all on TVMA. I have compromised, showing it as mag. 11.5. During the eclipse, I hope that someone checked its brightness; I would be interested in the result. However, it might be just an error in the AC magnitude, since the magnitude of another star, L07819, was given as 3.3 in AC, while it is shown faintly in TVMA. I assumed that this star, which was not occulted in the umbra during the February eclipse, is mag. 13.3. Another problem was found while matching BD positions with AC data. Usually, the positional differences were 1' or less, but some differences were as great as 3'. In all but one case, I could uniquely identify the BD star in the AC, although in six cases, the AC showed both components of a double of 1' or less separation in the BD position. The problem was with BD +12° 2192, which I identified with a 10.5-mag. AC star, L08280, even though this position is over 4' from the BD position. I have indicated uncertainty in this identification by putting DM? in the spectral type field. Another possibility is a 12.4-mag. AC star 3' south of this star (L08281), where the positional difference is less than 40" from BD. However, inspection of the TVMA shows that the AC magnitudes and positions (at least to 1' accuracy) are correct, and it is very unlikely that the BD observers would record a 12.4-mag. star and pass over a 10.5-mag. one. It is a little discouraging that BD errors can be this large; this combined with the problem of duplicity would make it very difficult to write a computer program to automatically match a large fraction of BD stars with AC data.

Future Work. The main future job will be the addition of D. Herald's AC data for the August 1989 and August 1990 eclipses. Also, these star fields, as well as that for the February 1990 eclipse and the Praesepe cluster, should be compared with the B.D. catalog and TVMA. David Werner has offered to help with this. This will take care of faint-star predictions until the next round of total and deep partial lunar eclipses begins on 1992 June 15. By then, the Space Telescope Guide Star Catalog will be available, and that will allow creation of a very comprehensive occultation prediction catalog, down to 15th magnitude, if we want.

ANALYSIS OF OCCULTATION OF 136 TAURI BY VENUS

Henk J. J. Bulder

136 Tauri (magnitude 4.5) was occulted by Venus on 1988 May 11. Because Venus has a very dense atmosphere, it is impossible to see anything of its surface from the Earth. That is why it is all the more satisfying to be able to say something about its cloud deck by observing an occultation. In several journals (including *Heelal*) an appeal had been made to amateur astronomers to observe this phenomenon closely, and especially to be aware of any dimming effects caused by Venus' atmosphere.

A large number of amateurs responded to this appeal. As noted in Jean Meeus' article in *O.N. 4* (9), 218-20, some 32 observers from Belgium, the Netherlands, and Germany participated in this activity, although circumstances in Belgium and the southwestern part of the Netherlands were far from ideal. The seeing described by the observers varied from perfect to very bad. In spite of the often bad seeing, the star could be well observed at the dark side of Venus. A reliable observation of a reappearance at the bright limb must have been impossible, although 3 observers tried it anyway, because it had been asked for in the appeal. Mainly because these observers strongly moderated their observations, the bright-limb events have been excluded from this analysis.

In the table (see *O.N. 4* (9), 219), you will find the observations and some calculations by Jean Meeus. Besides observer's name, place, aperture of telescope, and magnification used, you will find the distance of the last speck, duration of dimming effects, distance at moment of first dimming, and position angles at moments of last speck and first dimming. The last three quantities were calculated only at the moment the analysis seemed to come to a dead end. As described in Meeus' article, the distance of the star has been calculated in units of the planet's radius. Due to geographical differences, the position angle of each event is somewhat different.

As can be seen from the table, there is one observer (15) for which a strongly discordant disappearance value of distance has been calculated. Because this observation would have too much influence on the overall result, it was not considered in the analysis.

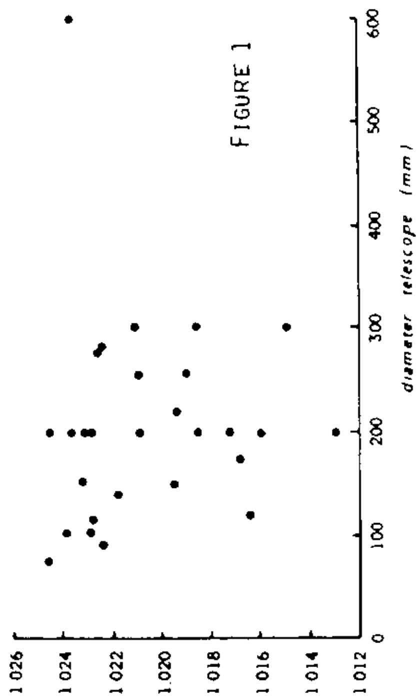


FIGURE 1

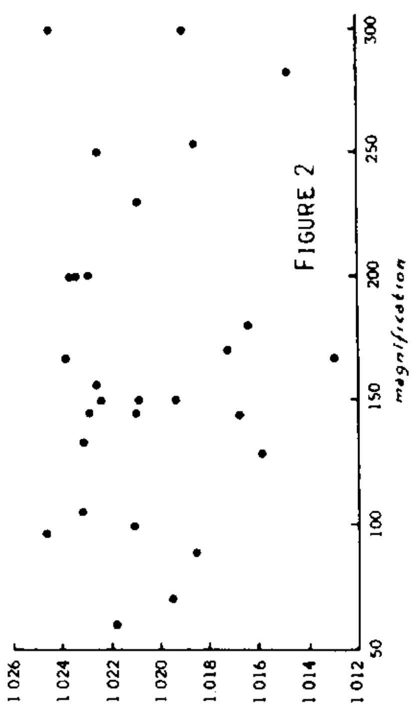


FIGURE 2

Often, analyses are done on the basis of hypotheses which are then tested to see if they make any sense. This is the method I have used. Because I expected the star to be visible for a longer period with a larger instrument (for you can see fainter stars with a larger instrument), I draw in Fig. 1 the distances against telescope diameter. As can be seen, there is a large spread, but no clear tendency, so we have to try something else. Because we know that a higher magnification gives a darker background, we might see the star longer, especially because we know this event took place in strong twilight. As can be seen in Fig. 2, there is no clear tendency here, either. Because usable magnification varies with aperture, I tried Fig. 3, which gives the distances against the magnification divided by the telescope aperture. But even this approach doesn't give a clear conclusion, although you might see some optimum near 0.8, but the spread is too great to be decisive about it.

After these failures, we have to find a new approach. When we look at Table 1 again, we see two clear groups of observations. One group of observ-

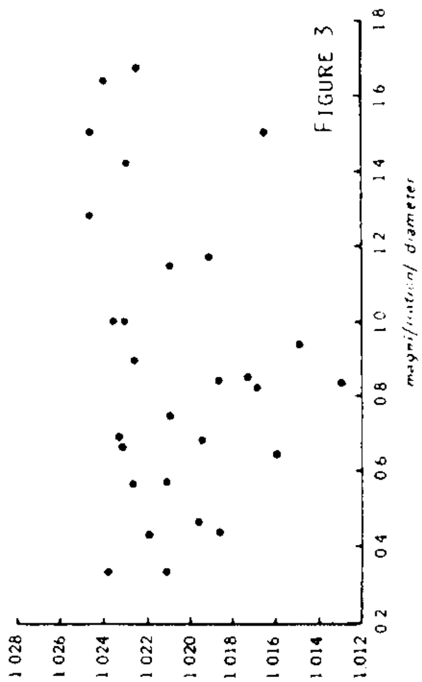


FIGURE 3

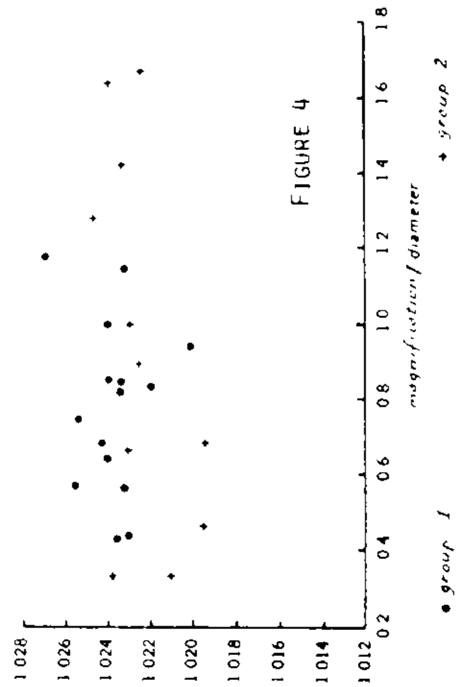


FIGURE 4

ers mentions dimming effects of some kind (group 1 with remarks 2 and 3), and another group mentions a sudden disappearance, or doesn't report anything special about the disappearance at all (group 2, with remarks 1 and *). When we calculate the distance at moment of first dimming for group 1, then we are able to compare it with the distance of sudden disappearance (group 2). The result can be seen in Fig. 4. The first thing we see is that the spread has diminished drastically. It seems we are talking about the same event here, being the outside limit of Venus' atmosphere. Group 2 seems to be somewhat closer to the surface of Venus, but that can be explained by the probability that some of the observers that report nothing special about the disappearance have seen some dimming after all, and only reported the time of last speck.

As can be seen from Fig. 4, group 1 still has some spread left too, although this is less than the spread of group 2. Part of it can be explained by the fact that part of the observed duration of dimming is based upon estimates. To see if this hypothesis is correct, Fig. 5 gives the distances in order of duration of dimming. The ones marked are based on estimates, whereas the rest are based on measurements. Most of the estimated ones have large deflections from the mean, whereas the measured ones are much closer to the mean, which confirms that estimates are less accurate, especially when durations are longer than 5 seconds. For this kind of observation, the same equipment is recommended as for observing grazing or asteroidal occultations.

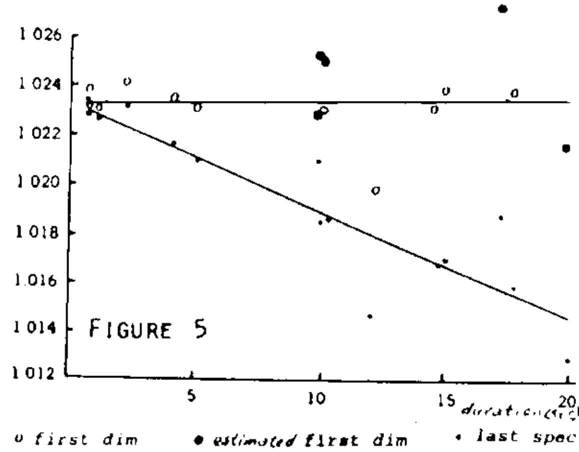


FIGURE 5

We still have no explanation for the fact that one observer reports a sudden disappearance, a second one reports a disappearance after clear dimming, and a third observer sees two or more disappearances. There can be two possible explanations for this.

The first explanation is based on a combination of factors that influence the physical observability of the phenomenon. The contrast, the seeing, and the experience of the observer play important roles here. To explain such a difficult combination of factors, researchers often resort to a model. In Fig. 6, I have such a model for the diminishing of starlight by Venus' atmosphere. In that model, it is supposed that the transparency of the atmosphere doesn't vary linearly with height above the surface. It is easily seen that observers see different

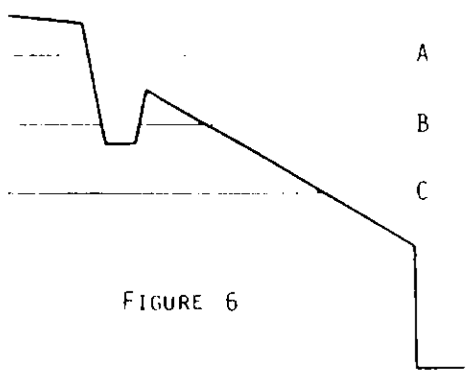
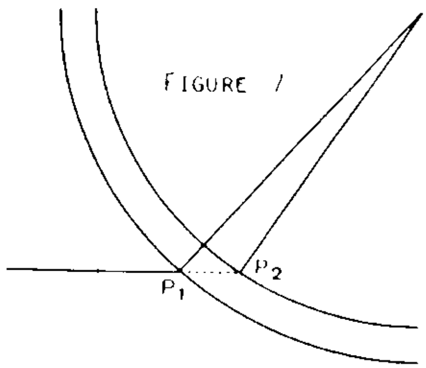


FIGURE 6



"first dim" (P1) en "last spec" (P2).

events depending upon the limiting magnitude they are able to see. Observer A will observe a sudden disappearance, whereas observer B, with a better limiting magnitude, will see two disappearances, and observer C, with an even better limiting magnitude, will see a clear dimming before a final disappearance. Of course, this model is very simple, and even with seeing superimposed, you will be able to see all kinds of effects that can well explain the different observations. However, the fact that first dimming observations do well agree with last speck observations of those who report a sudden disappearance indicates that there is a very sharp limit to Venus' atmosphere (steep density increase).

A second possibility to explain the difference between observers is that the density of Venus' atmosphere varies with the position angle of the event.

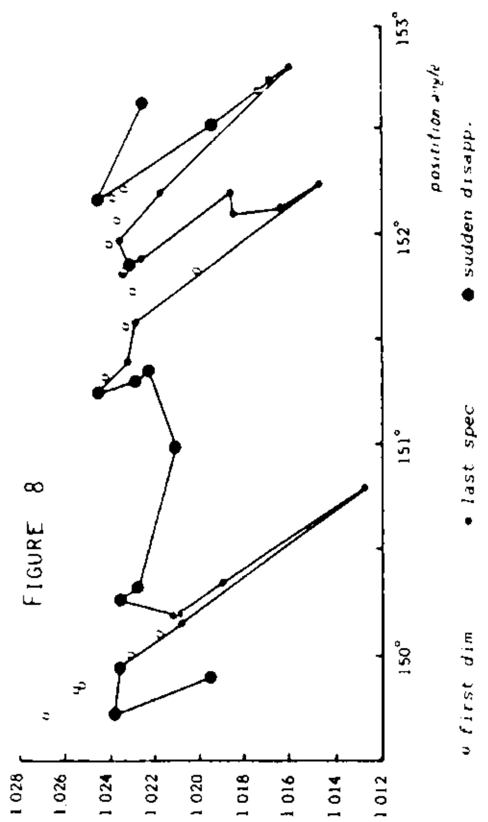


FIGURE 8

In Fig. 7, it can be seen why the position angle of first dimming and last speck are different. In Fig. 8, the distances of first dimming and last speck are shown against position angle. To make it easier to read, all last speck events (including the sudden disappearances) are joined by a line in the order of position angle. It can be seen that dimming effects are limited to specific areas. So it could well be that position-angle-dependent variations in the density of Venus' atmosphere are responsible for the different observations. This ends the analysis, and we summarize the conclusions:

1) There is a clear, sharp limit to Venus' atmosphere (steep density increase).

2) The difference between observers can be explained by non-linear variations in the density of Venus' atmosphere in relation to height above the planet's surface. These variations could be position-angle dependent as well. Photoelectric observations could probably give more quantitative results about these density variations.

Finally, the results are brought back to their proportions in Fig. 9. We see that the limit of Venus' atmosphere is much higher than the cloud deck based on the *Astronomical Almanac 1984*. Of course, this is not an absolute conclusion, because we have observations of only a small region of Venus' disk. Part of this difference could be explained by errors in the relative positions of the star and Venus. We need observations from more widely-spaced position angles to be more decisive.

I wish to express my thanks to Jean Meeus for the calculations he made for this article.

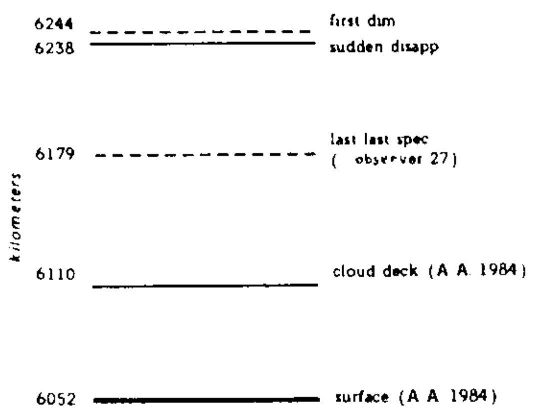


FIGURE 9

OCCULTATION OF 28 SAGITTARII BY SATURN IN JULY

David W. Dunham

The July 3rd occultation of 5.4-magnitude 28 Sagittarii (ZC 2725, SAO 187255, ADS 11652) by Saturn involves the brightest star yet predicted to be occulted by that planet for earthlings. Observations of the passage of the star behind Saturn's rings from many observatories can yield a detailed two-dimensional map of the ring structure. Observers throughout the Americas, most of the Pacific Ocean, New Zealand, and eastern Australia can take part in the campaign to record the star's variations with CCDs, photometers, video cameras, and even visual monitoring. Carolyn Porco, Lunar and Planetary Laboratory, University of Arizona, is coordinating efforts to record the event at large professional observatories. Douglas Mink, Harvard-Smithsonian Center for Astrophysics, has computed detailed predictions of the event.

Porco, Mink, and I will write a detailed article about the event that will appear in *Sky and Telescope*, probably the June issue. *Astronomy* magazine will also give the event extensive coverage. *O.N.* readers should watch for these articles; because of their wide distribution, the material will not be repeated in *O.N.* Both magazines will publish detailed charts showing the path of the star behind the rings and ball of Saturn for major observatories. Since the basic geometry changes little as seen from different parts of the Earth's surface, these can serve as guides for the general appearance for all observers. However, the specific predicted times of the various ring events does depend on geographical position. Arrangements have been made for Derald Nye to send Doug Mink station data for all IOTA members in the region of visibility of any part of the occultation. Mink will calculate detailed predictions for each of these stations, and send them either to DaBoll or to J. Carroll for distribution, possibly with this issue of *O.N.* The predictions list the ring or planet feature involved, whether the event is before (Imm or immersion) or after (Em or emersion) the occultation by the planet (Mid is middle, or closest approach to Saturn's center); the U.T. of the event in hours, minutes, and seconds; the distance of the star in arc seconds from Saturn's apparent center; the topocentric velocity on the sky plane in km/sec; and the altitudes of the star and the Sun in degrees above the horizon.

The topocentric velocity will be between 20 and 21 km/sec for all observers. The angular diameter of 28 Sagittarii is about 0."0014, which subtends about 9 km at Saturn. Hence, even an abrupt ring feature will produce a gradual occultation event lasting about half a second. Hence, the resolution will not be nearly as fine as that obtained with Voyager 2's photopolarimeter while monitoring Delta Scorpii during that spacecraft's Saturn flyby. However, that was only a one-dimensional observation, so we can expect to learn much new information from the two-dimensional data that can be obtained on July 3rd. Also, comparison with the Voyager data will permit an estimate of the time variation of the ring features.

A charged couple device seems to be the best way to record this event, especially if infrared wavelengths (star brighter, planet fainter to increase contrast) can be used. Photometers and video cameras subject to blooming (such as the RCA Ultricon) will have to contend with the bright background light from the rings, so long focal length (to decrease Saturn's surface brightness) and good tracking may be needed for success. Visual observers should be comfortable and have enough tape to record WWV (or other time signals) and their remarks on the star's brightness variations for nearly an hour (the duration of a passage through the rings). More ideas on observing the event will be given in our *Sky and Telescope* article.

ASTRONOMY AND PERSONAL COMPUTERS

Joan Bixby Dunham

Julian Date Computation Revisited. I made several mistakes in my comments on computing the Julian date in the last issue of the newsletter. The reference for the first Van Flandern method should have said *1968*, not *1986*. The full, correct, reference is *Communications of the ACM, Vol. II*, No. 10, Oct. 1968, p. 10. Also, the open and close braces, (and) were printed as ¼ and ¶ (paragraph symbol) in both of the Van Flandern method equations. This occurs in each equation in the part which starts 3*...

I left out a key step adjusting the year and month for January and February in the Meeus method. The corrected algorithm is as follows:

For dates after October 15, 1582, given a year, month, day, and hour, then

y = year (4 digit) and m = month (3-12) if after February

or

y = year -1 and m = 13 (January) or 14 (February)

B = 2 - int(y/100) + int[int(y/100)/4]. Here, int() means "integer part of the quantity inside the ()," so int(2.2) = 2, and int (3/2) = int(1.5) = 1.

JD = int(365.25*y) + int[30.6001(m + 1)] + day + hour/24 + 1720994.5 + B

The Meeus method is from *Astronomical Formulae for Calculators*, Willmann-Bell, 1982. Jean Meeus noted that I left the last "1" out in the constant 30.6001. He remarked that number 30.6 will give the correct result, but 30.6001 has been used so that the proper integer will always be computed. His example is a computation of 5 times 30.6, which gives 153 exactly. However, most computers would not perform the computation "exactly," and might get a result of 152.99999998 instead, whose integer part is 152. The final Julian day computed would then be incorrect.

The comment was made that an easy way to compute the Julian date for a given date is by adding the day of the year for that date to the JD of December 31 of the previous year. If the American Almanac is used as a source for the JD, please note that the dates are given for noon on Jan 0, Feb 0, etc., which correspond to noon on Dec 31 (of the previous year), Jan 31, and so on. The JD for noon on Jan 0, 1989 (December 31, 1988) is 2447527.5, and the JD for 0 hours Jan 1, 1989 is 2447527.5.

EASYILOC. Tom Campbell has written EASYILOC to generate machine-readable ILOC/IOTA occultation report forms on MS DOS machines. The program is written in BASIC, and is still in preliminary form. Tom provided me with a copy for my comment and review. It is copywritten, but he writes "I wrote it for IOTA's use — not to make any money off of it."

EASYILOC is a menu-based program that prompts the user for data to create a graze report. User errors are trapped, and the user prompted for the correct input. Once data are entered, the user may edit prior to saving the entries. The reports are generated in the ILOC format as well as in an "expedition report" format that is easier to read.

A feature of EASYILOC is assistance in computing the coordinates of observing sites from the observers' information. To save time in data reduction, the user first creates a data base of topographic maps for EASYILOC use. Each entry has the map name, coordinates, and scale. The data base can be created to include only one map, if the user wishes. The observers are expected to determine their locations relative to a landmark or feature discernible on the topographic map. To reduce that to coordinates, the distance of the feature from the edges of the map is measured, and that information, along with the map scale and the observing position relative to the landmark is used to compute the longitude and latitude.

Tom has also written a separate piece of software, FINDMAPS, that uses the data base of the topographic maps created for EASYILOC to identify the maps a graze limit line will cross. As he remarks, "Users will gain from this program only if they first endure a little pain. For the topo maps data base must contain map data from ALL your collection of topo maps." For some of us that may be quite a lot of typing, but, as Tom points out, the data need only be entered once.

By distributing the software as BASIC routines that users may modify if they wish, Tom avoids being caught in the trap of trying to provide software to cover all of the computer systems that are "MS DOS." I am continually annoyed by software developers, including some who have written commercial packages, who have made assumptions about how their software will be used and make no provision for modification. As an example, a very well-regarded tax program we are trying to use (it is that time of year) assumes that, if the program is run from the floppies, then the computer only has two disk drives, both 360K, and they are drives A and B. The program can be run from a hard disk, but then the program will only accept data stored in the same hard disk directory that contains the programs. There are just too many variations in the computer systems for developers to anticipate all of the possibilities. Developers like Tom, who cannot hope to ever be repaid for their efforts, are better off distributing the source code and letting the users take care of their own special cases.

Buses of the Future. A computer bus is the means of communication between the main computer board ("motherboard") and any added boards or peripheral cards. Not all computers have the option to add extra boards. A computer design described as "single board" generally has all the components needed to communicate with peripherals on the board and needs no extra cards. Peripherals by definition are anything that is not directly controlled by the main computer board or is not located on the main board, and can include monitor, keyboard, disk drives, clock, extra memory, modem, printer, plotter, tape drive, and more. Before the IBM PC AT was introduced, most computer buses were virtually synonymous with the computer make. An Apple II used an Apple bus, an IBM PC its bus, and several different bus designs were used with computers based on the Z-80 chip in the CPM world.

The bus specification includes the details of both the electrical and the mechanical connections of the card to the main board. The electrical connections are made by inserting the card into a slot on the main board so that copper stripes on the card match with the appropriate stripes in the receptacle. The use for each of the stripes is given in the specifications. Mechanical connections might be attaching the card to the computer frame with screws, and the bus specification details where the attachments are made and the size of the screws. Standards in bus specifications assure that computer owners can purchase add-on cards for their computers without fear that they will not fit or will not work.

As the power and capability of microprocessors increases, new computer designs with new buses are necessary to allow full use of the newer processors. When IBM designed the PC AT, it added the AT bus, which communicates data between the main board and the card in 16-bit words, instead of the 8-bit words of the PC bus. More recently, IBM has designed another bus, the MicroChannel Architecture (MCA) bus, to accommodate the PS/2's more powerful capabilities. There are reports in the microcomputer press that yet another bus will soon be announced by IBM, an enhanced MCA bus that can operate at higher speeds than the original MCA. A competing bus architecture, the Enhanced Industry Standard Architecture (EISA) bus, has also been announced by a consortium of computer manufacturers. The full MCA bus is only available on IBM PS/2 Model 70 and 80 computers; the EISA bus will presumably be used in designs of comparable power, if not price, to the 70 and 80.

A proliferation of confusing buses is a problem for manufacturers of computer peripherals, such as printers, modems, monitors, who would like to supply as wide a market as possible to maximize their profits. Having multiple bus architectures is also a problem for anyone who wants to use the more powerful new designs, but already has equipment, and does not want the expense and time of learning to use new equipment. Software developers also have problems in trying to provide products that can be used on all the various models.

At the moment, most individuals who own a computer or two for personal use need not be concerned about the newer buses. They do not need the higher speeds or the ability to allow multitasking these designs offer. There will come a time, however, when individual computer owners will need some understanding of the different architectures, if only to protect themselves from mistakenly purchasing the "wrong" model cards, or software that won't run on their systems.

Comments on Software Development. A project on which I am currently working involves comparing the results produced by several programs. We have sometimes had difficulty determining what these programs are really doing. Our complaints are undoubtedly familiar to anyone working with "mature" programs, software developed over many years by many people. The software is hard to understand. The documentation, when available, does not always provide accurate information about the programs or their designs. The original authors of the software are not available, if indeed they could even remember what they meant to do 15 years ago when they first designed their routines. The coding is done in clever ways, trying to save time, space, and the number of variables used, but this, coupled with the almost complete absence of comments in the code, makes it very difficult to follow what is being done.

As a result of this experience, I offer the following suggestions to software authors:

- It is almost impossible to provide too much documentation. Include comments in the code on what the variables are, what they do, and what the purposes of the calculations are.

- It is, however, possible to provide conflicting and confusing documentation. Longer is not always better if it only confuses the issue.

- If you are coding an algorithm, the code should follow the algorithm. This makes it easier to find errors.

- If you want your program to be fast, first code it to be right. Then find the parts that are the most time-consuming and optimize them. Also, find them by running the program and getting timing information, not by assuming that perticular parts or computations are more time-consuming than others.

- Keep routines short.

- Minimize the number of overlays and separate programs; short routines and long programs.

- When you change the program, change documentation and comments as well. If you wait until later, you will forget.

THE AUGUST 19TH OCCULTATION OF 63 OPHIUCHI BY VESTA

David W. Dunham

This occultation is important, since Vesta is a very unusual asteroid, and the largest for which an occultation has not been observed. Since Vesta is the brightest asteroid (mag. 6.6 on August 19th), most occultations by it are very shallow events that can only be detected with sensitive photometers. It is very unusual for Vesta to occult a star as bright as 6.2-mag. 63 Ophiuchi, bright enough that visual observers with small telescopes can detect the event. I believe that this is the first occultation predicted in over 20 years of star-catalog comparisons with Vesta's ephemeris where visual observers have a chance to make a contribution.

Possible video efforts to observe this occultation were discussed on p. 243 of the last issue. Observers in Miami and Michigan responded, saying they could deploy either photoelectric or video systems. However, by then, a proposal had already been sent from the University of Arizona to the National Geographic Society asking to support an observational effort for this event, without IOTA involvement (except possibly for one member in the Phoenix area). The chances for this proposal are unknown at the moment, but it asked for support to transport mainly relatively bulky C-14s and photoelectric equipment, with few simpler video systems that could be used with smaller telescopes.

If there are any observers in Brazil, Peru, or Ecuador who have portable telescopes, and photoelectric or video recording systems that could time this event to 0.1-second accuracy or better, they should make every effort to travel into the path in their countries; IOTA might be able to provide some support for such efforts. But, weather permitting, visual observers with small telescopes can time this occultation, so observers throughout northern South America are encouraged to make plans to travel into the path to observe this rare occultation. Depending on other efforts and my circumstances at the time, I may try to videorecord this event on my own from either the Galapagos Islands or from a safe area near the Pacific coast at a high-enough elevation to be above the usual coastal cloudcover. In any case, I would like to coordinate at least IOTA's efforts to observe this event, so anyone interested in attempting it is encouraged to contact me at: 7006 Megan Lane; Greenbelt, MD 20770; U.S.A.; telephone 301,474-4722.

Note that the path shown on page 22 of the 1989 Asteroidal Occultation Supplement to *O.N.* is too far north, based on the SAO position for the star. A better position has been obtained from a special plate taken with the Lick Observatory astrograph that is in good agreement with another Lick position for the star obtained for the Voyager-Uranus catalog. The path using these improved data is shown on p. 281. Since the diameter of Vesta is 0".52, it is unlikely that this path will change by as much as one path-width, and the actual path is likely to be within half a path-width of this nominal path. Hence, it is virtually certain that the occultation's northern limit will be entirely south of California, Baja California, the rest of Mexico, and all of Central America. Of course, observers throughout the Americas who do not travel to the path are nevertheless encouraged to monitor the appulse from their locations to time secondary extinctions that could be caused by satellites of Vesta.

SOLAR SYSTEM OCCULTATIONS DURING 1989

David W. Dunham

This is a continuation of the article with the same title starting on p. 244 of the last issue.

Path Differences. The paths for asteroidal occultations calculated by Edwin Goffin (he produced the asteroidal occultation supplements for 1989 that were distributed last year) and me sometimes have rather large differences, mainly because I usually use the new photographic star catalogs (Zodiacal Zone, or ZZ87, and Lick-Voyager) that Goffin did not have for 1989 predictions. Lunar graze observations have clearly demonstrated the superiority of the new catalogs, so the most accurate paths are usually the ones that I publish in the regional maps that cover the Western Hemisphere; Europe, Africa, and Middle East; and Australasia. Although Mitsuru Sôma uses data provided by me for plotting his world maps, these maps do not take the Earth's rotation into account during the event. Hence, for slow-moving asteroids, his paths will also differ somewhat from mine. My regional maps do not include time marks, so either the world maps by Goffin or Sôma, or the local circumstance predictions distributed by J. Carroll and H. Bode, must be consulted for the time.

Predictions for April through September. Data for these months are listed in two tables like those given for the first 3 months of 1989 in the last issue. Data for the last 3 months of 1989 will be given in the next issue. A new orbit for (2060) Chiron was derived by Brian Marsden and published in the 1988 December MPCs, too late for the last issue This orbit, which I designate as Marsdn88, is quite different from Marsden's previous orbit that I used last time. In addition, Arnold Klemola has measured

Table 1, Part B

1989 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	Possible Area	El Sun	MOON El	MOON %Snl	N Up	Ephem. Source
Mar 16	7h16m35	Chiron	16.0	11.731		10.0		6h 3m.4	16°59'	6.0	71s	119	43	NZ?s,HI?n,cen. Pacific	96°	20°	69+	all	Marsdn88
Apr 2	5 16	Vesta	7.1	1.769		10.2	F2	18 16.4	-18 9	.12	33	17	5	n. Chile, s. Brazil	98	44	21-	e 48W	Goffin86
Apr 2	9 48	Victoria	11.2	1.951		10.6		20 10.7	-15 11	1.1	4	9	24	Texas, Florida	71	19	19-	e 96W	MPC12187
Apr 3	19 26-43	Nemausa	10.3	1.259		11.7		11 24.2	5 24	0.3	17	27	13	seAsia,Pakistan,Urals	156	171	8-	none	Krstnn77
Apr 4	1 30-42	Nemausa	10.3	1.260		11.6		11 24.0	5 26	0.3	17	27	13	n. Africa, w. Europe	156	174	6-	none	Krstnn77
Apr 9	4 06-20	Chaldaea	13.2	2.038	142133	9.1	A0	18 7.3	-9 42	4.1	11	30	29	Venezuela?s;wEurope?s	106	144	13+	none	MPC11621
Apr 11	10 35-52	Marianna	13.9	2.821	206648	9.3	K0	15 23.1	-38 28	4.6	12	30	31	Peru, NZ,se Australia	139	143	34+	w155E	EMP 1986
Apr 11	20 42	Eurynome	13.1	2.856	145648	6.0	M0	21 43.6	-9 30	7.1	2	9	60	Australia?n	57	133	39+	none	Goffin88
Apr 12	1 35-41	Harmonia	10.3	1.460		10.9	F2	11 37.2	10 1	0.5	15	32	19	n. Argentina, Chile	149	69	41+	all	MPC12687
Apr 13	19 02	Diotima	13.1	3.285	59350	7.7	K0	6 37.5	31 10	5.4	10	16	22	South Africa?n	75	25	58+	all	MPC12305
Apr 15	10 08	Pales	13.0	2.985		12.5		5 58.4	23 16	1.0	5	11	28	Australia	65	53	73+	all	Herget77
Apr 15	19 23	Libussa	13.6	3.273	165746	6.7	K5	23 29.6	-11 49	6.8	1	8	88	Antarctic; South Is.?n	38	158	77+	none	EMP 1986
Apr 18	10 16-44	Nemausa	10.8	1.348		11.7		11 18.3	7 18	0.4	30	50	14	S.I.?n,eAustralia,PI?s	140	12	93+	all	Krstnn77
Apr 19	2 08	Freia	13.3	3.155		10.3	K0	6 7.6	21 31	3.1	6	11	24	eastern Canada?s	63	94	96+	all	EMP 1980
Apr 19	13 40	Kalypso	13.5	1.965	80046	8.3	K2	8 12.5	20 23	5.3	6	15	24	eastern Siberia	92	71	98+	all	MPC12188
Apr 20	9 55	Vaticana	10.9	1.426	119678	7.9	K0	12 54.1	9 35	3.1	9	24	23	(NZ, Tasmania)?2"n	155	22	99+	all	EMP 1986
Apr 20	10 34	Freia	13.3	3.172		10.5		6 9.5	21 31	2.9	6	11	24	se Siberia, Hokkaido	62	110	99+	all	EMP 1980
Apr 24	13 24	Laetitia	11.8	2.937		9.3	K6	7 41.1	17 17	2.6	8	16	27	Sri Lanka?n;nwAustralia	80	137	89-	e100E	MPC12686
Apr 25	11 41	Freia	13.3	3.232		11.8		6 16.8	21 31	1.8	6	11	25	Hong Kong, n. of Luzon	59	168	83-	none	EMP 1980
Apr 25	13 56	Hesperia	12.2	2.797	95719	6.2	G5	6 25.6	16 16	6.0	4	10	28	central Siberia	62	164	82-	none	Herget77
Apr 26	9 03	Alexandra	13.5	3.867	76461	5.2	F0	4 3.9	28 52	8.3	4	9	33	Papua New Guinea	30	149	75-	none	MPC11723
Apr 26	17 18	Eunomia	10.5	2.658	164594	9.1	K0	21 39.9	-12 16	1.7	10	12	14	Australia	73	44	72-	all	Goffin87
Apr 27	8 24	Aspasia	12.1	2.360	144921	8.7	F2	20 51.7	-8 42	3.5	8	14	20	central Chile,sBrazil	84	28	66-	all	Herget78
Apr 28	11 42	Pales	13.1	3.165		12.5		6 18.5	23 4	1.1	4	10	30	Manchuria, Japan	57	151	54-	none	Herget77
Apr 30	11 27-46	Nysa	10.4	1.583	159584	6.5	F5	15 53.4	-14 15	4.0	7	24	31	(Galapagos, Japan)?n	159	91	32-	e152W	MPC11982
Apr 30	12 29	Daphne	12.7	2.623	97077	8.8	G5	7 33.9	11 18	4.0	7	13	21	w. & cen. Australia?n	74	141	32-	none	MPC13294
May 6	0 53	Victoria	10.8	1.608	145291	9.5	K2	21 16.4	-8 5	1.6	5	10	20	Italy,Balkans,Ukraine	86	93	1+	none	MPC12187
May 8	7 22-29	Aurora	12.7	2.519	208492	8.4	B8	17 7.2	-32 58	4.3	21	31	17	T.delFuego?1"5;S.Pole	147	171	11+	none	EMP 1988
May 9	3 57	Laetitia	11.9	3.144	97448	8.8	A0	7 56.9	17 17	3.2	6	13	29	sMexico, Cen. America	70	22	18+	w 87W	MPC12686
May 11	15 27-34	Asia	11.0	1.286	158669	9.3	K5	14 33.7	-10 52	1.9	6	23	31	Kyushu,neChina,Siberia	168	90	41+	all	Herget78
May 16	19 58	Diotima	13.3	3.693		12.2		7 18.3	30 0	1.4	6	11	25	n.Spain(dusk),n.Africa	52	85	86+	all	MPC12305
May 19	13 30-58	Pandora	12.8	2.623		10.2	K5	11 26.6	3 58	2.7	18	86	56	(sIndia,swAustralia)?n	113	54	98+	all	Herget78
May 25	8 05	Ekard	15.1	3.823	(A)	8.4	A2	7 24.7	8 51	6.7	3	11	60	north Pacific Ocean	49	163	79-	none	EMP 1986
May 25	8 16	Ekard	15.1	3.823	(B)	8.7	A	7 24.7	8 51	6.4	3	11	60	Queensland	49	163	79-	none	EMP 1986
May 26	5 27-47	Emita	13.7	2.358	119809	9.5	G0	13 9.4	1 6	4.2	18	48	29	se Canada, USA, HI?n	131	114	71-	e 85W	MPC11621
May 29	21 04-45	Ophelia	12.5	2.114	139358	6.9	K0	13 26.4	-5 42	5.6	39	92	25	S.Africa?n;nArgentina	134	158	31-	none	MPC13294
Jun 6	18 52-65	Chaldaea	12.5	1.640	141914	8.2	B8	17 49.4	-4 46	4.3	9	22	24	(SI,Tasmania,S.Afr.)?n	158	146	11+	none	MPC11621
Jun 6	23 06	Daphne	12.7	2.932	97875	7.8	K0	8 28.5	11 48	4.9	5	9	23	Peru, Bolivia,s.Brazil	51	14	12+	w 42W	MPC13294
Jun 10	14 00-13	Bellona	11.4	1.985	141327	9.3	G5	16 40.5	-8 40	2.2	10	22	23	HI?s; s. Japan, China	164	89	43+	w153E	Herget78
Jun 11	19 23	P/SM-WM-1	13.4	5.888		11.0		23 56.8	6 4	2.5	5	25	85	Australia	79	173	55+	none	MPC11510
Jun 14	19 52-69	Martha	13.2	1.839	142459	8.9	F0	18 35.7	-8 39	4.4	8	24	32	south Asia, n. Africa	159	69	81+	w 95E	MPC13295
Jun 14	21 36	Laetitia	12.1	3.601		9.6	F5	8 44.1	16 1	2.6	4	10	33	Morocco	46	83	82+	all	MPC12686
Jun 16	1 53-65	Hermentaria	11.3	1.862	187080	5.7	B9	18 35.5	-23 33	5.6	10	23	25	(S.Afr.,T.delFuego)?n	166	51	90+	w 38E	MPC13442
Jun 16	4 26	Mars	1.8	2.390	79984	9.3	F2	8 6.5	21 35		151	7	1	w. USA; Tahiti?s	35	109	90+	all	NAO001
Jun 22	13 06-13	Lomia	12.4	2.071	228730	9.6	F8	18 4.6	-45 9	2.9	12	23	20	(SI,Tasm.,swAustral.)?n	158	44	88-	e110E	MPC13294
Jun 26	12 05-52	Germania	12.8	2.564	158222	9.3	K0	13 51.4	-16 20	3.5	51	95	22	seAustralia,Fiji,Samoa	117	154	49-	e167W	EMP 1986
Jun 27	15 33	Mars	1.8	2.451	97998	8.9	F5	8 36.2	19 54		147	7	1	Madagaskar, s. Pakistan	31	104	36-	none	NAO001
Jun 27	19 55	Themis	13.4	3.399	109295	8.8	G5	0 32.6	2 56	4.6	14	22	22	Sumatra,Malaysia,s.P.I.	87	17	34-	all	MPC13294
Jun 29	16 54-64	Hermentaria	11.2	1.830		10.7	M0	18 23.0	-24 21	1.0	9	22	24	Rebun I.,China,Arabia	178	136	15-	none	MPC13442
Jun 30	14 32-48	Olga	11.9	1.038		10.3	F8	19 7.6	3 30	1.9	10	31	22	Taiwan, s & e Asia	152	127	9-	none	EMP 1986
Jul 1	10 39-52	Hermentaria	11.2	1.829		11.9	03	18 21.3	-24 27	0.5	9	22	24	OR, HI?s,Japan?n,PI?s	176	161	4-	none	MPC13442

the positions of A.C. stars occulted by Chiron from existing Lick plates. The combination of the new orbit and improved star positions has been incorporated into the predictions given here, including the event on March 16th, which I have listed here again, and included in my April - June regional maps, because the prediction differs so much from that given in the last issue. These data also showed that an event on September 17th will miss the Earth's surface by about 5", so it is not listed. However, it will be in the local circumstance predictions, calculated by J. Carroll with my old data, and should be ignored. Also in MPC 13923, corrections to the previously published mean motions were published for

Table 2, Part B

1989 DATE	No.	Name	km-diam.	-//	RSOI	Type	Motion °/Day	P.A.	SAO No	DM/ID No	D	Min. Geocentric U. T.	Sep.	S	AGK3 No	Shift	Time	APPARENT R.A.	Dec.
Mar 16	2060	Chiron	400	0.05	12233	B	0.016	60°1		A1746194		7h20m7	0"45S	HC		-1"11	27m1	6h 5m7	16°59'
Apr 2	4	Vesta	501	0.39	3104	V	0.283	89.3		L 3 5616		5 22.3	1.27S	H				18 18.8	-18 8
Apr 2	12	Victoria	117	0.08	306	S	0.547	70.1		L 5 2894		9 47.7	3.59N	H				20 12.9	-15 4
Apr 3	51	Nemausa	137	0.15	457	CU	0.214	317.6				19 32.8	4.08N	C				11 26.2	5 11
Apr 4	51	Nemausa	137	0.15	457	CU	0.213	317.7				1 36.3	5.88N	C				11 26.1	5 13
Apr 9	313	Chaldaea	101	0.07	328	C	0.154	48.9	142133	- 9°4660		4 13.5	3.90N	US		1.03	-1.4	18 9.5	-9 42
Apr 11	602	Marianna	130	0.06	694	C	0.130	250.6	206648	C3810314		10 43.1	0.45S	S				15 25.7	-38 36
Apr 11	79	Eurynome	69	0.03	181	S	0.413	69.1	145648	- 9 5833		20 39.5	1.75S	UZ		-0.05	0.1	21 45.7	-9 20
Apr 12	40	Harmonia	111	0.10	358	S	0.169	283.6		+10 2318		1 37.5	4.22S	A	N10°1452			11 39.3	9 48
Apr 13	423	Diotima	217	0.09	1308	C	0.229	96.8	59350	+31 1381		18 59.3	2.02S	UR	N31 675	-0.13	0.2	6 40.0	31 8
Apr 15	49	Pales	154	0.07	668	CG	0.345	91.9				10 6.2	1.92S	C				6 0.8	23 16
Apr 15	264	Libussa	54	0.02	130	S	0.437	67.5	165746	-12 6510		19 25.4	2.47S	UY		-0.32	0.6	23 31.6	-11 36
Apr 18	51	Nemausa	137	0.14	457	CU	0.111	333.6				10 33.3	3.07S	C				11 20.4	7 5
Apr 19	76	Freia	190	0.08	961	P	0.326	89.8		+21 1141		2 6.6	2.78N	HX	N21 632	0.15	-0.4	6 10.0	21 31
Apr 19	53	Kalypso	119	0.08	374	XC	0.316	97.4	80046	+20 2028		13 38.7	4.21N	UX	N20 954	-0.27	0.2	8 14.8	20 16
Apr 20	416	Vaticana	90	0.09	261	S	0.225	263.2	119678	+10 2487		9 51.3	6.69S	RA	N 9 1565	-0.04	1.4	12 56.1	9 22
Apr 20	76	Freia	190	0.08	961	P	0.329	90.0		L 1 294		10 31.7	1.38N	H				6 11.9	21 31
Apr 24	39	Laetitia	159	0.07	759	S	0.238	87.9		L 4 2417		13 21.2	1.34S	H				7 43.4	17 11
Apr 25	76	Freia	190	0.08	962	P	0.338	90.8		+21 1196	F	11 38.6	0.32N	XA	N21 652	0.05	-0.1	6 19.1	21 30
Apr 25	69	Hesperia	143	0.07	547	M	0.392	86.8	95719	+16 1159		13 54.4	2.22N	RP	N16 623	-0.42	-0.3	6 27.8	16 15
Apr 26	54	Alexandra	171	0.06	875	C	0.357	83.4	76461	+28 619		9 0.6	0.89S	UP	N28 410	-0.40	0.4	4 6.3	28 58
Apr 26	15	Eunomia	272	0.14	1472	S	0.347	61.9	164594	-12 6074		17 20.9	0.22N	U7		-0.34	-0.2	21 42.0	-12 6
Apr 27	409	Aspasia	168	0.10	691	CX	0.305	58.5	144921	- 9 5608		8 27.2	0.55S	US		0.07	0.2	20 53.8	-8 33
Apr 28	49	Pales	154	0.07	675	CG	0.363	93.6				11 40.4	1.47N	C				6 20.9	23 3
Apr 30	44	Nysa	73	0.06	205	E	0.214	284.8	159584	-13 4290		11 36.1	1.30N	UZ		-0.85	0.5	15 55.7	-14 22
Apr 30	41	Daphne	182	0.10	803	C	0.307	81.0	97077	+11 1630		12 26.6	2.86S	UA	N11 873	0.06	-1.4	7 36.1	11 13
May 6	12	Victoria	117	0.10	300	S	0.491	61.8	145291	- 8 5627		54.1	5.13N	US		0.65	0.1	21 18.5	-7 56
May 8	94	Aurora	212	0.12	1356	CP	0.133	256.6	208492	C3212409		7 24.1	2.83S	S				17 9.8	-33 1
May 9	39	Laetitia	159	0.07	763	S	0.276	92.3	97448	+17 1725		3 54.8	0.67N	UH	N17 841	-0.27	-0.5	7 59.2	17 10
May 11	67	Asia	60	0.06	137	S	0.251	298.7	158669	-10 3932		15 26.6	4.71N	UX		-0.17	0.2	14 35.9	-11 3
May 16	423	Diotima	217	0.08	1307	C	0.302	99.0				19 56.1	1.20N	C				7 20.8	29 55
May 19	55	Pandora	68	0.04	228	M	0.047	147.1		+ 4 2477		13 37.8	1.21S	XA	N 3 1505	0.72	-3.9	11 28.6	3 45
May 25	694	Ekard	93	0.03	376	CP:	0.295	93.5		+ 9 1657	A	8 3.2	1.81N	A	N 8 982			7 26.8	8 47
May 25	694	Ekard	93	0.03	376	CP:	0.295	93.5		+ 9 1657	B	8 16.6	1.07S	A	N 8 983			7 26.8	8 47
May 26	481	Emita	116	0.07	501	C	0.088	244.7	119809	+ 1 2796		5 42.8	1.49N	UH	N 1 1535	-0.46	-0.2	13 11.4	0 53
May 29	171	Ophelia	121	0.08	499	C	0.049	267.5	139358	- 5 3702		21 21.5	2.19S	UH		-0.20	1.6	13 28.5	-5 54
Jun 6	313	Chaldaea	101	0.08	341	C	0.237	277.9	141914	- 4 4365		18 58.9	4.29S	S				17 51.5	-4 47
Jun 6	41	Daphne	182	0.09	768	C	0.402	93.3	97875	+12 1859		23 4.1	1.02S	UR	N11 994	-0.28	0.4	8 30.7	11 41
Jun 10	28	Bellona	126	0.09	542	S	0.209	269.1	141327	- 8 4296		14 6.7	2.76N	S				16 42.7	-8 44
Jun 11	6001	P/SM-WM-1	100	0.02	744		0.106	53.2				19 26.6	0.30S	C				23 58.8	6 17
Jun 14	205	Martha	84	0.06	279	C	0.198	283.0	142459	- 8 4665		20 0.8	1.64N	S				18 37.9	-8 37
Jun 14	39	Laetitia	159	0.06	771	S	0.336	99.9		+16 1816		21 34.6	1.58N	XA	N16 938	0.18	-0.9	8 46.3	15 53
Jun 16	346	Hermentaria	110	0.08	425	S	0.205	252.8	187080	C2314572		1 58.5	2.28S	7P		0.05	-0.2	18 37.9	-23 31
Jun 16	4	Mars	6782	3.91			0.621	102.5	79984	+21 1768		4 24.2	1.11N	UX	N21 905	-0.14	-0.1	8 8.8	21 28
Jun 22	117	Lomia	154	0.10	748	XC	0.198	272.9	228730	P45 9093		13 7.3	0.23S	S				18 7.6	-45 9
Jun 26	241	Germania	169	0.09	895	C	0.043	51.3	158222	-15 3764		12 30.2	2.16S	UX		-0.31	-3.4	13 53.5	-16 32
Jun 27	4	Mars	6782	3.82			0.623	105.0	97998	+20 2140		15 30.7	0.30N	XA	N19 861	0.24	-0.5	8 38.4	19 46
Jun 27	24	Themis	228	0.09	1550	C	0.158	67.2	109295	+ 2 72		19 58.9	0.76N	UX	N 2 51	0.42	-0.2	34.7	3 9
Jun 29	346	Hermentaria	110	0.08	423	S	0.224	255.2		C2414315		16 59.1	3.58N	HC		-0.51	-2.0	18 25.4	-24 20
Jun 30	304	Olga	68	0.09	144	C	0.207	251.1		+ 3 3925		14 34.5	3.91N	A	N 3 2405			19 9.6	3 33
Jul 1	346	Hermentaria	110	0.08	423	S	0.223	255.4		C2414287		10 44.8	3.39N	HC		-0.79	0.3	18 23.8	-24 26

a few asteroids, including (19) Fortuna and (521) Brixia, whose predictions have been updated in this issue. The differences, in the sense new - old, are given in the tables at the top of the facing page, so that you can correct the time and distance of closest approach in the appulse predictions sent to you by J. Carroll.

Table 1, Part C

1989 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	Possible Area	El Sun	MOON El	MOON %Snl	MOON N Up	Ephem. Source
Jul 2	8^h31^m	Sylvia	13.0	3.372		11.1	K	$13^h20^m.5$	0°31'	2.1	25^s	33	18	e.Australia?n;Antarctic	99°	109°	1-	none	MPC11507
Jul 3	7 33-42	Saturn	0.0	9.021	187255	5.4	K4	18 43.3	-22 27		2867	29	2	Americas, Pacific, NZ	179	175	0+	none	NAO001
Jul 5	1 51	Venus	-3.9	1.517	80331	9.0	F0	8 37.1	20 13		220	4	1	(e.Mexico, Texas)?n	24	1	4+	all	NAO001
Jul 11	22 41	Lamberta	14.3	4.043	76784	7.7	B3	4 47.7	28 14	6.5	3	10	43	Scandinavia	35	135	59+	none	MPC11620
Jul 12	21 26-44	Vesta	5.7	1.181	186209	9.4	B9	18 0.9	-22 32	0.0	68	29	3	swAsia,nAfrica,Brazil?n	160	50	68+	w 40E	Goffin86
Jul 16	13 42	Euphrosyne	12.0	3.077		13.1		3 47.2	24 38	0.3	7	9	18	Hawaii?s	54	154	94+	w164W	MPC13294
Jul 17	3 20	Winchester	11.7	1.990	129884	9.2	F2	2 22.3	-2 20	2.6	6	10	16	(U.K., w.Europe)?s	82	116	97+	w 8W	Landgraf
Jul 17	3 28	Winchester	11.7	1.990	129885	9.0	F2	2 22.4	-2 20	2.8	6	10	16	miss, 0"2 over N.Pole	82	116	97+	none	Landgraf
Jul 18	13 47-57	Georgia	12.1	1.394	212139	9.9	K	20 24.6	-30 23	2.3	5	26	42	(NZ, s. Australia)?n	168	11	100+	all	MPC13442
Jul 22	15 39-59	Siegena	12.3	2.445		11.6		16 32.8	4 24	1.2	19	34	20	east Asia; S.Africa?n	122	102	81-	e 84E	Landgraf
Jul 23	1 52-66	Zerbinetta	13.4	1.879	211938	11.0	F8	20 12.6	-38 8	2.5	6	23	39	S.Afr.,Uruguay,nChile	162	62	77-	e 64W	EMP 1986
Jul 24	19 01-09	Deiphobos	15.9	4.845		10.0	G0	0 20.5	33 28	5.9	9	30	54	e.Australia;Japan?w	101	24	59-	all	EMP 1986
Jul 25	23 19	Hebe	11.3	3.629	99117	8.6	G0	10 23.5	15 9	2.9	4	9	28	northern Chile	30	114	45-	none	Goffin86
Jul 26	6 53	Nausikaa	11.4	1.838	75764	8.6	F0	3 7.2	21 33	2.8	4	9	25	se USA,NovaScotia,Nfld.	72	8	42-	all	MPC12432
Jul 26	6 54	Nausikaa	11.4	1.838	75764	8.6	F0	3 7.2	21 33	2.8	4	9	25	e. USA, Ontario, Quebec	72	8	42-	all	MPC12432
Aug 1	7 02	Eugenia	13.0	3.293	93957	3.4	F0	4 25.8	15 46	9.6	7	12	22	s.Brazil?n;s.Africa(day)	61	57	0-	none	MPC13294
Aug 1	13 09	Nemausa	12.4	2.496		11.8		12 54.8	0 32	1.1	4	10	26	n.w. Australia	64	65	0-	none	Krstnn77
Aug 3	3 31	Klemola	15.5	2.927	139866	5.1	K0	14 17.0	-2 2	10.3	2	16	121	n.of Easter I.,cen.Chile	83	66	2+	w130W	EMP 1986
Aug 6	10 27-46	Metis	9.6	1.484	190531	9.0	A0	21 37.1	-23 26	1.1	17	22	11	Colombia,sSI;Tasmania?n	170	130	21+	w165E	MPC11234
Aug 7	9 15-35	Georgia	12.1	1.397	211847	8.1	K5	20 5.3	-30 43	4.1	6	28	42	Patagonia;s.Australia?n	160	97	29+	w138W	MPC13442
Aug 14	7 32-43	Kleopatra	10.7	1.634	125303	9.4	F5	19 56.5	0 32	1.6	14	25	17	se Canada, w USA, HI	152	29	90+	w 90W	EMP 1986
Aug 14	23 08-18	Niobe	11.1	1.816	145856	8.5	F8	22 2.5	-3 27	2.7	6	18	30	s.India,Yemen,n.Africa	167	40	94+	w 72E	EMP 1982
Aug 15	0 05-23	Aspasia	10.9	1.561	126180	8.9	K2	20 43.0	0 17	2.2	16	24	13	cen.Africa,sBrazil,Chile	160	28	94+	w 60E	Herget78
Aug 18	10 15	Hypatia	13.1	2.745		9.4	A0	4 41.8	13 34	3.7	6	13	26	n. Chile, nw Argentina	74	89	98-	all	EMP 1983
Aug 18	18 22-57	Victoria	8.9	0.885		12.0		22 18.3	8 29	.14	22	35	11	Fiji, Darwin;S.Africa?n	157	18	96-	all	MPC12187
Aug 19	4 16-30	Vesta	6.6	1.468	185928	6.2	B2	17 51.8	-24 53	1.01	12	54	4	Galapagos,Ecuador,Amazon	123	85	94-	e125W	Goffin86
Aug 20	20 22-32	Siegena	12.6	2.737		11.0	K2	16 35.6	0 40	1.8	12	23	23	U.K., w.Europe, Africa	99	125	82-	all	Landgraf
Aug 23	10 04-25	Patroclus	15.2	4.207		11.3		2 44.6	9 24	3.9	34	93	41	Hawaii?n; Alaska	108	18	54-	all	Goffin88
Aug 23	20 01	Nuwa	13.6	3.032	77297	9.0	K0	5 32.8	22 3	4.6	6	12	28	Indochina,HongKong,Taiwan	66	24	49-	all	MPC11508
Aug 25	21 35-78	Fortuna	11.1	1.775	186483	8.7	B9	18 10.2	-21 17	2.5	84	130	15	Africa	120	173	27-	none	MPC13923
Aug 26	19 39	Chloris	14.0	3.361		10.6	K7	5 9.3	16 33	3.5	6	18	38	Indochina; Japan?n	75	26	19-	e 97E	EMP 1984
Aug 28	12 51	Interamnia	11.8	2.896		9.3	SP	16 22.5	-26 3	2.6	23	23	13	Burma, China, Korea	94	125	7-	none	Schmadel
Aug 29	4 03	Ceres	8.9	2.887		10.1		5 31.7	20 16	0.3	37	13	4	Nigeria	72	48	4-	e 5E	MPC12187
Sep 1	3 18	Julia	11.2	2.147	57559	6.0	F5	4 56.9	39 19	5.3	7	13	20	n.w. Africa, Greece	81	91	1+	none	MPC12190
Sep 1	3 14	Julia	11.2	2.147	57559	9.7	F5	4 56.9	39 19	1.8	7	13	20	Congo Rep., Sudan	81	91	1+	none	MPC12190
Sep 2	0 19-37	Themis	12.4	2.546	109355	7.8	G5	0 37.2	3 23	4.6	22	30	16	India?n;S.Africa;Brazil?n	149	168	3+	none	MPC13294
Sep 2	10 00-15	Atropos	12.7	1.140	145234	7.3	F5	21 12.3	-8 34	5.4	3	19	52	Aleutians,Fiji,e.Austral.	157	134	4+	w140E	MPC13442
Sep 4	17 28-36	Wladilena	12.4	1.074	254423	5.1	K0	18 54.2	-60 16	7.3	2	15	62	N.Z.?n; w. Australia	111	69	18+	none	MPC13443
Sep 5	20 30-52	Eurynome	10.3	1.144		10.4	K0	23 20.9	1 43	0.7	9	27	24	China,India,s.Africa	169	127	26+	w 21E	Goffin88
Sep 9	0 04	Ausonia	12.7	2.630	77449	6.6	K0	5 40.2	29 11	6.2	5	16	35	s.e. Africa, s. India	80	177	56+	none	MPC11507
Sep 12	23 21-33	Fortuna	11.3	1.956		11.1		18 17.8	-21 26	0.9	19	30	17	Patagonia, S.Africa	105	41	91+	all	MPC13923
Sep 15	6 52-83	Victoria	9.1	0.936		11.5		21 59.4	5 8	.11	22	35	12	Cuba,Nicaragua,Antarctic	156	21	100+	all	MPC12187
Sep 16	10 38-56	Circe	12.8	1.976	109907	6.2	K0	1 25.8	7 42	6.6	12	29	24	nwCanada; HI?s; PNG?s	150	17	99-	all	MPC13294
Sep 17	15 45-54	Zerbinetta	14.1	2.280	211502	7.4	K2	19 40.1	-33 46	6.7	8	35	48	Caspian S. to Mozambique	116	94	93-	n28N	EMP 1986
Sep 18	12 25	Cybele	12.3	2.869		11.6		17 54.6	-20 36	1.2	15	21	18	Indonesia, Micronesia	94	128	87-	e120E	MPC12302
Sep 22	3 14	Amphitrite	11.4	3.160	183469	9.4	G0	15 23.4	-23 53	2.2	7	10	21	w. U.S.A.?s	56	146	50-	none	Landgraf
Sep 22	12 32-42	Hermione	11.5	1.967	129014	9.5	G0	0 50.9	-6 2	2.2	20	26	13	Alaska?s; e.Siberia	165	86	45-	e132E	MPC12191
Sep 23	20 31	Julia	11.0	1.931	40422	8.7	K2	5 29.6	41 37	2.5	11	20	18	n.w. Australia	96	31	32-	all	MPC12190
Sep 28	1 16	Hermentaria	12.3	2.583	186612	4.6	K5	18 14.9	-27 4	7.7	6	19	34	Mexico,Florida,Bermuda?	89	109	3-	none	MPC13442
Sep 28	8 03	Ceres	8.6	2.468		11.7		6 4.0	21 15	0.1	64	21	4	Panama,nw S.America	94	76	2-	e 50W	MPC12187
Sep 29	6 28	Eugenia	12.4	2.513		9.4	F0	5 18.6	15 22	3.1	27	40	17	(Chile,Argentina)?n	105	98	0-	none	MPC13294

1989 Date	Asteroid	Differences in Separation	Differences in Time
Jan. 20	2060 Chiron	1".09 N	+4.6 min.
Feb. 19	19 Fortuna	0.00	+0.4 min.
Mar. 16	2060 Chiron	1.64 S	-2.3 hrs.
Aug. 25	19 Fortuna	0.26 S	+7.5 min.
Sep. 12	19 Fortuna	0.06 S	+2.2 min.
Oct. 13	19 Fortuna	0.03 S	+0.9 min.
Oct. 23	521 Brixia	0.33 N	+1.3 min.

Table 2, Part C

1989 DATE	MINOR PLANET No.	Name	km-diam.	-//	RSOI	Type	Motion °/Day	P.A.	STAR SAO No	DM/ID No	D	Min. U. T.	Geocentric Sep.	S	COMPARISON DATA AGK3 No	Shift	Time	APPARENT R.A.	Dec.
Jul 1	346	Hermentaria	110	0.08	423	S	0.223	255.4		C2414287		10h 44.8	3.39N	HC		-0.79	0.3	18h 23.8	-24 26
Jul 2	87	Sylvia	271	0.11	2108	P	0.108	141°.5		- 0°2683		8h 27m.4	1".96S	HA	S 0 1825	0.59	-0.7	13h 22m.6	0°44'
Jul 3	6	Saturn	115644	8.84			0.074	264.4	187255	-22 4854	A	7 37.7	1.65N	7P		0.01	-0.3	18 45.7	-22 24
Jul 5	2	Venus	12220	11.11			1.214	104.4	80331	+20 2155		1 49.7	8.13N	UX	N20 1006	-0.02	0.0	8 39.4	20 4
Jul 11	187	Lamberta	135	0.05	660	C	0.317	78.1	76784	+28 704		22 41.6	2.08N	UX	N28 461	-0.11	0.0	4 50.2	28 18
Jul 12	4	Vesta	501	0.58	3128	V	0.205	247.8	186209	C2212499		21 37.3	4.72N	UH		-0.09	-0.4	18 3.4	-22 32
Jul 16	31	Euphrosyne	248	0.11	1310	C	0.396	61.9		H 0 2600		13 43.7	2.27N	E				3 49.6	24 46
Jul 17	747	Winchester	178	0.12	643	C	0.464	89.2	129884	- 2 406	B	3 22.2	3.97N	G				2 24.4	-2 9
Jul 17	747	Winchester	178	0.12	643	C	0.464	89.2	129885	- 2 406	A	3 29.4	4.86N	G				2 24.4	-2 9
Jul 18	359	Georgia	48	0.05	103	CX	0.210	258.6	212139	C3017921		13 48.6	1.81S	S				20 27.1	-30 15
Jul 22	386	Siegena	173	0.10	911	C	0.123	205.0		+ 4 3214		15 50.1	0.45S	A	N 4 2002			16 34.8	4 19
Jul 23	693	Zerbinetta	69	0.05	211	ST	0.211	271.0	211938	C3813940		1 59.8	0.12N	S				20 15.2	-38 1
Jul 24	1867	Deiphobos	131	0.04	991	D	0.099	359.8		+32 56		19 8.7	0.23E	A	N33 35			22.6	33 42
Jul 25	6	Hebe	186	0.07	914	S	0.378	107.5	99117	+15 2197		23 17.1	0.41S	UR	N15 1151	0.32	-0.1	10 25.6	14 57
Jul 26	192	Nausikaa	107	0.08	258	S	0.532	67.7	75764	+21 413	A	6 54.9	3.48N	UX	N21 287	0.10	0.1	3 9.5	21 43
Jul 26	192	Nausikaa	107	0.08	258	S	0.532	67.7	75764	+21 413	B	6 55.2	3.88N	U	N21 287			3 9.5	21 43
Aug 1	45	Eugenia	214	0.09	1187	FC	0.300	85.6	93957	+15 632	V	7 2.9	1.73S	NP	N15 370	-0.07	-0.3	4 28.1	15 51
Aug 1	51	Nemausa	137	0.08	463	CU	0.423	111.3		L 2 548		13 5.4	0.12N	H				12 56.8	0 19
Aug 3	1723	Klemola	35	0.02	79	S	0.237	120.5	139866	- 1 2938		3 27.4	0.32S	PU	S 2 859	0.15	-0.1	14 19.0	-2 13
Aug 6	9	Metis	190	0.18	840	S	0.243	245.2	190531	C2317044		10 36.8	1.25S	US		-0.02	-1.0	21 39.4	-23 15
Aug 7	359	Georgia	48	0.05	102	CX	0.194	272.8	211847	C3017675		9 25.1	3.83S	G				20 7.8	-30 36
Aug 14	216	Kleopatra	137	0.12	531	M	0.200	243.8	125303	+ 0 4374		7 41.7	2.38N	A	N 0 2438	0.71	-2.3	19 58.6	0 39
Aug 14	71	Niobe	87	0.07	294	S	0.273	277.5	145856	- 3 5372		23 13.6	1.64N	US		0.17	0.7	22 4.6	-3 16
Aug 15	409	Aspasia	168	0.15	712	CX	0.217	252.6	126180	- 0 4087		14.0	1.43S	A	N 0 2576	0.10	1.1	20 45.1	0 26
Aug 18	238	Hypatia	156	0.08	667	C	0.313	96.0		+13 711		10 18.6	2.11S	A	N13 374			4 44.1	13 38
Aug 18	12	Victoria	117	0.18	303	S	0.196	252.3				18 38.7	5.04S	C				22 20.3	8 41
Aug 19	4	Vesta	501	0.47	3157	V	0.101	119.1	185928	C2413615		4 10.9	3.26N	HL		0.22	2.2	17 54.3	-24 53
Aug 20	386	Siegena	173	0.09	898	C	0.169	144.0		+ 0 3557		20 26.3	2.09N	A	N 0 1998			16 37.7	0 35
Aug 23	617	Patroclus	149	0.05	1082	P	0.034	35.7				10 11.8	1.67N	C				2 46.8	9 35
Aug 23	150	Nuwa	157	0.07	706	CX	0.307	89.6	77297	+21 900		20 3.6	0.46N	UX	N22 549	-0.03	-0.3	5 35.2	22 5
Aug 25	19	Fortuna	171	0.13	705	G	0.038	106.4	186483	-21 4904		21 30.4	2.82N	UH		-0.35	3.2	18 12.6	-21 16
Aug 26	410	Chloris	128	0.05	607	C	0.200	86.5		+16 724		19 43.1	0.50N	XA	N16 449	0.03	-0.1	5 11.6	16 36
Aug 28	704	Interamnia	333	0.16	2447	F	0.165	71.9		C2511503		12 46.7	1.70N	Y				16 25.0	-26 8
Aug 29	1	Ceres	946	0.45	10295	G	0.297	83.0		A2042296		4 5.8	0.32S	C				5 34.1	20 18
Sep 1	89	Julia	159	0.10	575	S	0.340	71.4	57559	+39 1133	A	3 20.8	0.46N	AG	N39 567	-0.20	-0.2	4 59.6	39 23
Sep 1	89	Julia	159	0.10	575	S	0.340	71.4	57559	+39 1133	B	3 16.8	1.43S	A	N39 567			4 59.6	39 23
Sep 2	24	Themis	228	0.12	1530	C	0.135	247.1	109355	+ 2 86	X	0 26.9	1.23S	UX	N 3 76	0.69	1.6	39.3	3 36
Sep 2	273	Atropos	32	0.04	49	SCTU	0.317	201.4	145234	- 8 5613		10 8.0	2.67N	US		0.50	-0.1	21 14.4	-8 24
Sep 4	852	Wladilena	25	0.03	28		0.409	34.5	254423	P60 7213		17 31.4	6.51S	PG		-0.13	-0.1	18 57.7	-60 13
Sep 5	79	Eurynome	69	0.08	158	S	0.227	239.9		+ 1 4719		20 42.4	0.51S	XA	N 1 2821	-0.57	1.8	23 22.9	1 56
Sep 9	63	Ausonia	108	0.06	383	S	0.256	81.4	77449	+29 970		7.7	0.91S	UR	N29 604	-0.08	0.5	5 42.7	29 12
Sep 12	19	Fortuna	171	0.12	695	G	0.156	92.2		B2171084		23 20.4	1.69S	C				18 20.2	-21 25
Sep 15	12	Victoria	117	0.17	310	S	0.192	214.6				7 5.9	4.51S	C				22 1.5	5 20
Sep 16	34	Circe	118	0.08	478	C	0.158	237.2	109907	+ 7 213	A	10 46.6	2.78N	ZA	N 7 162	-0.01	0.3	1 27.9	7 55
Sep 17	693	Zerbinetta	69	0.04	212	ST	0.125	16.6	211502	C3314420		15 43.2	1.62N	G				19 42.7	-33 40
Sep 18	65	Cybele	230	0.11	1393	P	0.180	97.4		B2168104		12 21.8	0.87N	C				17 57.0	-20 36
Sep 22	29	Amphitrite	219	0.10	1141	S	0.350	102.2	183469	C2312284		3 13.9	2.86N	UX		-0.17	0.1	15 25.7	-24 2
Sep 22	121	Hermione	217	0.15	1214	C	0.182	248.0	129014	- 6 158		12 38.1	4.21N	US		1.00	1.2	52.9	-5 48
Sep 23	89	Julia	159	0.11	585	S	0.239	67.4	40422	+41 1217		20 34.6	3.26S	A	N41 573			5 32.4	41 38
Sep 28	346	Hermentaria	110	0.06	409	S	0.217	91.8	186612	C2712684		1 14.0	2.28N	7H		-0.34	0.7	18 17.4	-27 3
Sep 28	1	Ceres	946	0.53	10204	G	0.199	81.3				8 6.6	0.08S	C				6 6.4	21 15
Sep 29	45	Eugenia	214	0.12	1187	FC	0.104	108.4		+15 794		6 31.3	3.78S	A	N15 465			5 20.9	15 24

Note that magnitudes from the AGK3 are photographic. The visual magnitudes will be considerably brighter, and the magnitude drops larger, for AGK3 stars of spectral type K and M, as noted on p. 263.

Soma's world maps are published here only if the event is not included in Edwin Goffin's predictions; or if the star is mag. 8.0 or brighter; or if the star is double, and I have drawn a line showing the second component path on Sôma's map.

Priority List. I have published individual maps of the U.S.A. for three of the best asteroidal occultations that will be visible from North America during the next three months. One of these is for the occultation by (324) Bamberga, which was listed in the tables in the last issue. Finder charts for the event are given on page 11 of Goffin's 1989 Asteroidal Occultation Supplement for North American Observers, with a detailed chart only 1 degree on a side on p. 250 of the last issue; another chart appears on p. 296 of this month's issue of *Sky and Telescope.* You should practice finding this star before the night of the event, when moonlight will interfere considerably (for this reason, allow more time than usual to locate the star on the night of the event). Unfortunately, new unforeseen work has forced Lowell Observatory to abandon its observational effort for this event, which promises to be one of the best in the U.S.A. this year. They may be able to contribute to an astrometric update for the event. In any case, an astrometric update should be available by the time you receive this issue; it can be obtained by calling our IOTA occultation line at 301,474-4945, and will probably also be available from the Chicago and Houston numbers, as well (I do not usually inform those updating those messages about updates unless the path affects those regions).

In the priority list in the next column, EAON is the European Asteroidal Occultation Network and IOTA usually refers to attempts that will probably be made by William Penhallow in Rhode Island. When possible, numbers give a relative ranking of the priority, with "1" indicating the highest priority. Lowell Observatory was going to attempt astrometry for Bamberga on March 18th, but their PDS, which they use for measuring plates, is out of order for the foreseeable future.

Notes about Individual Events. Wayne Warren supplied important information about some stars, especially doubles.

Jan. 25: The star is Aitken's Double Star (ADS) 4602. The 13.2-mag. companion, 10".8 away in position angle (P.A.) 258°, will not be occulted. If the seeing is not good enough to resolve the stars, the apparent Δm will be 1.9 if component A is occulted, rather than the 5.0 given in the table that assumes that it is clearly resolved. In case of poor seeing and an occultation of component B, the apparent Δm will be only 0.21, not the tabular 3.4 for clear resolution.

Feb. 3, Mars and SAO 92912: Mars will be 89% sunlit. The disappearance will be on the dark crescent, 0".8 wide at most.

1989 Date	Asteroid	Lick	Lowell	EAON	IOTA
March 12	44 Nysa				2
March 16	2060 Chiron	2			3
March 18	324 Bamberga	2			1
April 2	12 Victoria				3*
May 9	39 Laetitia				3
May 26	481 Emita				1
June 11	P/S-W1				2
June 29	87 Sylvia			x	
July 3	Saturn	1			
July 17	747 Winchester			x	
July 26	192 Nausikaa				2
Aug. 14	216 Kleopatra		1		
Aug. 19	4 Vesta	2?	1?		2?
Aug. 20	386 Siegena			x	
Aug. 25	19 Fortuna			x	
Sept. 1	89 Julia			x	
Sept. 16	34 Circe				2
Sept. 28	346 Hermentaria				1
Oct. 15	617 Patroclus				1
Oct. 23	521 Brixia		1	x	
Oct. 23	146 Lucina			x	
Nov. 11	1 Ceres		2		2
Nov. 13	712 Boliviana			x	
Nov. 18	146 Lucina			x	
Nov. 26	146 Lucina			x	
Dec. 2	895 Helio				1
Dec. 3	146 Lucina			x	
Dec. 8	146 Lucina			x	
Dec. 28	150 Nuwa			x	

*Astrometry for this event will be difficult.

Mar. 16: Although updated, the predicted path for this distant mysterious asteroid (large comet?) is still uncertain. A finder chart was given on p. 251 of the last issue, and a special notice about the new path was distributed to observers in the possible area of visibility along with the February 20th lunar eclipse occultation supplement.

Apr. 11, (79) Eurynome and SAO 145648: The star is 47 Capricorni (ZC 3187) and has an angular diameter of 0".0032, requiring 0.18 second for the edge of the asteroid to cover for a central occultation.

Apr. 15, (264) Libussa and SAO 165746: The star has an angular diameter of 0".0016, requiring 0.09 second for the edge of the asteroid to cover for a central occultation.

Apr. 20, (416) Vaticana and SAO 119678: The star has an angular diameter of 0".0006, requiring 0.06 second for the edge of the asteroid to cover for a central occultation.

Apr. 30, (44) Nysa and SAO 159584: The star is ZC 2278.

May 25: Separate paths are calculated for the components of this double star, ADS 6088, with separation 10".3 in P.A. 77°.

May 26: The star has an angular diameter of 0".0004, requiring 0.10 second for the edge of the asteroid to cover for a central occultation.

May 29: The star has an angular diameter of 0".0009, requiring 0.43 second for the edge of the asteroid to cover for a central occultation.

June 11: The occulting object is the massive periodic comet Schwassmann-Wachmann-1; its diameter is unknown.

June 16, (346) Hermentaria and SAO 187080: The star is ZC 2706.

June 16, Mars and SAO 79984: Mars' 4" disk will be 97% illuminated; the dark crescent will be at most 0".1 and lost in irradiation.

June 26: The star has an angular diameter of 0".0003, requiring 0.16 second for the edge of the asteroid to cover for a central occultation.

June 27, Mars and SAO 97998: See June 16 Mars note.

July 3: See separate article on p. 268.

July 5, Venus and SAO 80331: Venus' 11" disk will be 91% sunlit. Disappearance will be on the dark crescent, 1".0 wide at most.

July 17: Separate paths are calculated for the components of this double star, ADS 1839, with separation 8".4 in P.A. 275°.

July 26: The star is ADS 2375, with equal 8.6-magnitude components 0".6 apart in P.A. 109 degrees. The magnitude drop in the table is for one star. But the stars are not likely to be resolved, so when an occultation occurs, the apparent brightness will drop by half from the combined magnitude of 7.8 to 8.6. The predicted separate paths for the stars are labelled (A) and (B) on the map.

Aug. 1, (45) Eugenia and SAO 93957: The star is Theta 2 Tauri (ZC 671) in the Hyades, a spectroscopic binary with a 5th-magnitude companion perhaps 0".02 away, so the occultation events will be in steps probably more than half a second apart. The primary star has an angular diameter of 0".0009, requiring 0.07 second for the edge of the asteroid to cover for a central occultation.

Aug. 3: The star is Upsilon Virginis and has an angular diameter of 0".0016, requiring 0.16 second for the edge of the asteroid to cover for a central occultation.

Aug. 7: The star has an angular diameter of 0".0013, requiring 0.16 second for the edge of the asteroid to cover for a central occultation.

Aug. 14, (216) Kleopatra: See note for Mar. 31 on p. 249 of the last issue. This occultation will occur at a phase about midway between minimum and maximum on the lightcurve, so unlike the 1980 October occultation, there is some hope this time for resolving the possible dumbbell shape.

Aug. 15: The star has an angular diameter of 0".0008, requiring 0.09 second for the edge of the asteroid to cover for a central occultation.

Aug. 19: See separate article on p. 271.

Sep. 1: The star is 5 Aurigae or ADS 3589, with separation 3".9 in P.A. 280°. The magnitude drop in the table is for one star. But the stars might not be resolved, so if the primary is occulted while the secondary is visible, the magnitude drop will be about 3.7. But if the secondary star is occulted while the primary is visible, the magnitude drop will be only 0.07, which would require a photometer to detect.

Sep. 2, (24) Themis and SAO 109355: Lunar occultation data suggest that the star is a close binary.

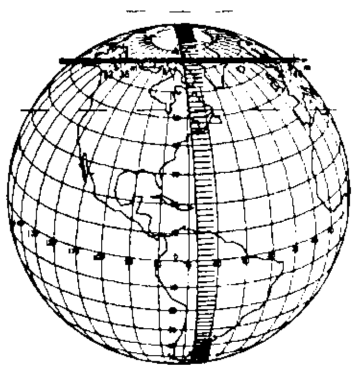
Sep. 4: The star is Omega Pavonis and has an angular diameter of 0".0029, requiring 0.17 second for the edge of the asteroid to cover for a central occultation.

Sep. 9: The star has an angular diameter of 0".0010, requiring 0.09 second for the edge of the asteroid to cover for a central occultation.

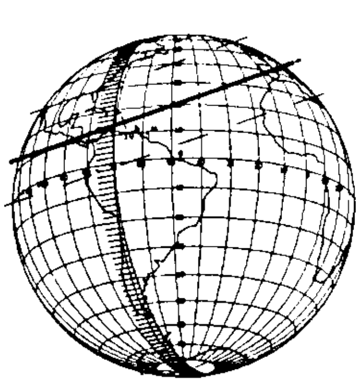
Sep. 16: The star is ZC 214. Its 8th-magnitude companion 69" away in P.A. 99° will not be occulted. The primary has an angular diameter 0".0012, requiring 0.18 second for the edge of the asteroid to cover for a central occultation.

Sep. 17: The star has an angular diameter of 0".0008, requiring 0.15 second for the edge of the asteroid to cover for a central occultation.

Sep. 28, (346) Hermentaria and SAO 186612: The star is ZC 2650 and has an angular diameter of 0".0059, requiring 0.66 second for the edge of the asteroid to cover for a central occultation. The path shown on p. 281, crossing eastern Cuba and Guatemala, was computed using Lick-Uranus catalog positional data for the star, which are known to contain E-term errors (see p. 263). More important, the star is probably too bright to accurately measure on a photographic plate like the one exposed at Lick for this field. Combined Z.C-Perth70 (ZP70) data for the star predict a more northerly path crossing central Mexico and Florida, as shown on p.70 of the January issue of *Sky and Telescope*. That path will probably be closer to the actual path than the southern one based on Lick data. Unfortunately, the Lick data were used for the appulse/local circumstances predictions distributed by Joseph Carroll (my error, that's what I sent him.

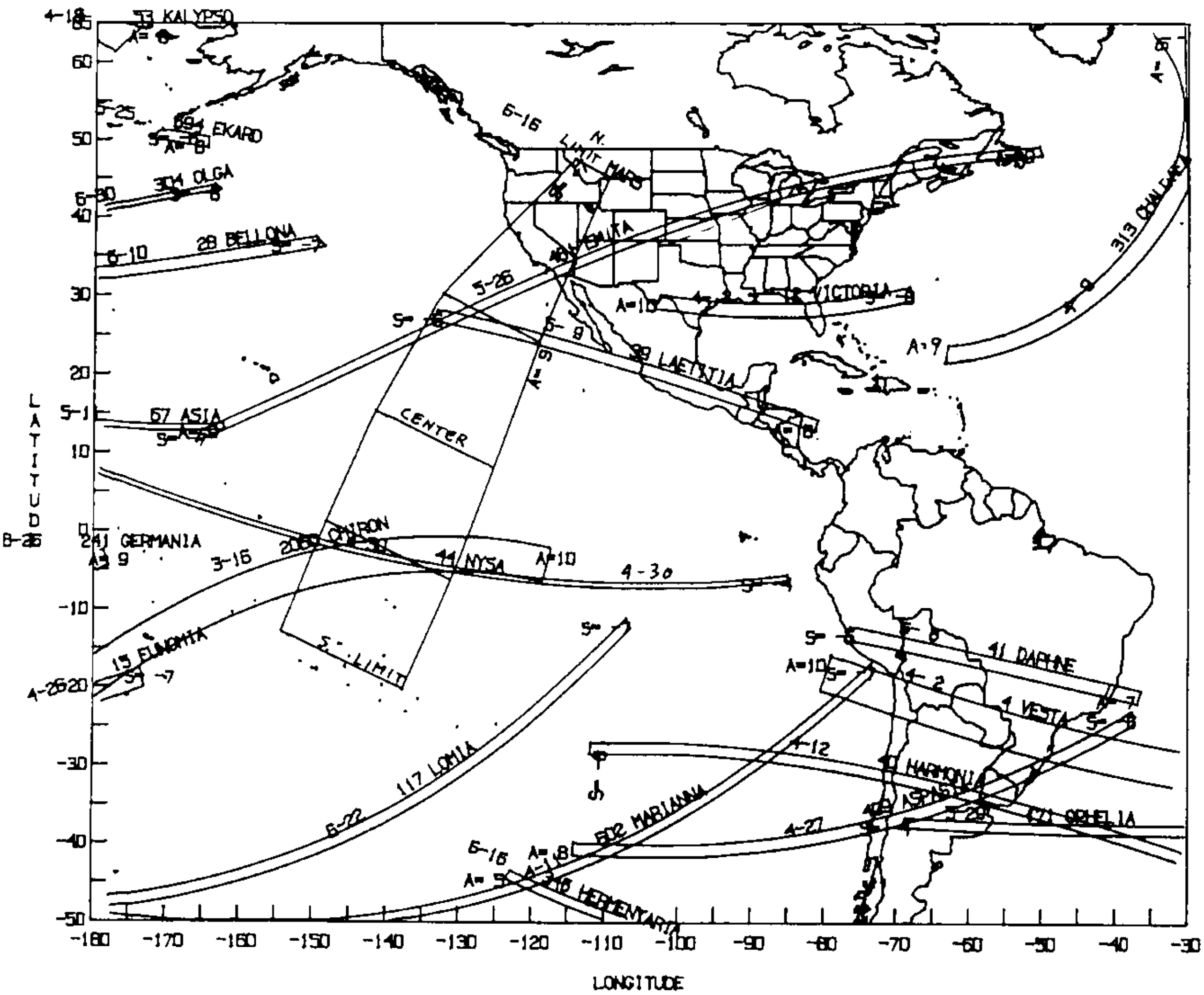


Anonymous by Pales 1989 Mar 16



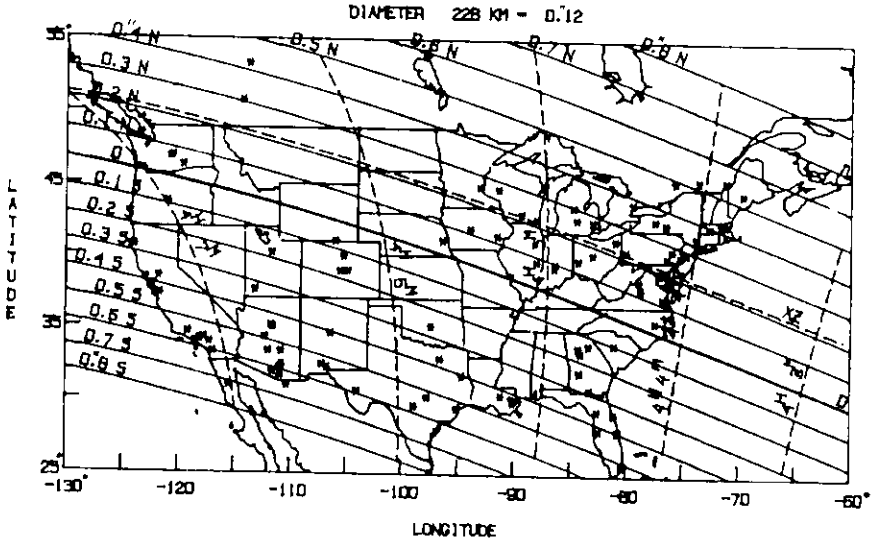
L 5 2162 by Victoria 1989 Mar 27

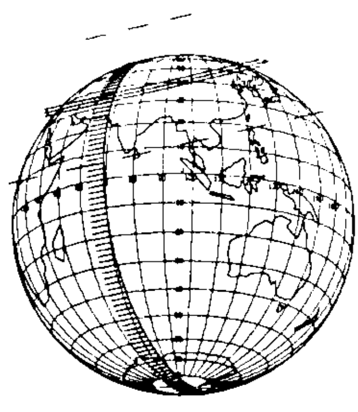
PLANETARY OCCULTATIONS. 1989 APRIL-JUNE



1989 3 18 (324) BAMBERGA SAO 138118

DIAMETER 228 KM = 0."12

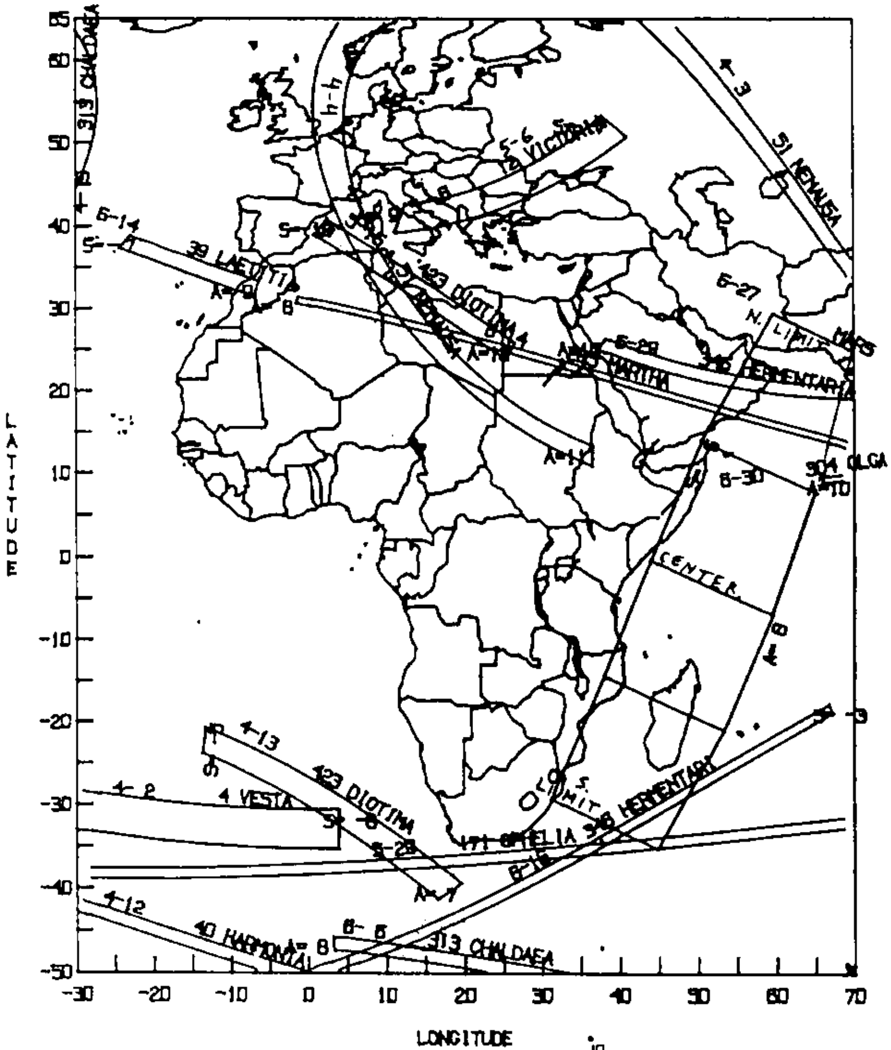


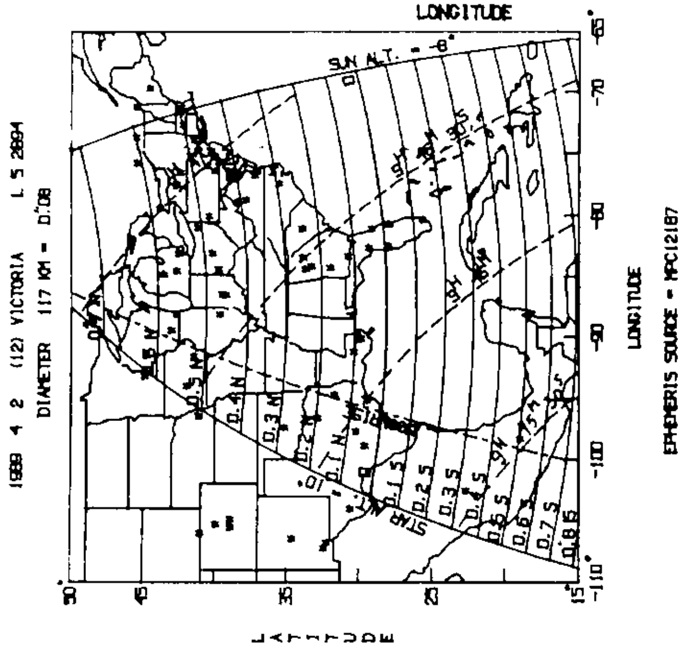


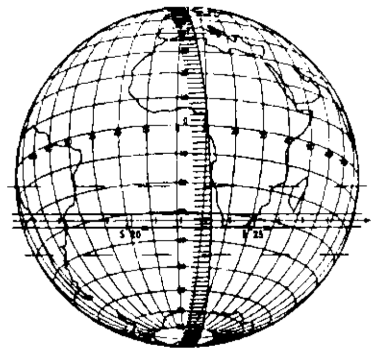
EPHEMERIS SOURCE = MPC11724

SAO 163429 by Psyche 1989 Mar 28

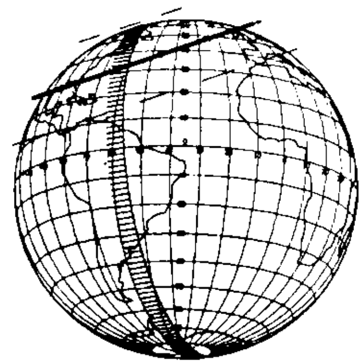
PLANETARY OCCULTATIONS. 1989 APRIL-JUNE



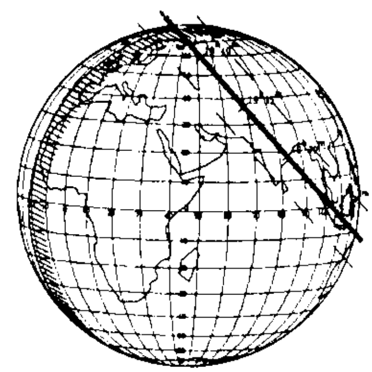




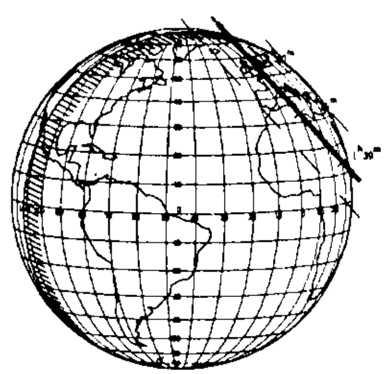
L 3 5616 by Vesta 1989 Apr 2



L 5 2894 by Victoria 1989 Apr 2

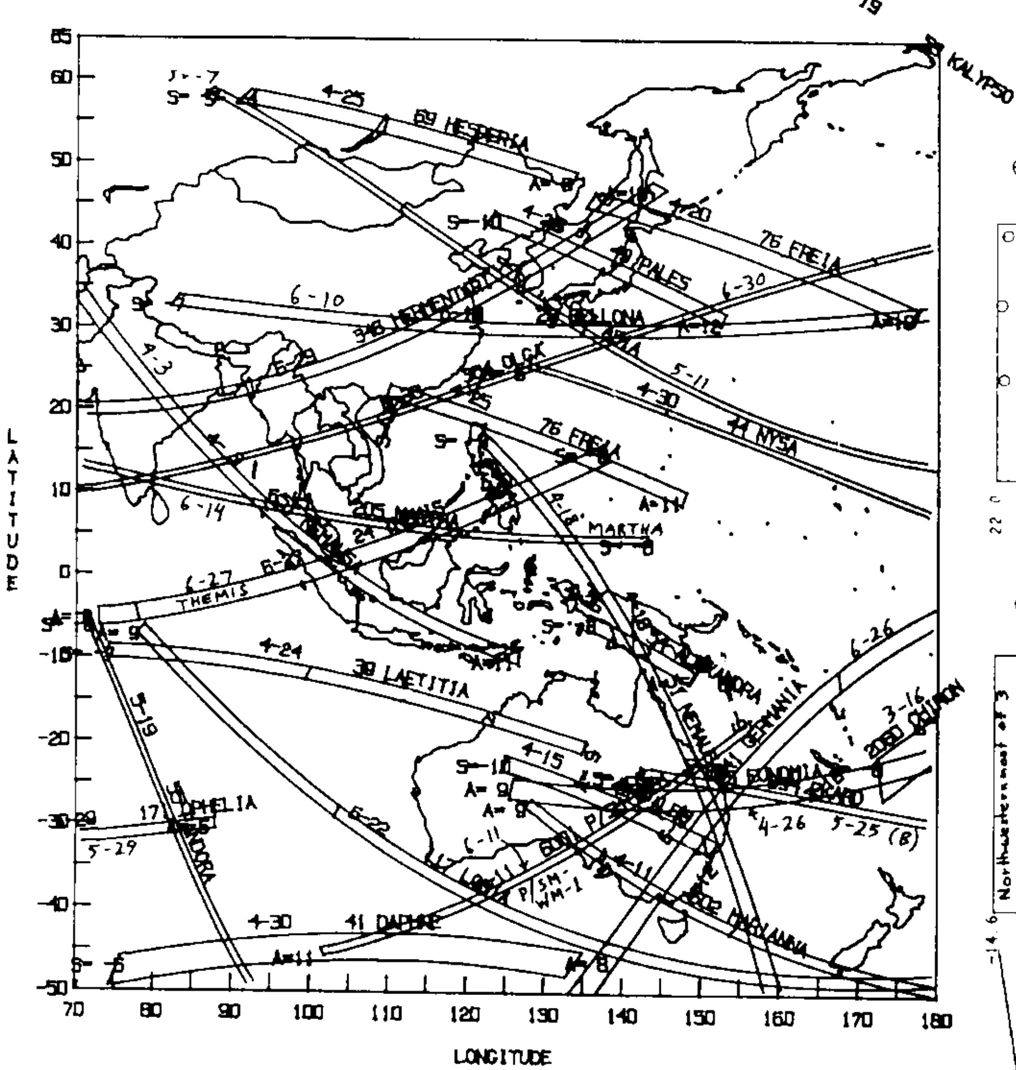


Anonymous by Nemausa 1989 Apr 3

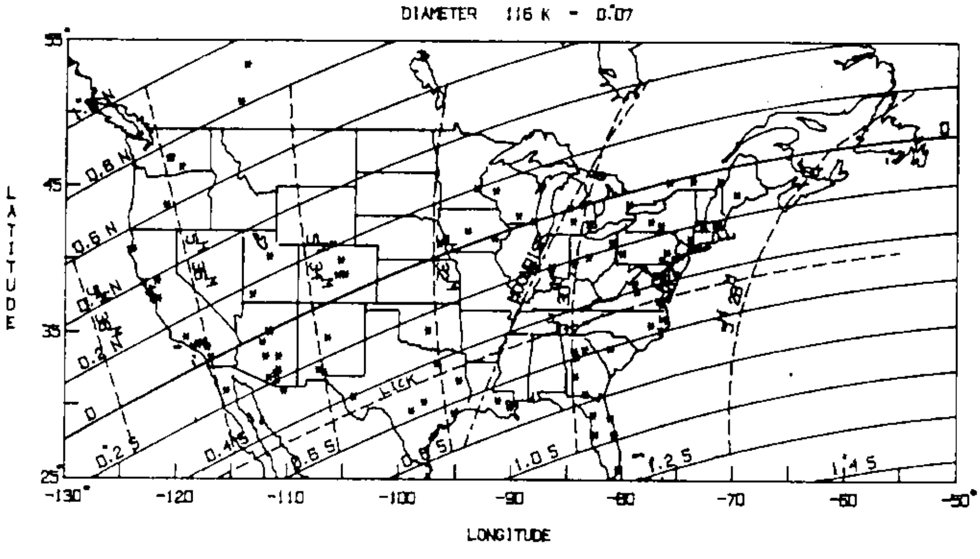


Anonymous by Nemausa 1989 Apr 4

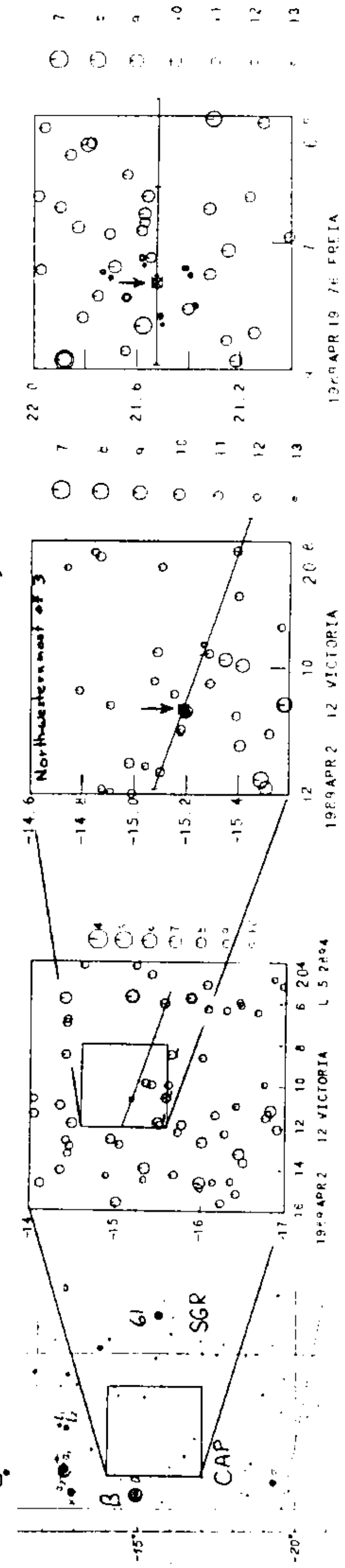
PLANETARY OCCULTATIONS. 1989 APRIL–JUNE



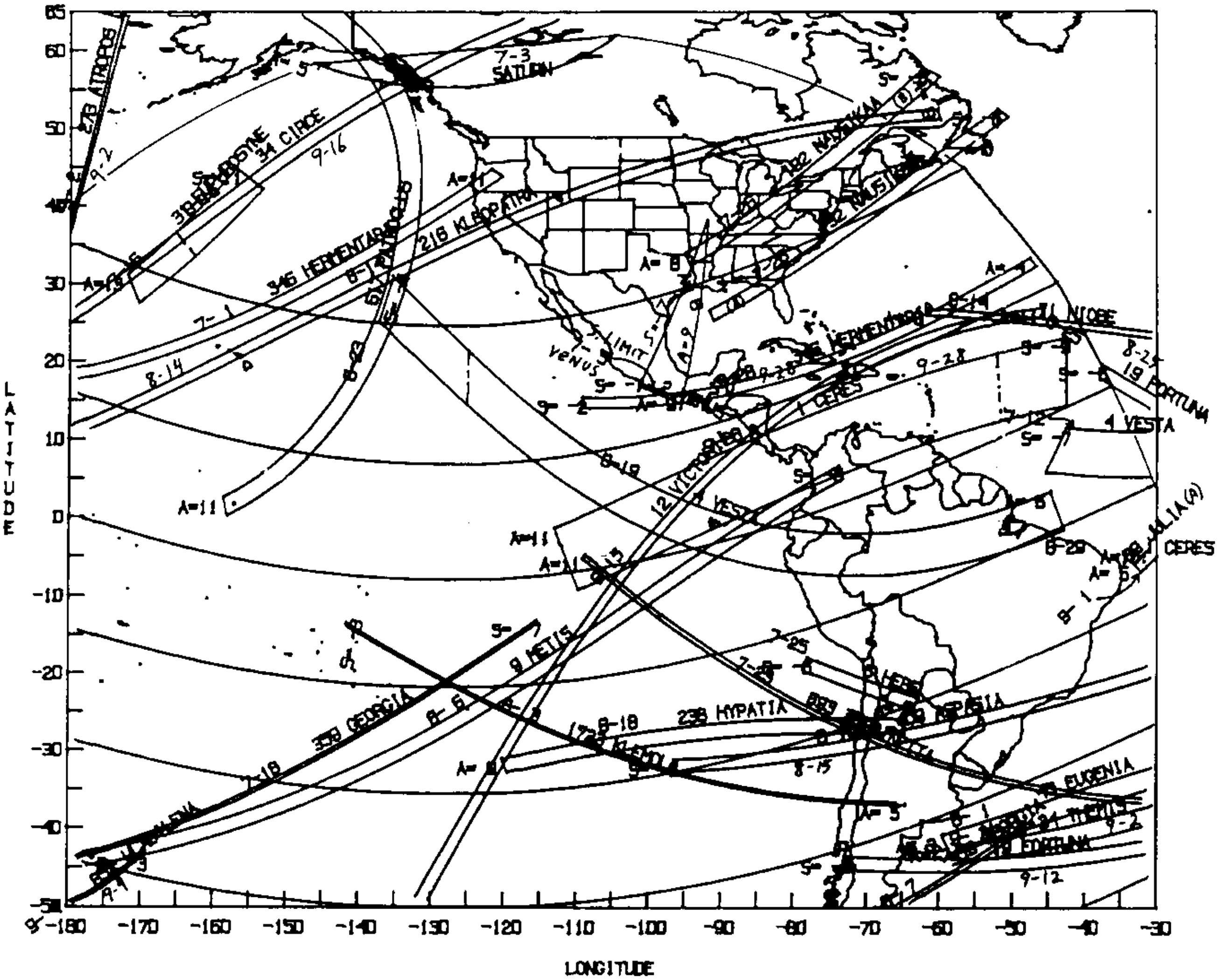
1989 5 26 (481) EMITA SAO 119808
DIAMETER 116 K - 0.07

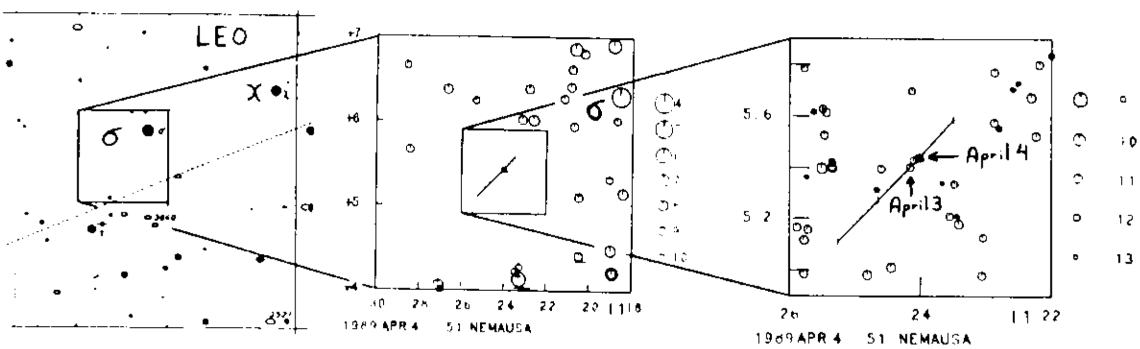


EPHEMERIS SOURCE = MPC11621

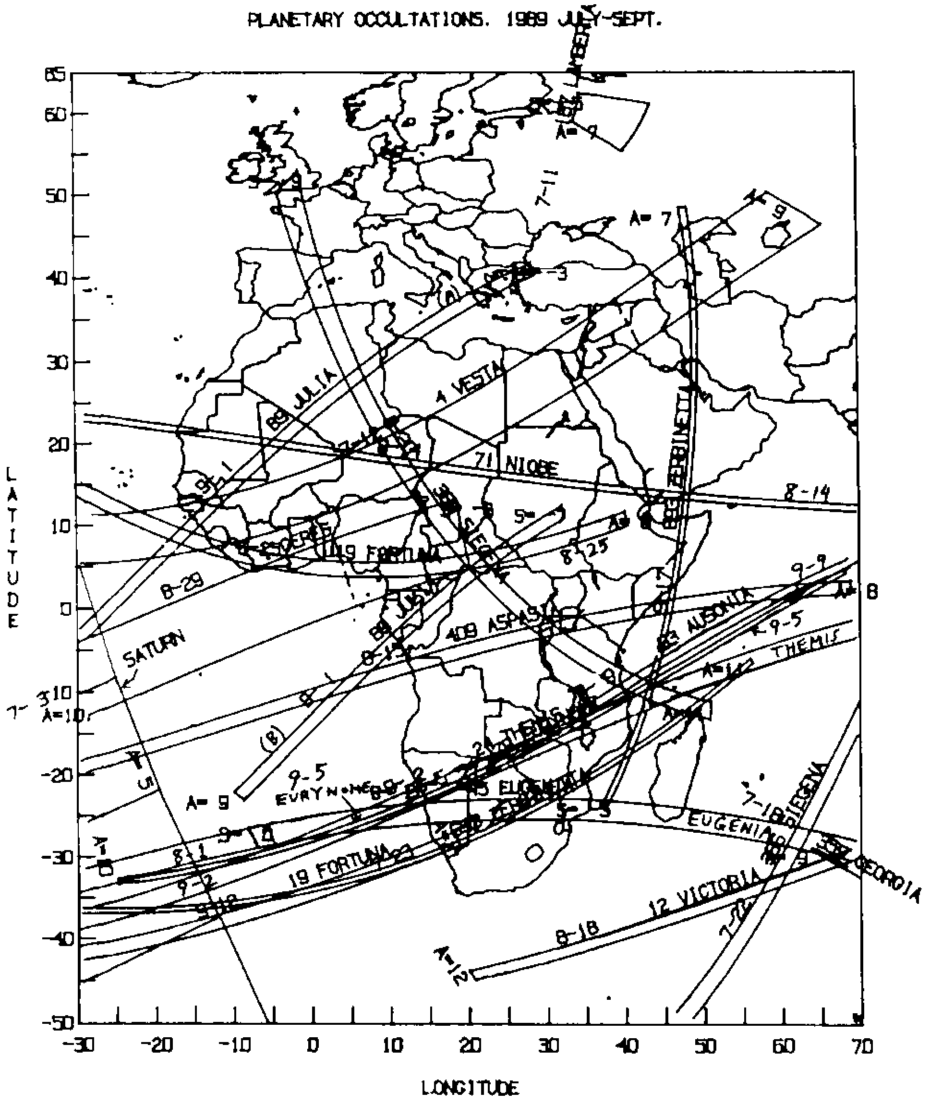


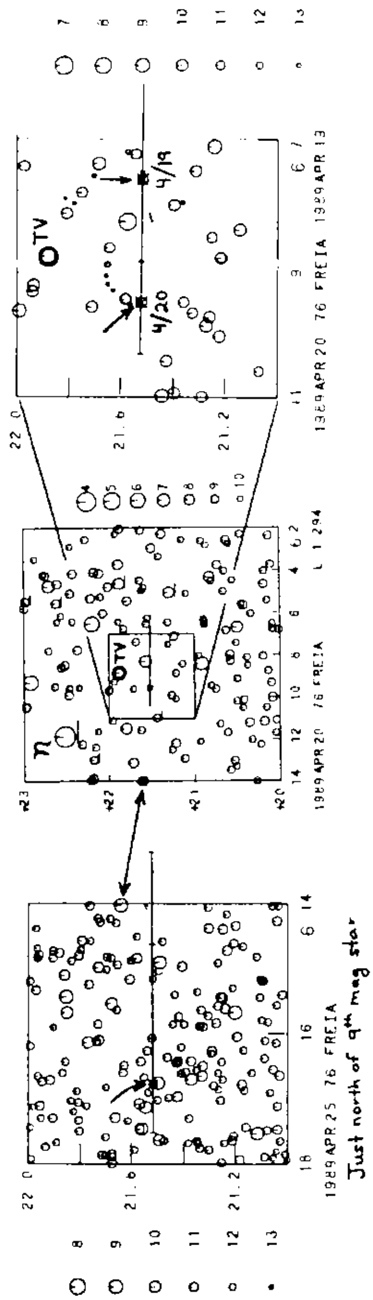
PLANETARY OCCULTATIONS. 1989 JULY-SEPT.

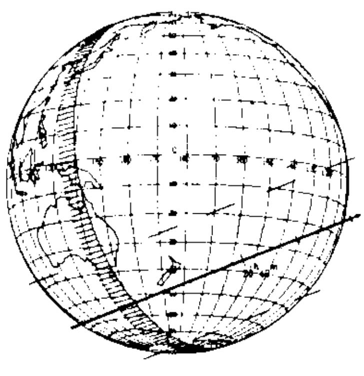




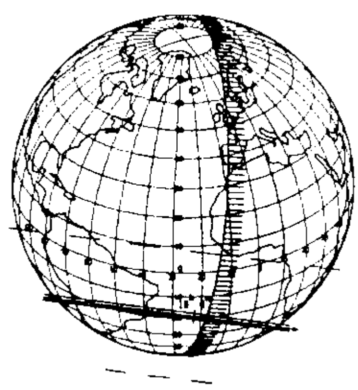
Both stars on path
are occulted



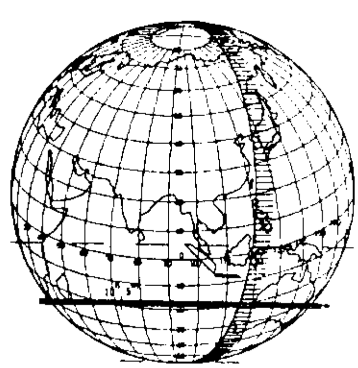




SAO 145648 by Eurynome 1989 Apr 11



SAO 59350 by Diotima 1989 Apr 13



Anonymous by Pales 1989 Apr 15

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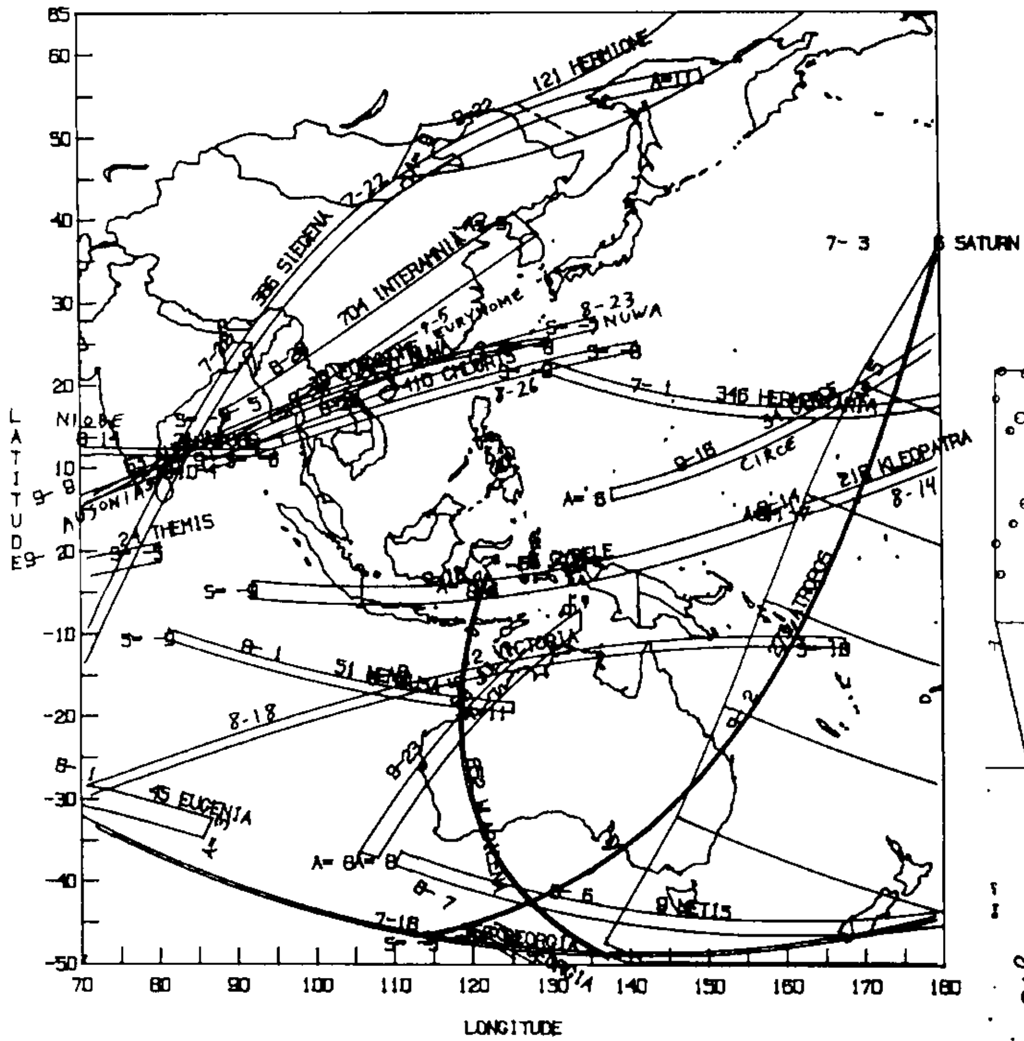
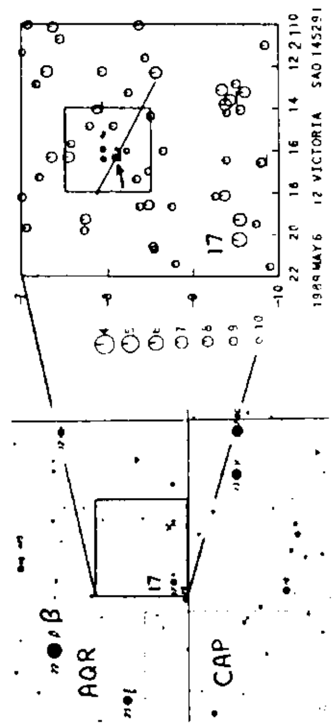
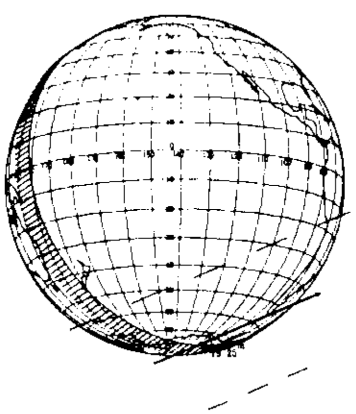
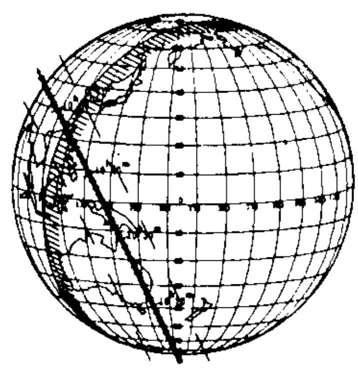


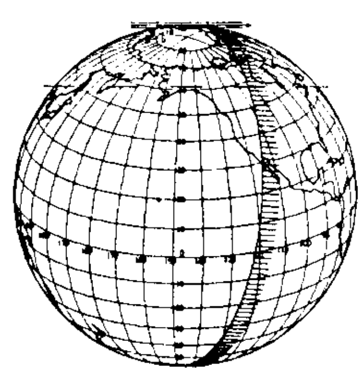




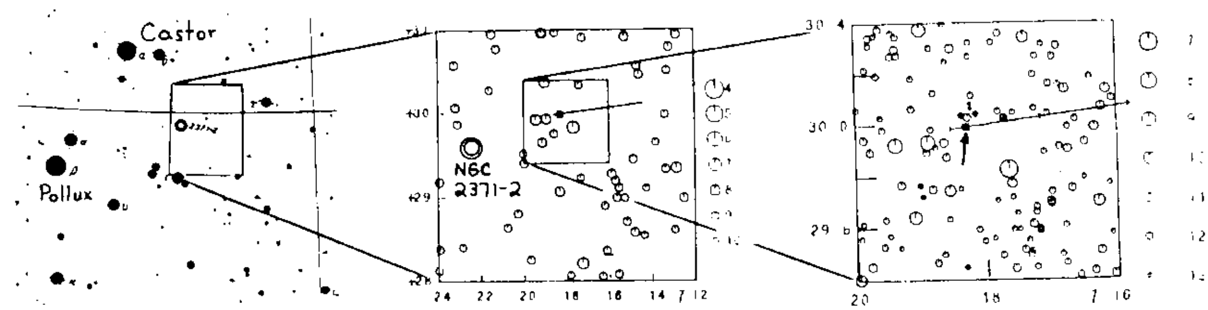
SAO 165746 by Libussa 1989 Apr 15



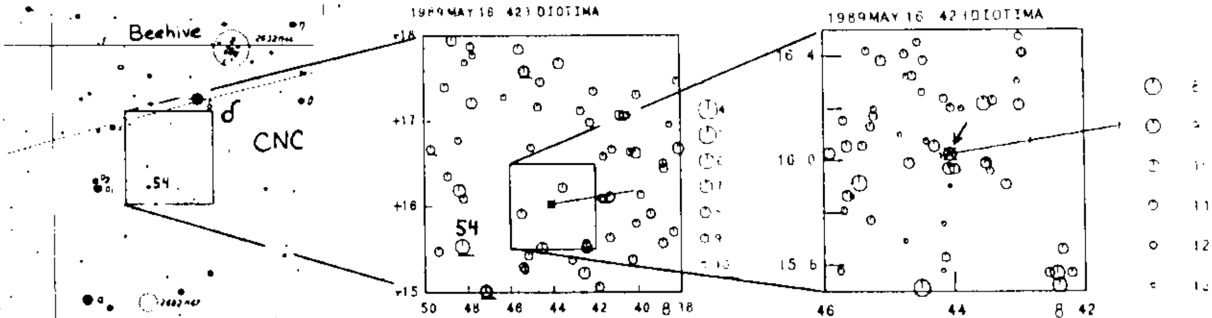
Anonymous by Nemausa 1989 Apr 18



+21° 1141 by Freia 1989 Apr 19



1989 MAY 16 423 DIOTIMA   1989 MAY 16 423 DIOTIMA



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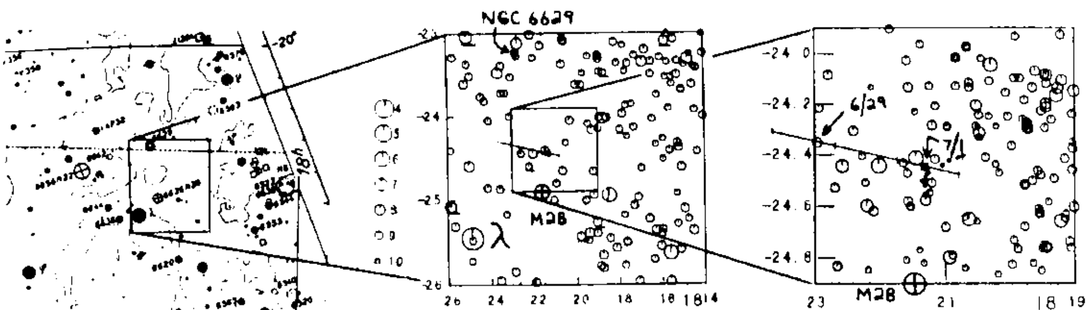
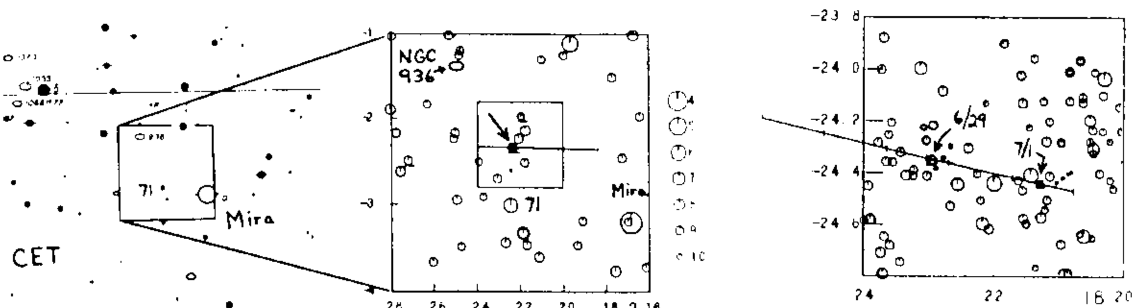
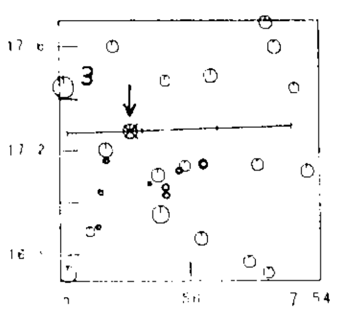


1989 JUL 1 346 HERMENTARI C24 14287   1989 JUL 1 346 HERMENTARIA

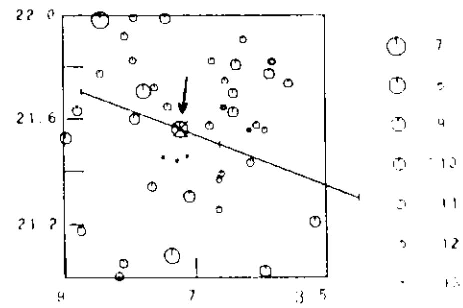


1989 JUL 17 747 WINCHESTER SAO 129885   1989 JUN 29 346 HERMENTARIA

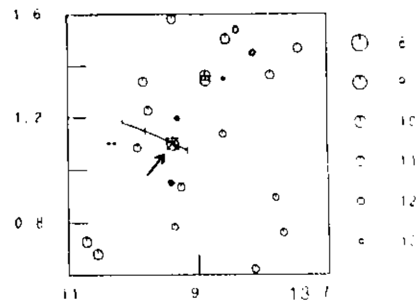
See Finder Chart Above



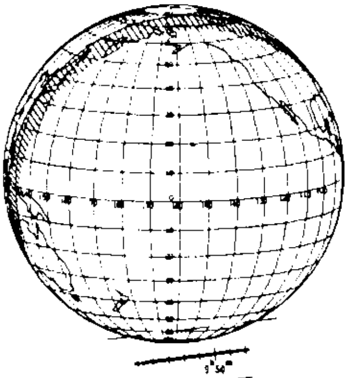
1989 MAY 3 39 LAETITIA SAO 97448



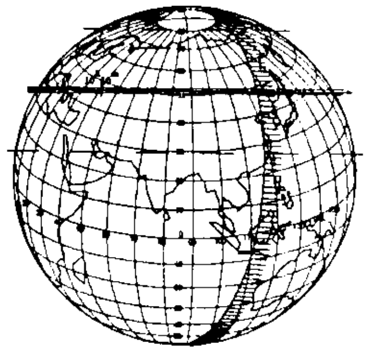
1989 JUL 26 192 NAUSIKAA SAO 75764



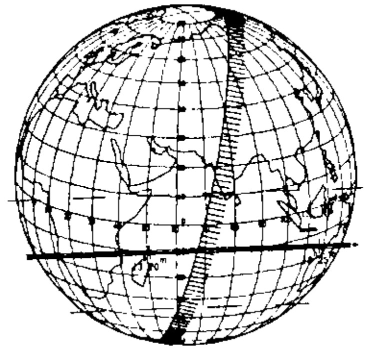
1989 MAY 26 481 EMITA SAO 119809



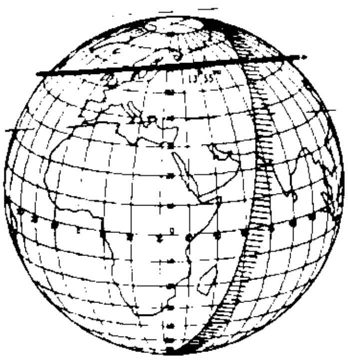
SAO 119678 by Vaticana 1989 Apr 20



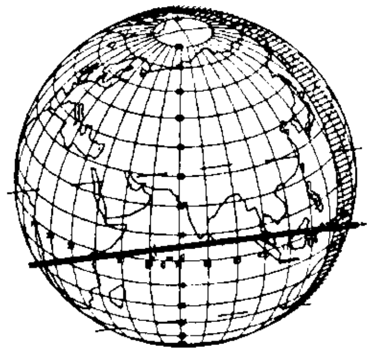
L 1 294 by Freia 1989 Apr 20



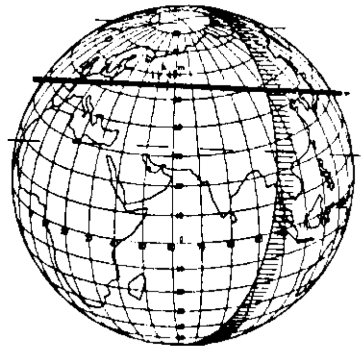
L 4 2417 by Laetitia 1989 Apr 24



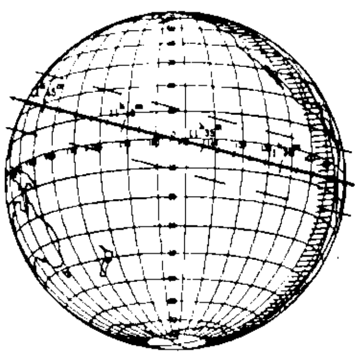
SAO 95719 by Hesperia 1989 Apr 25



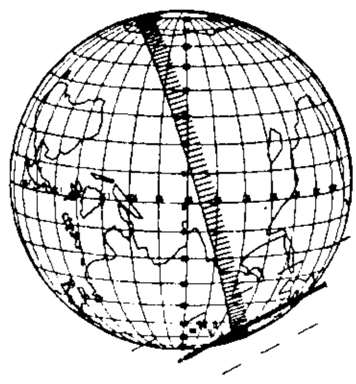
SAO 76461 by Alexandra 1989 Apr 26



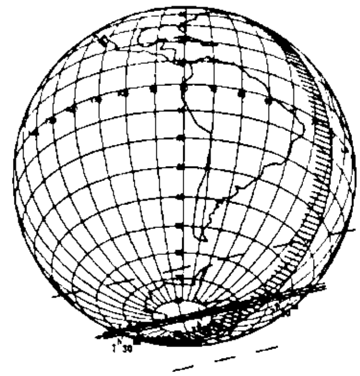
Anonymous by Pales 1989 Apr 28



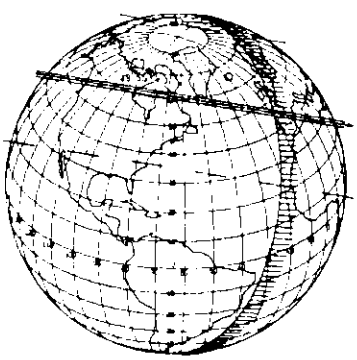
SAO 159584 by Nysa 1989 Apr 30



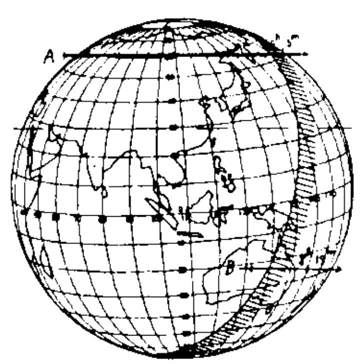
SAO 145291 by Victoria 1989 May 6



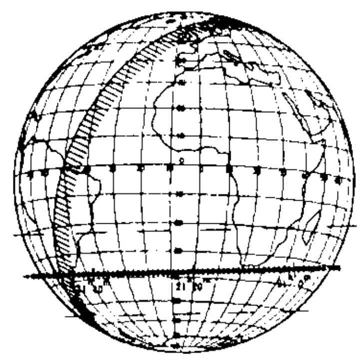
SAO 208492 by Aurora 1989 May 8



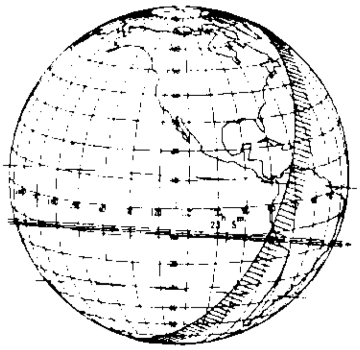
Anonymous by Diotima 1989 May 16



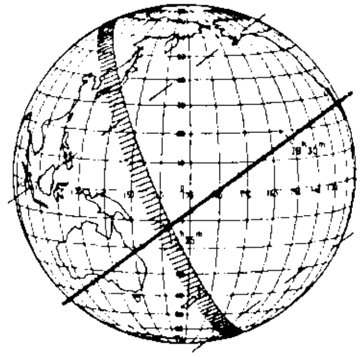
+9° 1657 by Ekard 1989 May 25



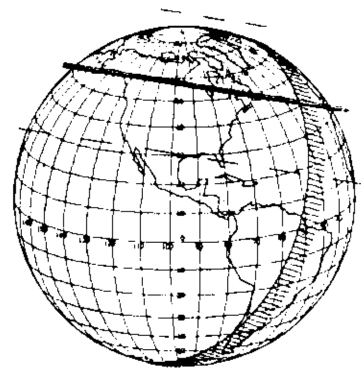
SAO 139358 by Ophelia 1989 May 29



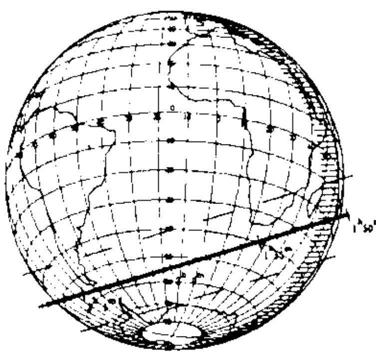
SAO 97875 by Daphne 1989 Jun 6



Anonymous by P/SW-WM-1 1989 Jun 11

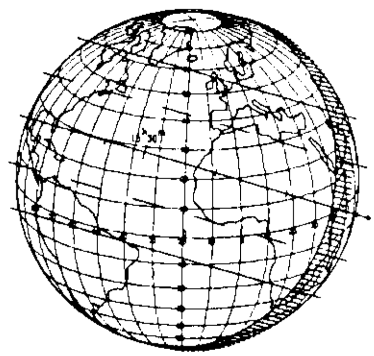


+16° 1816 by Laetitia 1989 Jun 14

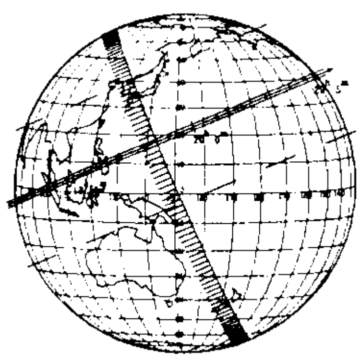


SAO 187080/Hermentaria 1989 Jun 16

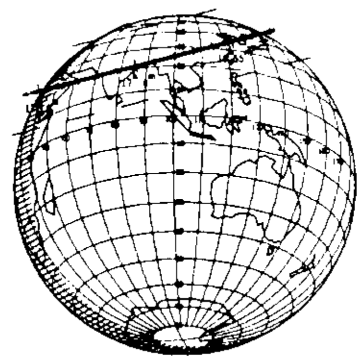
SAO 79984 by Mars 1989 Jun 16



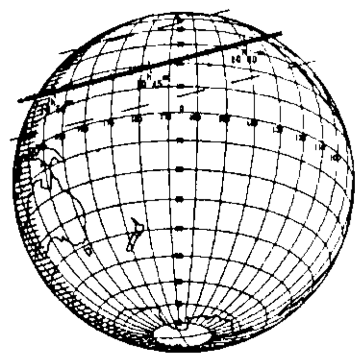
SAO 97998 by Mars 1989 Jun 27



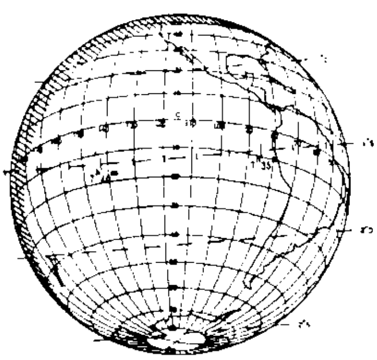
SAO 109295 by Themis 1989 Jun 27



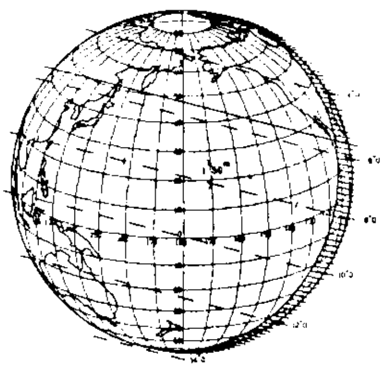
C2414315 by Hermentaria '89 Jun 29



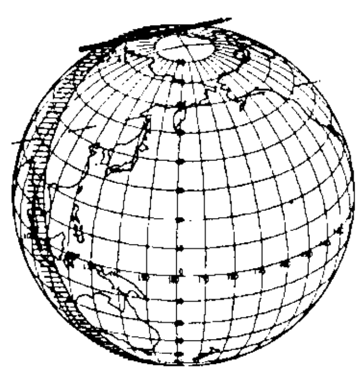
C2414287 by Hermentaria 1989 Jul 1



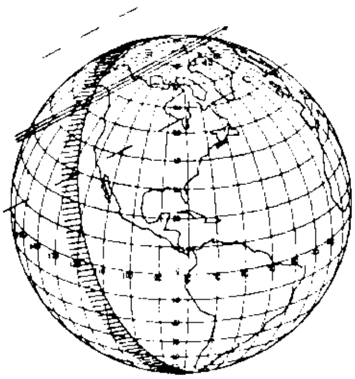
SAO 187255 by Saturn 1989 Jul 3



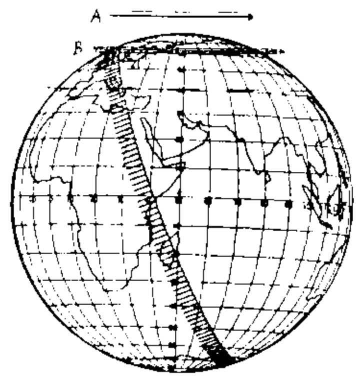
SAO 80331 by Venus 1989 Jul 5



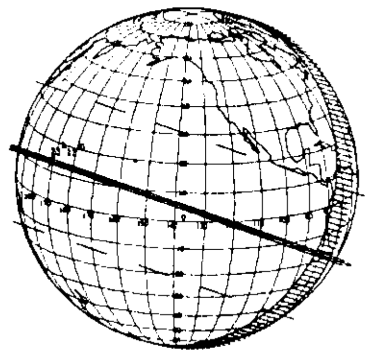
SAO 76784 by Lamberta 1989 Jul 11



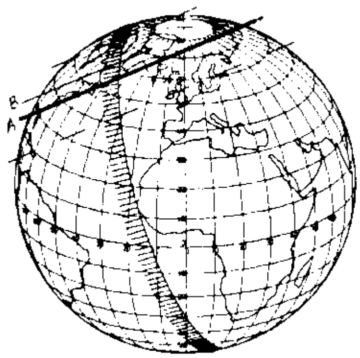
H 0 2600 by Euphrosyne 1989 Jul 16



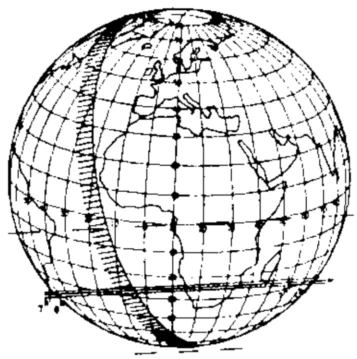
SAO129884 by Winchester '89 Jul 17



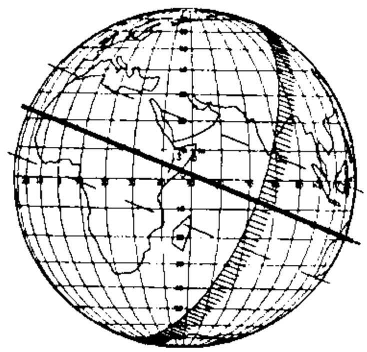
SAO 99117 by Hebe 1989 Jul 25



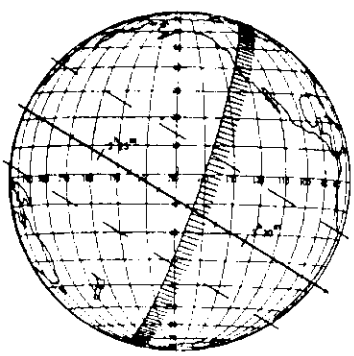
SAO 75764 by Nausikaa 1989 Jul 26



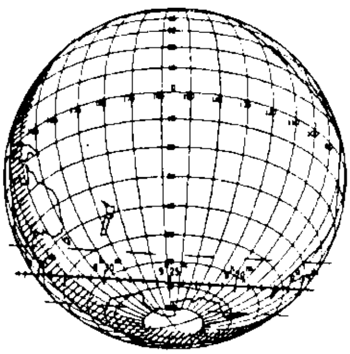
SAO 93975 by Eugenia 1989 Aug 1



L 2 548 by Nemausa 1989 Aug 1

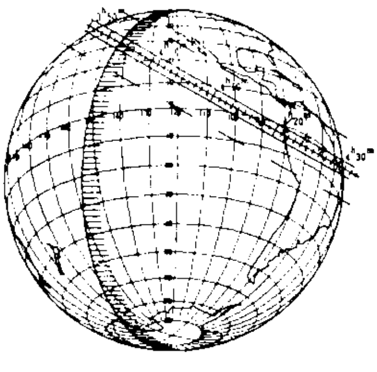


SAO 139866 by Klemola 1989 Aug 3

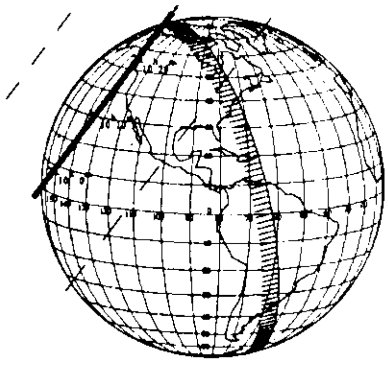


SAO 211847 by Georgia 1989 Aug 7

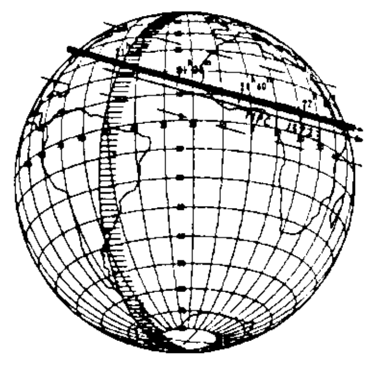
Anonymous by Victoria 1989 Aug 18



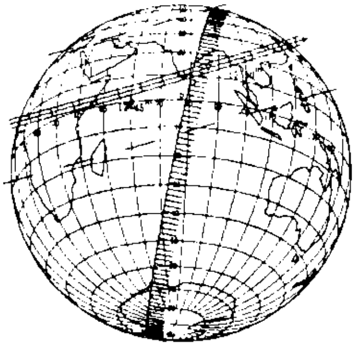
SAO 185928 by Vesta 1989 Aug 19



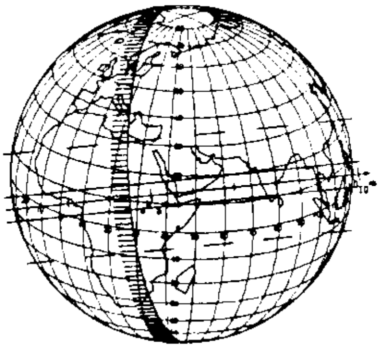
Anonymous by Patroclus 1989 Aug 23



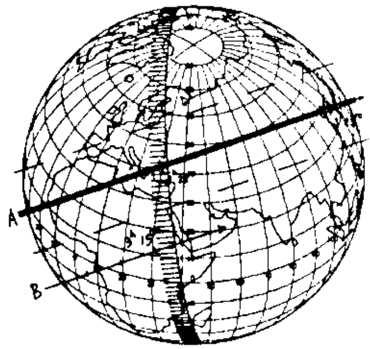
SAO 186483 by Fortuna 1989 Aug 25



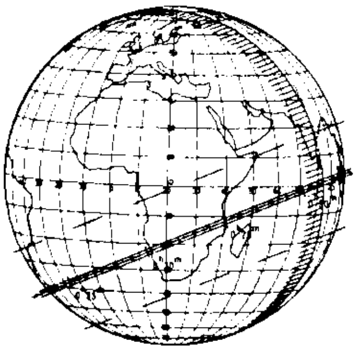
C2511503 by Interamnia 1989 Aug 28



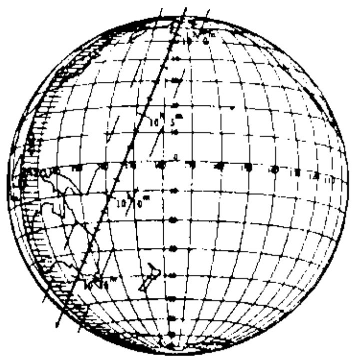
A2042296 by Ceres 1989 Aug 29



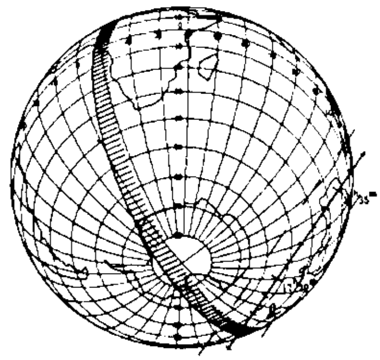
SAO 57559 by Julia 1989 Sep 1



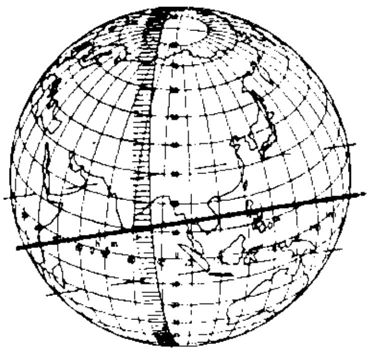
SAO 109355 by Themis 1989 Sep 2



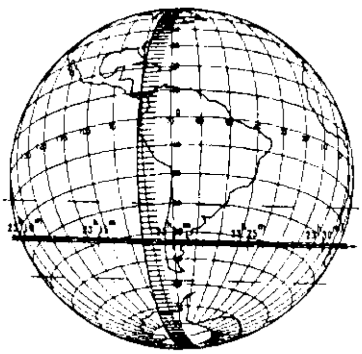
SAO 145234 by Atropos 1989 Sep 2



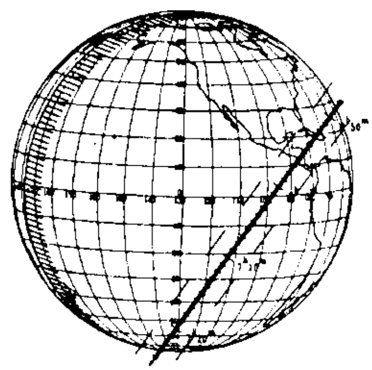
SAO 254423 by Wladilena 1989 Sep 4



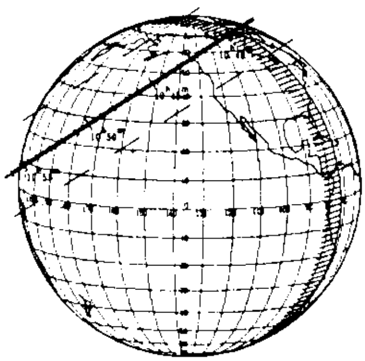
SAO 77449 by Ausonia 1989 Sep 9



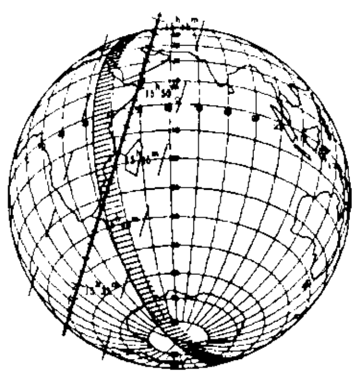
B2171084 by Fortuna 1989 Sep 12



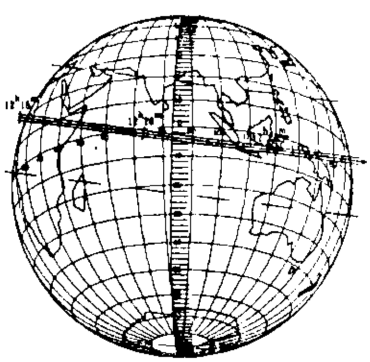
Anonymous by Victoria 1989 Sep 15



SAO 109907 by Circe 1989 Sep 16



SAO 211502/Zerbinetta 1989 Sep 17



B2168104 by Cybele 1989 Sep 18