Occultation Newsletter

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FROM THE PUBLISHER

For subscription purposes, this is the second issue of 1984.

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

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

IOTA NEWS

David W. Dunham

This year's meeting of the International Occultation Timing Association will be held at the Lunar and Planetary Institute, 3303 NASA Road One, Houston, Texas 77058, on Saturday, October 20th. The location is the same as last year's meeting. The meeting will begin at 10 am Central Daylight Time, and will last most of the day. The following topics are on the agenda: Observations of the May 30th annular eclipse; final plans for the November 22nd total solar eclipse; plans to observe occultations during the 1985 May 4th total lunar eclipse from or near Africa, including the simultaneous north-south grazes of 2.9-mag. Zubenelgenubi (Alpha Librae) during totality; other interesting occultations, especially by asteroids, during 1985; and preliminary plans to observe Halley's Comet from southern Africa in 1986. We also will have some discussion about photoelectrically recording occultations, perhaps including a comparison of the German photometer (the designer, Wolfgang Beisker, is in the U.S.A. for a year) with the Chen photometer. Peter Chen tells me that his system is being redesigned somewhat to include more off-the-shelf components, to improve the reliability and decrease the need for repairs in Austin. A manufacturer will be sought for the system after the changes have been tested. Chen also hopes that the reduction software can be converted to run on microcomputers, so that this work also can be done independently. Those planning to attend the IOTA meeting should contact Paul Maley, 15807 Brookvilla, Houston, TX 77059, U.S.A., telephone 713,488-6871.

Some problems with last year's graze predictions were described in *O.N. 3* (4), p. 81 & 89. The problems have not been corrected, and the differences between the 80F (or 80G) and 78A USNO prediction versions are even greater this year. For waning-phase northern-limit grazes with latitude libration greater than zero, you should apply (to the ACLPPP profile, which is based on version 78A) the correction 0".12 × (lat. libration in degrees), as described in *O.N. 3* (5), p. 100 (observations of two grazes this July seem to indicate this is the best way to proceed so far this year). The 1983 observations were not numerous enough to solve the problem definitively, and things could happen a little differently this year, so preliminary information about observations of any waning northern-limit grazes with large HEIGHT values during the next two months will be valuable for deciding how to deploy for events during the following months and next year. If you plan a large expedition, get the latest information about the shifts from me; around full moon, I will leave a message giving recommendations on our answering machine at 301,585-0989.

Other important news that might ordinarily be found here is covered in two other articles of this issue, entitled "IOTA/ES News" and "Asteroidal Occultation News." You should read both, whether you are a member of IOTA/ES or not, since the first article has some information which may be of interest to all IOTA members.

Also, residents of the U.S.A. should notice the discussion about deducting travel costs from their income when calculating their 1984 taxes, near the end of the article about the May 30th solar eclipse. That discussion also applies for travel to observe grazing occultations or asteroidal occultations.

IOTA Special Bulletin Number 8, containing information about asteroidal occultations in July and August, was distributed as a stopgap measure when unforeseen difficulties prevented preparation of this issue in time. We plan to distribute the next issue in 3 to 4 weeks, to include the material which would not fit in this or previous issues, and more information about grazing occultations, including some more reduction profiles by Robert Sandy, Independence, MO. *O.N. 3* (10) is scheduled tentatively for late November.

MORE ON THE GRAVITATIONAL CONSTANT

David W. Dunham

The statements which I made about the non-variability of the gravitational constant in *O.N. 3* (6), 118, based on analysis of the Martian lander radio ranging data, appear to be an oversimplification of the actual situation. When small effects due to general relativity are studied, the natures of the observed quantities become important. The various cosmological theories predict different results if the observables are "space-like" (predominantly measurements of distance) or "time-like." For example, Dirac's large-numbers hypothesis predicts a changing gravitational constant for "time-like" measurements but not for "space-like" measurements.

Lunar occultation timings are "time-like" measurements. Hundreds of revolutions of the moon have been observed, and the observed quantity of interest is $\dot{n}$, the rate of change of the lunar mean motion, or more precisely, the mean angular motion in ecliptic longitude. There are both tidal and cosmological contributions to the lunar $\dot{n}$, but the two can be separated using different types of observations, as explained by Van Flandern in his article, "Is the Gravitational Constant Changing?", in the 1981 September 1 issue of *Astrophysical Journal 248*, pp. 813-816. He gives a value for the excess rate of change in lunar mean motion of possible cosmological origin as

$$\dot{n}/n = (+3.2 \pm 2.2) \times 10^{-11} \text{ per year,}$$

which results in

$$\dot{G}/G = (-6.4 \pm 2.2) \times 10^{-11} \text{ per year,}$$

when interpreted with the scalar covariant cosmology of Canuto and Hsieh.

The accurate Viking ranging data primarily measure distances, and are consequently predominantly "space-like." The data were accurate enough to measure a cosmological change in the mean motion in spite of only about four revolutions being observed. This also could give a "time-like" measurement, except for one problem. The change is so small over the interval that it can be absorbed in the determination of the masses of the asteroids, whose long-period perturbations also appear as a constant change in the Martian mean motion over the time interval of the Viking data. Since the transmitters on the Viking landers are dead, the observation interval can not be extended. Hence, the Viking result is almost entirely "space-like."

Although lunar laser ranging measures distance, the relatively fast lunar motion results in laser data giving a more "time-like" measurement of $\dot{G}$ via determination of $\dot{n}$. Mean motion can be measured since the moon's right ascension and declination are effectively determined from the laser data due to the changing distance resulting from the motion of the ranging observatory around the earth's axis of rotation. A program of regular lunar laser ranging has resumed using the 107-inch reflector at McDonald Observatory, TX. There was a gap in the laser observations when problems were encountered with the dedicated ranging facility at Haleakala, HI, and a new smaller system at McDonald. As the electronics are improved, it should be possible to make regular lunar laser ranging observations with telescopes with apertures smaller than 1 meter, which will permit more observatories to participate in this important program. That also will result in more accurate determination of earth polar motion and U.T.

Time is on the side of lunar occultation and laser ranging observations, since $\dot{n}$ is proportional to time squared. Hence, the determination will become much more accurate in the future. A good determination of the "space-like" rate of change of the semi-major axis (mean distance) of the lunar orbit will be made from the laser data during the next several years. Lunar laser ranging probably will have the final word in the gravitational constant controversy, as good "time-like" and "space-like" determinations of cosmological parameters are obtained.

I thank Tom Van Flandern and lunar laser ranging pioneer Carroll Alley, Department of Physics, University of Maryland, for discussions which were most valuable for preparing this article.

ASTEROIDAL OCCULTATIONS OF UNCATALOGED STARS, AND SOME NEMAUSA A.C. EVENTS, DURING 1984

Robert L. Millis, Lawrence H. Wasserman, Otto G. Franz, Edward Bowell, Arnold Klemola, and David W. Dunham

An earlier version of this article was published as part of *IOTA Special Bulletin* Number 8, which was distributed to all *O.N.* subscribers. Events before August will not be included in the more legible list published with this article, since they already have taken place, and none of them were observed, as far as we know.

Additional occultations of uncataloged stars by seven of the largest asteroids during 1984 have been found by scanning photographic plates at Lowell Observatory. The techniques were the same as those used for a similar list of 1983 events published in *O.N. 3* (2), 25, except that the star positions have been improved using plates taken at Lick Observatory. The 1984 events have been published by the first four authors in *Astronomical Journal 89* (5), 698. All events involving these large asteroids were found by the first five authors at the Lowell and Lick observatories, but the predictions listed here were calculated by Dunham. One of the events found at Lowell, an occultation by (65) Cybele on July 13, was found by Dunham and published in *O.N. 3* (6), 124. The A.C. and newly measured positions of the star, and consequently the predicted paths, are in good agreement.

Bob Millis has photoelectrically observed the stars to be occulted on August 5, 19, and 20, and on November 17, to assess the observability of these events, which will be marginal even photoelectrically. The identification number of the star to be occulted by (704) Interamnia on Sept. 2 is a B.D. number, not a Lowell reference number. After the *Astron. J.* article was published, another occultation was found at Lowell. An 11th-mag. star will be oc-

(Text continues in second column, next page)

culted by 8th-mag. (4) Vesta at about 12^h 17^m U.T. along a path nominally crossing central Mexico. More information about this photoelectric event will be given in a presentation at the American Astronomical Society's Division for Planetary Astronomy in Hawaii in October, and in future *O.N.*'s.

The stars to be occulted by (51) Nemausa are all from the Astrographic Catalog and were found by Dunham using the same techniques used to find the other A.C. events during 1984 described in *O.N.* 3 (6), pp. 120-133.

W. Landgraf, Max-Planck-Institut für Aeronomie, Lindau, GFR, has found that the faint 38-km asteroid (717) Wisibada will occult 8.9-mag. SAO 75930 (=B.D. +20° 568, sp. F8, 1950 R.A. 3^h $23^m.8$, Dec. +21° 17') on 1984 December 1 from 4^h 38^m to 4^h 49^m U.T., along a narrow path crossing North America from the Canadian Atlantic Provinces to California. Using a newly determined orbit, he also predicts that the large asteroid (154) Bertha will occult 8.1-mag. SAO 42551 (= B.D. +47° 1612 = AGK3 N46° 740, sp M0, 1950 R.A. 8^h $44^m.7$, Dec. +16° 53') on December 18 from 3^h 47^m to 3^h 53^m U.T., along a path crossing Europe approximately from Italy to Holland using the AGK3 position, but missing the earth's surface by 1".0 with the SAO position. However, these paths might be in considerable error; see the discussion about the occultations by (747) Winchester in the article about

(Text continues on next page)

Table 1 is at left. Table 2 is below.

1984 DATE	UNIVERSAL TIME	PLANET NAME	PLANET m_v	PLANET Δ,AU	STAR Star No	STAR m_v	STAR R.A. (1950)	STAR Dec.	OCCULTATION Δm	OCCULTATION Dur	OCCULTATION df	OCCULTATION P	OCCULTATION Possible Area	El SUN	MOON El	MOON %Snl	MOON Up	Ephem. Source
Aug 5	18^h21^m-43^m	Patientia	11.7	2.30	L931708	11.2	$0^h42^m.1$	-17°06'	1.0	38	41	12	Manchuria, Japan, Australia	128°	117°	68+	none	HERGET78
Aug 5	6 36-47	Interamnia	10.8	2.10	L944324	13.5	18 15.6	-20 55	0.09	41	34	9	U.S.A.?s	141	36	63+	w 95 W	EMP 1977
Aug 8	11 37-56	Interamnia	10.9	2.13	L941608	13.2	18 14.2	-20 42	0.12	46	39	9	NewZealand?s;Queensland,Indonesia	138	8	90+	all	EMP 1977
Aug 15	19 00	Nemausa	12.3	2.91		11.4	6 13.1	15 24	1.3	4	9	28	Papua New Guinea	50	84	85-	all	KRSTNN77
Aug 19	3 0-24	Interamnia	11.0	2.22	L941618	13.6	18 11.4	-20 01	0.10	75	65	10	e Brazil, e U.S.A.	127	136	57-	e 70 W	EMP 1977
Aug 20	5 31-43	Hygiea	9.7	2.02	L945703	13.4	20 32.8	-15 52	0.03	45	28	7	se U.S.A., nw Mexico, Hawaii	159	115	46-	e 95 W	SCHMADEL
Aug 29	3 45-66	Interamnia	11.2	2.33	L941624	12.7	18 11.3	-19 27	0.2	80	71	10	South America	117	84	8+	none	EMP 1977
Aug 31	0 22	Nemausa	12.2	2.75		14.5	6 39.2	14 35	0.2	5	10	26	Arabia, Iran	58	117	24+	none	KRSTNN77
Sep 2	15 3-22	Interamnia	11.2	2.38	-19°4924	8.9	18 12.1	-19 13	2.4	64	57	10	Seychelles, India, w China	113	21	52+	w100 E	EMP 1977
Sep 3	16 40	Nemausa	12.2	2.71		10.5	6 45.2	14 20	1.9	5	10	26	Japan?s	60	162	63+	none	KRSTNN77
Sep 4	3 31-40	Cybele	12.2	2.65	L930121	15.4	1 21.4	5 42	0.05	39	40	12	U.S.A.?s	140	109	68+	w 55 W	EMP 1975
Sep 7	2 45-59	Patientia	11.2	2.07	L931908	13.2	0 32.2	-20 58	0.2	24	24	11	swEurope,nwAfrica,Brazil,Bolivia	154	51	91+	w 0	HERGET78
Sep 8	21 3-12	Cybele	12.1	2.62	L930123	13.5	1 19.6	5 25	0.3	33	34	12	Europe	145	50	98+	all	EMP 1975
Sep 11	19 37	Nemausa	12.2	2.62		12.1	6 58.3	13 44	0.8	5	10	25	Australia	65	98	98-	all	KRSTNN77
Sep 14	7 23	Nemausa	12.1	2.59		11.8	7 02.2	13 32	0.9	5	11	25	Cuba, Bahamas	66	70	86-	all	KRSTNN77
Sep 18	1 58	Nemausa	12.1	2.54		13.5	7 07.9	13 13	0.3	5	11	24	southern Africa (low)	68	28	54-	all	KRSTNN77
Sep 23	4 41	Nemausa	12.1	2.48		12.0	7 15.5	12 45	0.8	6	11	24	Canary Is., nw Africa	71	46	6-	e 10 W	KRSTNN77
Sep 27	22 46	Nemausa	12.0	2.42		11.6	7 22.3	12 18	1.0	6	12	23	southern India?m	74	113	11+	none	KRSTNN77
Oct 6	5 26	Nemausa	11.9	2.32		12.1	7 33.5	11 28	0.7	7	13	22	n. Brazil	80	139	88+	w 30 W	KRSTNN77
Oct 12	8 23	Nemausa	11.8	2.24		12.1	7 41.2	10 50	0.6	7	14	21	n. U.S.A.	84	71	95-	all	KRSTNN77
Nov 17	2 59	Hygiea	11.0	3.15	L946104	13.5	20 53.8	-14 37	0.10	19	15	10	sw Canada	77	155	41-	none	SCHMADEL
1985																		
Jan 9	19 8	Cybele	13.0	3.57	L929831	11.6	0 52.2	2 29	1.7	17	21	17	n. Africa, Arabia	84	131	91-	e 15 E	EMP 1975

1984 DATE	MINOR PLANET No.	MINOR PLANET NAME	km-diam.	-"	RSOI	Type	MOTION °/Day	MOTION PA	Star No	S	APPARENT R.A.	APPARENT Dec.
Aug 5	451	Patientia	281	0.17	1835	C	0.106	174°	L931708	H	$0^h43^m.9$	-16°54'
Aug 5	704	Interamnia	339	0.22	2382	C	0.132	301	L944324	H	18 17.7	-20 54
Aug 8	704	Interamnia	339	0.22	2378	C	0.115	305	L941608	H	18 16.3	-20 41
Aug 15	51	Nemausa	153	0.07	582	U	0.426	96		C	6 15.0	15 24
Aug 19	704	Interamnia	339	0.21	2366	C	0.068	332	L941618	H	18 13.4	-20 01
Aug 20	10	Hygiea	443	0.30	3588	C	0.162	259	L945703	H	20 34.7	-15 45
Aug 29	704	Interamnia	339	0.20	2354	C	0.060	28	L941624	H	18 13.3	-19 27
Aug 31	51	Nemausa	153	0.08	580	U	0.408	99		C	6 41.1	14 33
Sep 2	704	Interamnia	339	0.20	2349	C	0.074	47	-19°4924	H	18 14.1	-19 13
Sep 3	51	Nemausa	153	0.08	579	U	0.403	100		C	6 47.2	14 18
Sep 4	65	Cybele	311	0.16	2464	3C	0.100	237	L930121	H	1 23.2	5 53
Sep 7	451	Patientia	281	0.19	1822	C	0.187	232	L931908	H	0 34.0	-20 46
Sep 8	65	Cybele	311	0.16	2467	3C	0.120	239	L930123	H	1 21.5	5 36
Sep 11	51	Nemausa	153	0.08	578	U	0.390	102		C	7 00.2	13 41
Sep 14	51	Nemausa	153	0.08	577	U	0.385	102		C	7 04.1	13 29
Sep 18	51	Nemausa	153	0.08	576	U	0.378	103		C	7 09.8	13 09
Sep 23	51	Nemausa	153	0.09	575	U	0.367	105		C	7 17.5	12 41
Sep 27	51	Nemausa	153	0.09	575	U	0.356	106		C	7 24.3	12 14
Oct 6	51	Nemausa	153	0.09	573	U	0.334	108		C	7 35.4	11 24
Oct 12	51	Nemausa	153	0.09	572	U	0.316	110		C	7 43.1	10 45
Nov 17	10	Hygiea	443	0.19	3712	C	0.248	75	L946104	H	20 55.8	-14 29
1985												
Jan 9	65	Cybele	311	0.12	2545	3C	0.168	65	L929831	H	0 54.0	2 40

astrometric plans on this page.

The format of the two tables is similar to that of the tables for the other 1984 events in *O.N.3* (6), except that much of the stellar information is not available for these fainter stars; the consequent differences are explained in *O.N. 3* (2), 25 for the similar lists of 1983 events.

PLANS FOR ASTROMETRY FOR LATE 1984 ASTEROIDAL AND PLANETARY OCCULTATIONS

David W. Dunham

Astrometry for the occultation of SAO 186001 by Neptune was described in *IOTA Special Bulletin* #8. According to *IAU Circular* 3962 (dated 1984 July 23; the number inadvertently was left off), no occultation by the planet occurred at the European Southern Observatory (ESO) in Chile. I have not heard whether any observations were made from more southerly locations, such as Santiago or New Zealand. A probable occultation (about 2 seconds long) by a small satellite of Neptune, at least 15 km in diameter, was recorded at ESO at $5^h 40^m$ U.T., according to *IAU Circulars* 3962 and 3968. R. Scott Ireland and Michael C. Mooney report photoelectric drops of about 45 seconds duration at $4^h 21^m$ and 37^m U.T. at Big Pine Key, FL; and a 2-step disappearance after 6^h was recorded at the Florida Institute of Technology in Melbourne, FL.

Speaking of planets, don't forget Venus occulting Lambda Sagittarii on November 19. Astrometric improvement will be impossible for that event. A last-minute IOTA expedition may be undertaken to British Columbia to observe the occultation, if the weather forecast is good (not likely). If you are interested in trying this and are not planning on observing the total solar eclipse three days later, contact me.

Asteroidal occultations which are potentially visible from North America are given in a list below. A "1" in the priority column means that we are asking Arnold Klemola to try to obtain plates at Lick Observatory; "2" signifies that preliminary astrometry will be requested from others, especially Bill Penhallow at Quonochontaug Observatory in RI. If possible, the new Lowell 18-inch astrograph will be used for some of the "2" events and for the "1" events which might not be possible at Lick; see p. 161. Some of the events found during plate scans at Lowell discussed on p. 158 may also be added to the list based on the results of Millis' photoelectric observations. (747) Winchester is followed with an "H" or an "E", designating that the Herget or EMP ephemeris, respectively, shows the event to occur in North America. Only one group or the other will be considered, depending on which ephemeris turns out to be correct based on astrometry for the first Winchester events on the list. W. Landgraf at the Max-Planck-Institut für Aeronomie, Lindau, German Federal Republic, recently computed an improved orbit and an associated ephemeris for Winchester. In early September, this ephemeris is closer to Herget's ephemeris, but in December, Landgraf's ephemeris lies about a third of the way from the EMP 1982 path to that computed from Herget's elements. Landgraf's times are in good agreement with EMP 1982. For the occultations of four AGK3 stars, the table below gives the shift of the path from the EMP 1982 ephemeris, computed by me (under Dunham) from the differences between the ephemerides, in the sense of Landgraf - EMP 1982 (the "Landgraf - Dunham paths of the world and regional maps), and from Landgraf's own calculations of the occultations (under Landgraf).

1984 Date	Dunham Shift	Dunham Δt	Landgraf Shift	Landgraf Δt
Sep. 2	$+1''.43$	$0^m.3$E	$+2''.59$	$9^m.1$E
Oct. 15	+1.45	0.3E	+4.77	2.5L
Nov. 28	+1.68	0.3L	+9.43	27.9E
Dec. 26	+1.74	0.0	+1.68	0.0

"+" indicates a north shift from the EMP 1982 path, "E" means that the time correction is early, and "L" means that it is late. The corrections I have calculated are more consistent with each other than Landgraf's, and mine result in occultation paths close to those computed at Lowell Observatory using Landgraf's orbital elements to generate the ephemeris. So I suspect that Landgraf's occultation calculations (except, for some unknown reason, the one on Dec. 26) have errors. Planned Lick astrometry should settle the matter. The list of events for North American Astrometry is given below.:

1984	Asteroid	Priority	Note
Sep. 2	Winchester - E	1	1
Sep. 4	Dido	1	
Sep. 15	Hebe	1	2
Sep. 16	Aglaja	1	
Sep. 23	Winchester - H	1	3
Oct. 2	Chicago	2	
Oct. 6	Corduba	2	
Oct 12	Nemausa	2	
Nov. 4	Hermione	2	
Nov. 8	Pretoria	2	
Nov. 13	Ceres	1	
Nov. 24	Faina	2	
Nov. 28	Winchester - H	1	
Dec. 16	Hebe	1	
Dec. 17	Athor	2	4
Dec. 22	Winchester - E	1	5
Dec. 30	Vesta	1	

Notes

1. Winchester events on Aug. 28 and 30 can be checked.

2. Hebe events on Sept. 14 also can be checked.

3. Other events on Sept. 23 can be checked.

4. This event could occur in Europe, where astrometry might be obtained.

5. Other events through Dec. 27 could be checked.

No efforts are planned for the August 20th occultation by Halley's Comet, since even the 44% sunlit moon 37° away will hinder observation of the very faint star. Improved positions of the stars which may be occulted on Sept. 5, Nov. 23, Nov. 24, and Dec. 27 are probably available in the International Halley Watch Comet Halley Star Catalog based on Lick Observatory data, so the predictions for those events will be updated on the basis of the IHW data, if possible.

The events listed below are potentially visible from Europe, and astrometry might be obtained with the Bordeaux photoelectric meridian circle or perhaps by Taylor at R.G.O.; see p. 161. I have not communicated with the astrometrists concerned, so I can not promise that attempts will be made for any of the events. Those marked "B" under "Notes" indicate that astrometry probably can be obtained before the event at Bordeaux.

1984	Asteroid	Notes
Sep. 1	Doris	B?
Sep. 1	Hektor	
Oct. 9	Doris	B
Oct. 21	Messalina	
Nov. 2	Doris	B
Nov. 4	Winchester - E	B
Nov. 12	Hypatia	B
Dec. 16	Dejopeja	B?
Dec. 17	Athor	B
Dec. 25	Winchester - H	B

A similar list for southern Africa, which might be improved by Joe Churms at Cape Observatory, is below:

1984	Asteroid	Notes
Nov. 12	Hypatia	See Europe above
Dec. 30	Ate	

ASTEROIDAL OCCULTATION NEWS

David W. Dunham

Gordon Taylor announced that he will be taking premature retirement from the Royal Greenwich Observatory this August, according to his *Bulletin* 33 of the International Astronomical Union's commission 20 Working Group on Predictions of Occultations by Satellites and Minor Planets. Taylor will continue to act as Chairman of the working group until the next meeting of the I.A.U. in 1985 November, and he will have continuing access to resources needed for improvements of occultation predictions for events upcoming in Europe until the end of 1985. He notes that the asteroidal occultation predictions for 1986 probably will be computed at Lowell Observatory and published in the *Astronomical Journal*.

While preparing a finder chart for the November 2nd occultation by (747) Winchester, I found that the computer-generated chart based on Astrographic Catalog data for the event bore no resemblance whatsoever to the real sky shown in the True Visual Magnitude Photographic Star Atlas (T.V.M.A.). It also was puzzling to me that some of the A.C. charts contained no stars south of declination 3°8. It turns out that declination 3°8 is the boundary between the Toulouse and Algiers zones of the A.C. Apparently, all the Algiers data used by Fresneau for creating the A.C. tape are wrong. Hence, the A.C. data south of declination 3°8 should be ignored, and you should delete from the list starting on p. 126 of *O.N. 3* (6) the occultations of A.C. stars south of dec. 3°8 by (45) Eugenia and (747) Winchester on the following 1984 dates: October 13, 14, 17, 19, 20, 23, and 31; November 2, 4, and 6; and December 9, 11, 12, and 29. On rare occasions, an Algiers-zone star may have been given an incorrect declination much farther north, in one of the other zones with good data. Hence, stars on the A.C. tape north of dec. 3°8 sometimes do not exist in the real sky; this usually can be checked with the T.V.M.A. I have found a few relatively bright stars which are not in T.V.M.A on the A.C.-based detailed charts, and have removed them from the charts published in *O.N.* However, I have not done this checking for charts not published in *O.N.*, primarily sent to Southern-Hemisphere and Asian observers. For relatively bright stars, the Atlas Eclipticalis (A.E.) is sometimes also helpful.

On all the AGK3-based charts, a one-degree box centered on the star to show the region for the A.C.-based charts is shown for all events for the rest of 1984, whether there is a corresponding A.C. chart or not (none are given outside the declinations covered by good A.C. data, from +3°8 to +33°, or if the star or asteroid is 8th mag. or brighter so that AGK3 data will suffice for finding it). An example is the chart for (238) Hypatia on Nov. 12. Also, there is a plotting error if the asteroid's motion is very steep, nearly due north-south. In this case, the path is plotted as a stairstep, when in fact it should be smooth with small horizontal bars to mark the days, rather than steps. An example is the chart for (790) Pretoria on Nov. 8.

I have not produced finder charts for some very marginal events, with small magnitude drops or faint stars with strong interference by moonlight, and also for some relatively favorable events visible from parts of the earth where no astronomers are known to live. If you want a chart for one of these events, write to me and I will try to provide it.

Bob Millis invited me to give a talk, about the well-observed 1983 Pallas and Nemausa occultations, at Lowell Observatory at the end of June. The visit would also provide a chance for a detailed comparison of our ephemeris-generation software. I arranged to stay there June 28-30, and got an unplanned visit with Peter Manly in Phoenix when a delayed flight caused me to miss my connecting flight to Flagstaff the evening of the 27th (we compared eclipse videotapes). Much of the time at Lowell was spent with Larry Wasserman, who with some help from me was able to run my ephemeris program on the Lowell PDP-11 computer. The comparisons with Ted Bowell's ephemeris program were quite satisfactory, the main difference being a slow deviation of the mean motion amounting to about one arc second after 16 years. This difference, due either to the difference in integrators or to different planetary ephemerides, could effectively be eliminated by using recent osculating elements. The calculations of astrometric ephemerides from the same integrated heliocentric rectangular coordinates were in exact agreement. Hence, we are now confident in computing the same results from preliminary astrometry obtained a few months before a given occultation, as well as for last-minute astrometry. A large disagreement in our computed paths for an occultation by (704) Interamnia on July 6 turned out to be due to a transcription error in the published star position.

I was given a tour of the most-used Lowell telescopes. Most interesting was an 18-inch f/8 aerial camera lens, which had been designed also for possible astronomical use, which recently was mounted in an observatory less than 100 m from the reduction facilities in the planetary research building. That observatory had housed a 20-inch f/18 refractor which had been used by the Aeronautical Chart and

Information Center for their lunar mapping work in support of the Apollo program nearly 20 years ago. Plans are to use the 18-inch lens as a wide-field astrograph with a 60"/mm plate scale, comparable to the Lick Observatory twin astrograph. The field of view will be about 3 by 4 degrees. Measurements of the first test plates are encouraging, and routine astrometric work with the telescope may begin within a few months. If it works as planned, it will permit a large increase in last-minute astrometry, since it will be much more convenient to use than the Lick astrograph and will have no higher-priority competing program. Ted Bowell is looking forward to using it to improve the accuracy of his extensive routine astrometry of asteroids, since the positions obtained with the 13-inch astrograph now used are only accurate to about 1". Also while in Flagstaff, I saw Robert Fried's 16-inch telescope at Braeside Observatory, which is largely controlled by microcomputers for variable star photometry.

Lowell Observatory is especially interested in the occultation of a 10th-mag. star by Ceres, which can be observed photoelectrically from Mexico and probably much of Florida on November 13; see *o.N. 3* (6), pages 126, 127, and 133, and my map in the Planetary Occultations article in last January's *Sky and Telescope*. They have obtained some support from the National Geographic Society for the effort. Ten portable photoelectric systems, from Lowell, M.I.T., and the universities of Arizona and Maryland, have been mobilized for the event.

Arnold Klemola and the Lowell astronomers also recently had completed scans of Lick plates of the northern Milky Way fields which will be traversed by (6) Hebe and (747) Winchester late this year and early next year. The results will be presented at the Division of Planetary Sciences meeting in Hawaii in October. Most of the non-AGK3 events during 1984 already had been found in my A.C. searches and published in *o.N. 3* (6), 119. Some well-observed occultations of these asteroids will be important for analysis of radar observations planned at Arecibo, PR, in 1985 January. Several of the occultations are potentially visible from North America. The visit to Lowell also gave us an opportunity to decide which events during the remainder of 1984 were most important for last-minute astrometry; see p. 160.

Graham Blow reports that the occultation of SAO 158162 by (230) Athamantis on May 11th was timed at four stations in and near Brisbane, Queensland; more about this best Australian success to date will appear in a future issue. Asteroid occultation activity in Europe is discussed on p. 162. Remember to send asteroidal appulse and occultation reports to Jim Stamm; Route 13 Box 109; London, KY 40741; U.S.A. for publication in *o.N.*; his first summary article will appear in the next issue.

IOTA/ES NEWS

David W. Dunham and Hans-Joachim Bode

Four occultation workers from Denmark, Dunham from the U.S.A., and 21 from the German Federal Republic attended the regional meeting of the European Section of IOTA in Hannover, G.F.R. on June 16th. The meeting had been announced in IOTA NEWS in the last issue. The meeting provided a useful exchange of ideas between IOTA and IOTA/ES, and paved the way for increased cooperation. A major agreement was a pledge to avoid duplication of effort between the two organizations. Services (graze predictions, asteroidal appulse predictions, etc.) for observers in Ireland, the U.K., and Europe (except the R region in part of the U.S.S.R.) would be provided only by IOTA/ES, and any current IOTA prediction obligations to observers in those areas would be transferred to IOTA/ES. Some Europeans have purchased *o.N.* subscriptions direct from IOTA, so they can receive the issues more quickly, and IOTA will continue all paid subscriptions. This sometimes has meant the difference between receiving a finder chart before or after an asteroidal occultation, since *o.N.* often has been distributed by IOTA less than a week before some events covered in the issue were to take place. After this issue, we will try to rectify this problem by covering events taking place at least a month after the issue is distributed by IOTA, at least for events potentially visible from Europe. Then, Europeans can get the issue one or two weeks later less expensively from IOTA/ES. IOTA/ES will be less lenient with those who are behind on their payments, and will provide more reliable service. Dunham gave Bode the tape of 1985 graze data at the meeting, so that these predictions can be computed much farther in advance than was previously possible. First-class mail will be used for time-critical communications. With the proposed changes, IOTA/ES will have more honorary members, who can not send us a payment because they live in currency-controlled countries, than IOTA. In order to equalize the burden, IOTA will give IOTA/ES a discount on the price charged for the copies of *o.N.* provided to IOTA/ES based on the number of honorary and paid members in the organizations. There is usually only one honorary member in a currency-controlled country, and his membership is provided with the understanding that he will distribute IOTA information to others in his country, and provide us with observational reports.

Asteroidal occultations were the first item on the scientific agenda of the regional meeting. Dr. Wolfgang Beisker presented his analysis of timings of the 1983 March 11th occultation of SAO 93315 by (19) Fortuna obtained at three Czech observatories and at Wiesbaden, G.F.R., and of the 1984 February 19th occultation of AGK3 +6° 1540 by (9) Metis as timed by three observers in Lübeck and Kiel, G.F.R., and two in Rethe and Kalauch, German Democratic Republic. The observation in Lübeck was photoelectric. Dunham gave accounts of the occultations by (2) Pallas and (51) Nemausa which were so successfully observed in the U.S.A. in 1983. Bode said that the Astronomische Arbeitskreis Hannover was working towards a capacity for making astrometric observations for "last-minute" improvement of asteroidal occultation predictions. W. Landgraf and L. Kristensen asked if more information might be published in *o.N.* to allow detailed calculation of circumstances for for individual events. Dunham felt that this would be impractical, and of not much use to the majority of *o.N.* readers, considering the other information already published and the local-circumstance predictions distributed to IOTA members. Dunham would provide lists giving the time and angular distance of geocentric closest approach, and the position angle of motion, to those who wanted to compute more details, and he would provide accurate ephemerides and star positions to those calculating updated predictions from "last-minute" astrometry.

Occultations of stars by comets were discussed next. Dunham noted that the nucleus of Comet IRAS-Araki-Alcock was at least a few kilometers in diameter, larger than expected, based on doppler radar observations obtained at Arecibo and reported at I.A.U. Colloquium 83, "Comet Dynamics," in Rome two days before. The radar data also indicated a large cloud of particles, each at least 1 cm across, in agreement with Nolthenius' occultation observation reported in *o.N. 3* (4), 86. We concluded that the best way to record an occultation by a comet would be with an image-intensified video system. Dunham pointed out that this is also the best way to record occultations during total lunar eclipses, such as the one on 1985 May 4, when Alpha Librae (Zubenelgenubi) will be grazing along a line passing near Khartoum, Sudan; Addis Ababa, Ethiopia; and the Seychelles. We planned to see if a practical system could be assembled without too high a cost. Bode said that IOTA/ES planned an expedition to South Africa to observe Halley's Comet (and possible occultations) in early 1986. Dunham, Bode, and two other IOTA/ES members attended the International Halley Watch astrometry workshop at the European Southern Observatory headquarters near Munich on June 18-19; Ted Bowell distributed predictions of some occultations by comets at that meeting.

The May 30th eclipse was next on the agenda at Hannover; see p. 163. An American-format VHS VCR and television set had been borrowed and were used to show Dunham's and Fiala's video records of the eclipse. Bode showed his spectacular series of slides with details of Baily's beads. Another series of slides taken by Bode's colleague, Joe, overexposed the beads but showed the red chromosphere well. The Knudsens passed around their photoes of the projected image taken in the Azores. Bode plans to give a presentation about solar eclipse radius measurements and the May 30th eclipse at the Astronomische Gesellschaft meeting in the G.F.R. in early September.

The Hannover meeting concluded with a discussion about lunar occultations, with Fiala's videotape of the 1981 May 10th graze of Delta Cancri being a highlight. The possibility of computing residuals was discussed in light of the long delay in getting these results from the ILOC. Kyril Fabrin could use the Besselian elements tape which he gets each year from USNO for computing USNO-like total occultation predictions, to compute residuals also, if he can obtain some official support for this work at Aalborg, Denmark. Dunham noted that the Lunar Section of the British Astronomical Association is now computing residuals for some of their members using a personal computer. Europeans and others interested in doing this themselves might obtain more information from Alan E. Wells, 135 Elmdon Lane, Marston Green, Birmingham B37 7DN, England. Wells also reports the ability to compute accurate graze paths when events are identified in the "graze nearby" messages of the USNO total occultation predictions.

Bohumil Malecek has sent information about the 3rd European Symposium on Occultation Projects. The basic program lasts from August 30th to September 3rd, with sessions on August 31st to September 2nd at the Observatory, Valasske Mezirici, Czechoslovakia. Topics of the meeting include predictions and observations of occultations by solar system bodies (the Moon, minor planets, Halley's Comet), and cooperation of European observers. The registration fee, including accommodation at the Apollo Hotel, is 620 Czech crowns or DM 150. An afternoon sightseeing trip is planned for Sept. 1, and an optional sightseeing tour of Prague and vicinity is planned for Sept. 3-5. This will be a good opportunity to visit one of the most occultation-active countries of Europe. More information can be obtained from the authors or from Bohumil Malecek, Hvezdarna, 75701 Valasske Mezirici, Czechoslovakia.

THE 1984 MAY 30TH SOLAR ECLIPSE

David W. Dunham

Plans for this eclipse, including a summary of the 1st regional coordinators' notice for the eclipse, were published on p. 149 of the last issue. Skies were overcast along virtually the entire path in Virginia and Assateague Island. But conditions hardly could have been better along the rest of the path in the U.S.A. from Louisiana to North Carolina, and many observers recorded broken annularity and the surrounding partial annularity phases photographically and with video equipment. Many saw the chromosphere briefly, and some reported muted shadow bands. Harold Povenmire observed visually with his 6-inch reflector from Atlanta. He timed a few bead events, then moved all beads out of view and removed the front-end filter. He was able to observe for nearly 15 seconds before the light became too intense; he saw the chromosphere and innermost part of the corona, but does not recommend such observations, although he suffered no permanent eye damage. Alan Fiala, U. S. Naval Observatory, and I successfully videorecorded the eclipse from Fair Play, South Carolina. Our first impressions are that the path may have been a little south of our prediction. Observers within the predicted path in Louisiana reported that the annulus was always broken, as seen in their video records. Paul McBride, Green Forest, AR, who observed with Barry Simon's group along LA Highway 3127 in St. Charles Parish, watched an image (about 30 cm in diameter) projected with his 15-cm reflector. He said the ring "was continuous and unbroken" at mid-eclipse, although his photograph showed one break. We had predicted that true annularity, with no breaks in the ring, should have occurred there for at least a couple of seconds.

Guillermo Mallen reports that nearly 1000 stations were set up near the edges of the path of true annularity in Mexico. It was cloudy at about 400 sites, but reports will be provided for as many as 600 sites. High school students manned most of the stations, and many visually timed the duration of true annularity, if there was any. Those who had no true annularity were to report the number of breaks in the annulus at central eclipse. Mallen worked with the Mexican department of education and the National Council of Science and Technology to organize the massive effort.

I distributed a 2nd coordinators' notice on May 15. The main pupose of that notice was to include the results of a recently completed analysis of observations of the 1983 June 11th eclipse, including Alan Fiala's and Ken Schatten's videorecord of that event which was shown at several different meetings during May. The corrections derived from the analysis were:

+0".09 ±0".02 to the solar radius
+0".65 ±0".03 to the lunar ecliptic longitude
-0".19 ±0".02 to the lunar ecliptic latitude

Since the 1984 May 30 and 1983 June 11 eclipses took place at similar places in the earth's and moon's orbit, I reasoned that the corrections for the two eclipses would be similar, so I predicted that the path for the May 30th eclipse would shift 400 ±250 meters south, measured perpendicularly to the path, from my nominal predictions ultimately referred ephemeris data and corrections implicit in Van Flandern's OCC program, 80F version. The longitude correction implied that the eclipse would occur 2 ±½ seconds early. The 1983 radius correction, when compared with those from other recent eclipses published in *o.N. 3* (6), 119 (but see also p. 150 of the last issue), indicates that the solar radius may be expanding currently. When just the form and merge events were used in the 1983 analysis, the radius correction became insignificant, 0".01 ±0".04. Since these events determine the true annularity limits, I didn't expect much deviation from the expected path width for the May 30th event.

Also in the 2nd notice, some errors in the eclipse photography tables of Allen Seltzer's article in the May issue of *Astronomy* magazine were pointed out and corrected. Pre-eclipse tests and comparison with Kodak's formula showed that most of Seltzer's exposure times were about ten times smaller than they should have been. Some errors in my 1st notice also were corrected. The 2nd notice contained some other observing tips and noted that Joseph Rao at Compu-Weather in New York had made arrangements with radio hams along the eclipse path to distribute weather information. These arrangements were broadcast in short hourly messages on WWV. We also announced the availability of a videotape presentation about the eclipse which we had hurriedly prepared for Astronomy Day. It discussed eclipses in general; predictions for the May 30th event, including Fiala's simulation; the interesting parts of Fiala's video record of Baily's beads near the southern limit of the 1983 June 11 total solar eclipse; and observational techniques, following discussions in the 1st coordinators' notice. At the end of the 2nd notice, prediction information was given for the Azores and Morocco.

A 3rd coordinators' notice was distributed on May 23rd. It included information provided by Joe Rao about the ham radio net, am and fm standard-broadcast stations near the eclipse path which planned to carry the special Compu-Weather eclipse forecasts, and other possible sources of weather information. But its main purpose was to give an extensive list of telephone numbers of local coordinators, and expedition meeting times and places. I thank all coordinators for providing me with all this information in time for distribution.

During the afternoon of May 27th, we had an equipment check-out gathering and party at our home in Silver Spring, MD. About 30 attended, including a crew from CBS News from New York City who wanted to get some TV footage of astronomers preparing for the eclipse and a demonstration of safe ways to view the eclipse (we recommended and showed projection with binoculars). Some of the shots were shown on the CBS television national news broadcast the evening of the 29th and the morning of the 30th.

At about the same time as the 3rd notice, I also distributed a notice giving details of the DC-area National Capital Astronomers expedition plans for the eclipse, to those who planned to participate. Our planned site was Bishop's Corner, VA, about 50 miles southwest of Petersburg. Alan Fiala, and some others from USNO and out-of-town IOTA members, also planned to join this effort. We set up three options, depending on how far people were willing to travel for clear skies. Several of us left the morning of the 29th, aiming for Georgia or Alabama, where clear skies were predicted (NCA "Option 1"). Many others, led by IOTA member Richard Taibi, stayed at reserved motel rooms in South Hill, VA, 15 miles south of Bishop's Corner. Several others planned to leave the Washington area the morning of the 30th to drive directly to Bishop's Corner. Wayne Warren cancelled this effort when the weather forecast showed almost no hope of being able to drive far enough to get to clear skies before the eclipse.

I had distributed a one-page plot showing the path at 1:250,000-scale in four strips across most of Virginia. When the weather forecast became pessimistic for Virginia two days before the eclipse, I plotted the path southward down to Louisiana, but there was no time to mail copies. In retrospect, I should have asked someone to prepare these plots earlier, in time to distribute to all coordinators or even to publish for sale, since the 1:250,000-scale maps show nearly all roads and are about the minimum scale for being sure to be within the narrow path. Wayne Warren got copies of the important parts of the maps for me and for Richard Taibi on the 28th. On the afternoon of the 29th, I left a copy with the AAVSO in Petersburg. Richard Fleet, from Zimbabwe, was staying in Petersburg and said that he and over a dozen others copied the maps and dashed into North Carolina to observe the eclipse successfully. Several at South Hill, using Taibi's copies, did the same thing. Many others rerouted to places and expeditions described in the 3rd coordinators' notice, or used the maps in *USNO Circular* 166, to get into the path and observe the eclipse.

Many called my answering machine at 301,585-0989, published in the May issue of *Sky and Telescope*, to track us down or to get the latest weather forecast. I thank Joseph Rao and others at Compu-Weather for providing these good forecasts. Although I was able to update the message on the answering machine from remote telephones, I was not able to retrieve messages. This is because many of those who called listened to the entire message and stayed on the line, not hanging up until after the beep signalling the start for them to record a message had sounded. At one point on the 30th, I tried to retrieve the messages, but gave up after listening to hang-up clicks for many minutes, getting a few messages, the last of which was at 2 pm on the 29th. Long-distance calls are too expensive to wait so long. Next time, I will ask (in the outgoing message) those only interested in hearing the outgoing message to hang up before the beep.

We stayed the night of the 29th in Greenville, SC. On the morning of the 30th, we met several others at the Physics Department at Furman University. We especially thank Dr. Taylor, chairman of the Physics Department, for letting us copy maps and make long-distance phone calls for the final arrangements.

There were still quite a few clouds, which the local forecaster said probably would dissipate by eclipse time. But he recommended going about 40 miles farther west to ensure clear skies. We ended up going to the home of Sandy Reidhead, at the south edge of the broken annularity zone at Fair Play, SC, near the Georgia border. Altogether, there were 16 there who had left the DC area on the 29th, including Hans Bode, leader of the European Section of IOTA in Hannover, German Federal Republic, and Richard Nolthenius, Los Angeles, CA. Among several others who had travelled separately to Fair Play were Robert Elliot, Univ. of Wisconsin, Eau Claire, and Bob Melvin, the regional coordinator for the Carolinas. We observed from four sites spread across the broken annularity zone, the southernmost being at the Reidhead residence. After the eclipse, the Reidheads gave an impromptu but lavish party, during which Fiala and I showed our videotapes of the eclipse on their video projection system.

The group from Furman University successfully observed the eclipse from Easley, a few miles west of Greenville. Joseph Rao and Irving Price, an NCA member, saw the eclipse at a school on the northeast side of Greenville. During the hour before the eclipse, the clouds also departed along most of the path across North Carolina. Leroy Doggett and some others from USNO found about 15 amateurs, mostly from Raleigh, at the end of a dirt road near Hyco Lake a few miles south of the Virginia Border northwest of Roxboro, NC. Although there were clouds around the horizon, the sun was in the clear at central eclipse. That's the northeasternmost group which saw annularity, as far as I know. It was still cloudy at Bishop's Corner, only about 40 miles away.

Alan Fiala used a filtered lens with an effective focal length of 600 mm to obtain a direct videorecord of the eclipse; Carl and Marie Lukac assisted him. I videorecorded a transmitted image projected onto a translucent screen with a 5-inch Schmidt-Cass; Joe Mack assisted. Our records show the bead phenomena about equally well; we both used RCA Ultricon low light level video cameras. But my video record does not show the chromosphere and some of the finer bead detail which I could see visually on the projection screen. The records of bead disappearances and reappearances should be quite useful, but this might not be the case for form and merge events due to blooming and irradiation. We also made a super-8 movie of our projected image, but it was of poor quality compared with the video record. Fiala watched the eclipse coverage by all the major networks on the news that evening, and none of them showed as much detail as our records. This may be due to their insistence on using color cameras, which might not have the dynamic range of the Ultricon black-and-white camera. The Cable News Network got the best network record, with a quality comparable to our record.

In retrospect, those who videorecorded the eclipse should have made an effort to combine forces, so that four cameras could record four separate arcs, about 100° long each, of the annulus. This would have shown smaller beads and given more detail, as noted during the 1983 total eclipse in the 2nd coordinators' notice (during a total eclipse, the beads are confined to a shrinking crescent, on which the cameraman can concentrate). A couple of days before the eclipse, I recommended this by phone to a couple of the regional coordinators, but at that point there was not enough time to combine video forces. An adjustment like this is much easier when recording a projected image than direct methods, so I recommend using a projected image for future video solar eclipse work. As far as I know, all video records of the May 30th eclipse show the full disk, at least during the annular phases of the eclipse. Photographs generally have better resolution than video, so we are interested in comparison between the two techniques, especially 16-mm movies and 35-mm stills with motorized backs. I know of very few successful photographic records in these two categories. Scott Shaw informed me that a good 16-mm movie was made by University of Georgia personnel. Hans Bode at our site obtained a spectacular series of 35-mm slides at half-second intervals; he says that one of these will be published on the cover of *Stern und Weltraum*. Dr. N. P. Wieth-Knudsen and his wife obtained some good photographs of a projected image of the annulus at Praia de Vitoria, Terceira, Azores. Many Germans and other Europeans attempted observations in Morocco, but clouds foiled most of these efforts.

Reporting Observations and Analysis. The first thing we want to do is collect copies of all the successful video and photographic records of the eclipse, to see which methods recorded the most bead detail. If you have some good shots, please send a copy either to me at P.O. Box 7488, Silver Spring, MD 20907, or to Dr. Alan Fiala, U.S. Naval Observatory, Washington, DC 20390. Late in August, we will make a videotape showing the central one or two minutes of every video record of the eclipse which we have received, and if practical, some zoom shots of the best photographic material to show detail. We can make video records of slides and movies by projecting them on the translucent screen we used for projecting the eclipse (we did that for the eclipse demonstration video record for Astronomy Day mentioned above and in the 2nd coordinators' notice). We will send copies of this to all who send us videotapes; they can copy and further distribute it. In general, we will return the videotapes sent to us, with a copy of all the records recorded either starting at the beginning over the record you sent us, or starting at the end of your record, whichever you prefer. We will try to set up a schedule so that those submitting only photographic material will also have an opportunity to see the videotape of all the observations. We will either return the photographic copies sent to us, or buy outstanding ones. We are especially interested in good 8-mm and 16-mm movies.

After we see the material, we will select the better records for detailed analysis. Location also will be considered. Valuable unique records were obtained at Clemson University, SC; Fernbank Science Center, GA; and perhaps other places which were outside the zone of broken annularity (where everyone with portable equipment went) but within the region of partial annularity. It took me nearly a week's effort to analyze nearly all of the 1983 June solar eclipse Baily's beads data, and each video record of the May 30th eclipse has as much, and maybe more, data! The observers will need to help us a great deal in order for their data to be analyzed. We will provide blowups of the predicted lunar profile, such that the Watts angle (position angle measured relative to the lunar axis of rotation) of each predicted mountaintop and valley bottom can be read to the 0°2 resolution of Watts' limb data (this might not be done until late July or August). Observers can match this with their most central picture to determine which beads they recorded. The times of individual bead events can then be determined by comparison of the most central view with preceding and following views. For video records, we can help by superimposing a count of seconds and hundredths from a known epoch, if you have WWV on the audio channel. We will need from you the coordinates of your observing site measured from a 1:24,000-scale USGS map (Dr. Fiala has most of them, if you want to borrow his copy of the one showing your site rather than buy one from USGS or a local map dealer) and bead times and identifications. Remember to report the height above sea level, as well as the longitude and latitude. The three coordinates should be given to an accuracy of 20 feet, or 0"2 in longitude and latitude. The bead events should be identified (disappearance, reappearance, form, and merge), the U.T. given to 0.1 second, and the Watts angle specified to 0°2. The time scale for the analysis will be very long, since both Fiala and I postponed several important projects to prepare for the eclipse, and these and these now are demanding our attention. I will not undertake a complete analysis of the eclipse data until after I have completed the analysis of observations of last year's occultations by Pallas and Nemausa, and formal papers giving the results have been submitted for publication. I hope to analyze some of the May 30th data in time for the total eclipse in November, and perhaps in time for Hans Bode's presentation about eclipse radius measurements at a meeting of the Astronomische Gesellschaft in the German Federal Republic in September. I am sorry that we can't respond more quickly to the many reports we are receiving.

If you travelled to the path of annularity intending to obtain timed visual, photographic, or video records of Baily's beads, your travel expenses for the eclipse were effectively a donation to IOTA and can be deducted from your income when computing your 1984 U.S. income tax. This is true even if you are not a member of IOTA. Keep records of your expenses. At about the time we distribute the videotapes with all the observations, we will distribute forms (not yet prepared) for reporting your expenses. These forms should be completed and sent to IOTA treasurer H. F. DaBoll, who will validate each form by signing his initials and returning it to the sender.

Many thanks to all of you who responded to our appeal for observations of Baily's beads during the May 30th eclipse.

OBSERVATIONS OF ASTEROIDAL APPULSES AND OCCULTATIONS

David W. Dunham

[Continued from *O.N. 3* (7), 149]

Accounts of individual events are given below; they are reasonably comprehensive only during the later part of 1983. Clouded out attempts usually are not included in the accounts.

Dione and Rhea, 1980 March 3: This mutual occultation involving Saturn's satellites was recorded photoelectrically at Agassiz Station, MA; the trace is published in *Astron. J. 89* (2), 287. K. Aksnes *et al.* discuss the observation in an appendix: "The purpose of this note is . . . to record (as a sort of warning) a single instance of the observation of a secondary event, associated with a predicted occultation, which had, by chance, a clear and nonastronomical origin." The plot shows two distinct drops in the combined light of the satellites. "The second minimum whose midtime occurs about 90 seconds before the predicted time corresponds to an occultation of S4 (Dione) by S5 (Rhea). The earlier minimum is the anomalous one and might have remained a mystery but for the nearby presence of the 16-day-old moon. Sky conditions were generally good, though a very thin, diminishing cirrus layer was visible in the moonlight. Also visible to the observer was a faint discrete feature whose length and narrow fuzzy width suggested that it had originated as a persistent contrail from a jet aircraft. The passage of this extended linear feature over Saturn corresponded in midtime and duration to the first dip on the plot. In the absence of moonlight, this definite identification would not have been possible."

(114) Kassandra and SAO 95572, 1983 February 14: No occultation was observed with the 104-cm telescope of Uttar Pradesh State Observatory in Naini Tal, India, according to H. S. Mahra.

(511) Davida and SAO 162050, 1983 February 28: No occultation was seen by M. Clark at Mt. John, New Zealand, according to Circular C83/9 of the Occultation Section of the Royal Astronomical Society of New Zealand.

Uranus and A.C. -21° 64352, 1983 March 3: A short, almost grazing occultation of the star by Uranus' Epsilon Ring was recorded photoelectrically at Perth Observatory, Western Australia.

(137) Meliboea and B.D. +3° 2001, 1983 March 6: No occultation occurred at Naini Tal, India.

Umbriel and A.C. -21° 64352, 1983 March 25: The relative positions of the star and Uranus were determined accurately from the Perth observations of the March 3rd occultation of the same star by the Epsilon Ring. An improved orbit for Umbriel about Uranus was derived at CERGA, Grasse, France, using observations made in France and at the European Southern Observatory in Chile. The revised predicted path crossed southeastern Australia, similar to the original prediction shown in *O.N. 3* (3), 62. Paul Maley traveled to Australia to observe the event, but had no occultation at a site several miles west of Canberra. No occultation also occurred at Brisbane and Perth; clouds prevented observation from Victoria and eastern New South Wales. During the trip, Maley also visited New Zealand and New Guinea, where he was able to make preliminary arrangements and important local contacts for IOTA's expedition for the total solar eclipse next November.

(2) Pallas and SAO 104460, 1983 March 28: Lionel Hussey, observing with a 20-cm Schmidt-Cass at Christchurch, New Zealand, timed a 0§2 occultation starting at U.T. $16^h\ 36^m\ 21^s.2$. It is very unlikely that such a short event would be caused by Pallas itself. Hussey estimates that the possibility of the one-magnitude drop being spurious was about 40%.

(2) Pallas and SAO 104751, 1983 May 4: The occultation was observed at Kazan, U.S.S.R., as noted in *O.N. 3* (6), 114. Marco Cavagna reports that no occultation was seen from two sites in Milan, Italy.

(65) Cybele and Lowell 680214, 1983 May 5: Jan Hers, observing with a 14-inch Schmidt-Cass at Sedgefield, South Africa, long. 22°.7960 E., Lat. -34°.0121, height 10 M, reported that the star disappeared at U.T. $1^h\ 10^m\ 50^s.9 \pm 0^s.5$ ("may be a little late") and reappeared at $1^h\ 11^m\ 02^s.7 \pm 0^s.3$ (quite sudden and distinct"). A "very uncertain, maybe atmospheric" $1^s.3$ brightening started $1^s.8$ after the disappearance. The sky was completely clear, but proximity of the moon and very poor seeing made observing difficult. The observed duration is half the predicted central duration of 24 seconds.

(71) Niobe and SAO 117178, May 6, 1983: Jim Hale, Jasper, AR, saw no occultation, as expected from Lick astrometry mentioned in *O.N. 3* (5), 104.

(159) Aemilia and SAO 163629, 1983 July 15: No occultation occurred at Bulawayo and Harare, Zimbabwe; and at Cape Town, Durban, Grahamstown, Johannesburg, and Kempton Park, South Africa, according to a summary supplied by M. D. Overbeek.

(508) Princetonia and SAO 213361, July 19: No occultation occurred at Bulawayo and Harare, Zimbabwe, and Johannesburg, South Africa.

(45) Eugenia and SAO 162591, July 23: P. Raw saw no occultation at E. Doncaster, Victoria, Australia, according to Circular C84/3 of the Occultation Section of the Royal Astronomical Society of New Zealand.

(185) Eunike and SAO 101045, July 23: No occultation occurred at Manerbio, Italy; Casinos, Spain; La Seyne-sur-Mer, Carnial, and Vars-les-Elaux, France; and at Dourbes, Belgium, according to reports sent by R. Boninsegna, Dourbes, Belgium, and the Club Antares Observatory.

(511) Davida and Hyderabad A.C. -22° 76308, August 1: Robert Price, Cootamundra, N.S.W., Australia, reported a dimming of the star for 8 seconds starting at U.T. $8^h\ 33^m\ 51^s$. He felt that this was possibly due to thin cloud, although nearby stars seemed unaffected. No occultation was seen at Brisbane and Bundaberg, Queensland. Glenn Evans, Oxford, New Zealand, noted two possible one-magnitude brightness drops, one for $0^s.2$ and the other for about a minute, but felt that they could be atmospheric.

(336) Lacadiera and SAO 127446, August 3: No occultation occurred at Vilanova, Spain, according to a summary published by the Agrupacion Astronomica de Sabadell in *Astrum*, #55 (1984 March), p. 25.

(40) Harmonia and SAO 188145, August 3: No occultation occurred at La Seyne-sur-Mer, France.

(206) Hersilia and SAO 146454, August 3: No occultation occurred at La Seyne-sur-Mer and Janville, France, and at Furfooz, Koksijde, and Hove, Belgium.

(78) Diana and SAO 188283, August 6: No occultation occurred at Grahamstown, Johannesburg, and Nigel, South Africa.

(45) Eugenia and SAO 162357, August 6: P. I. Van Blommestein timed a $1^s.0$ occultation beginning at U.T. $19^h\ 1^m\ 41^s.4$, with $0^s.6$ p.e. applied, in Kimberley, South Africa, at longitude 24° 47' 59".9 E., latitude -28° 44' 20".0, height 1206 m. Using an 11-cm reflector, he noted that observing conditions were good and that the event did not resemble the momentary dimming usually associated with poor seeing. The disappearance and reappearance were almost instantaneous and 11th-mag. Eugenia remained visible during the occultation. No occultation was seen at Grahamstown and Johannesburg.

(712) Boliviana and SAO 159867, August 13: No occultation occurred at E. Doncaster and Mt. Eliza, Victoria, and at Bundaberg, Queensland, all in Australia.

(81) Terpsichore and SAO 183178, August 20: No occultation occurred at Bulawayo and Harare, Zimbabwe, and at Durban, Johannesburg, Pietermaritzburg, Pretoria, Sedgefield, and Sutherland, South Africa.

(909) Ulla and SAO 129717, September 4: Photoelectric observation with the Indian Institute of Astrophysics' 40-inch reflector showed no occultation at Kavalur, according to J. C. Bhattacharyya.

Neptune and KMN 31, September 12: This occultation was recorded photoelectrically with the 104-cm telescope at Naini Tal, India, according to H. S. Mahra.

(94) Aurora and SAO 183331, September 13: Peter Anderson, Brisbane, Australia, saw a possible drop to 75% brightness for about 15 seconds (twice the predicted duration) with a slower recovery at $9^h\ 0^m$ U.T., although a similar dimming had been seen with a wispy cloud a few minutes earlier.

(259) Aletheia and SAO 77803, September 14: Luiz Augusto L. Silva saw no occultation at Porto Alegre, R.S., Brazil.

(120) Lachesis and SAO 185970, October 1: No occultation occurred at Johannesburg, South Africa.

(10) Hygiea and SAO 183401, October 8: Peter Anderson, Brisbane, Australia, saw a "definite" occultation lasting $6^s.7$ starting at $9^h\ 47^m\ 48^s.3$ U.T. He described the thrill this event gave him as being very similar to when Australia II won the Americas' Cup yacht race. No occultation occurred farther south in Australia, at Queenscliff and Gymea, New South Wales, and at W. Footscray and Glen Waverley, Victoria.

(55) Pandora and B.D. +20° 2365, October 14: No occultation occurred at Paris, France, and Brussels, Belgium.

(159) Aemilia and SAO 188979, October 27: No occultation occurred at Naini Tal, India.

(532) Herculina and SAO 187978, November 19: Last-minute astrometry by J. Churms at Cape Observatory, South Africa, indicated that this occultation would pass over the Cape Coast, according to my calculations, relayed to M. D. Overbeek. Low altitude and clouds prevented any observations from being made.

(6) Hebe and SAO 187870, November 20: No occultation occurred at W. Footscray and Bendigo, Victoria,

Australia.

(545) Messalina and SAO 128200, November 24: No occultation occurred at Naini Tal, India.

(208) Lacrimosa and SAO 78799, December 14: No occultation occurred at Johannesburg and Pretoria, South Africa, and at Barcelona and Sabadell, Spain.

(849) Ara and SAO 113068, December 16: No occultation occurred at Como, W.A.; Bendigo, Vic.; and Brisbane, Qld., all in Australia; and at Whangarei, New Zealand.

(62) Erato and SAO 118937, December 25: No occultation occurred at Barcelona and Sabadell, Spain.

(140) Siwa and B.D. +21° 812, December 25: No occultation occurred at Brisbane, Australia.

(27) Euterpe and B.D. +5° 2507, 1983 December 26: No occultation occurred at Naini Tal, India.

(194) Prokne and SAO 117122, 1984 January 20: As noted in *O.N. 3* (6), 132, Lick Observatory exposures in early November implied a 0.″26 ±0.″3 south shift. Three exposures were taken with the 61-inch U.S.N.O. astrometric reflector at Flagstaff, AZ. Unfortunately, Klemola was attending a meeting in Florida at the time and was unable to provide secondary reference star positions. The Flagstaff exposures were reduced using 7 AGK3 stars, giving shift values of 0.″77, 0.″70, and 0.″74, all north. This large north shift indicated that the path would cross New York and southern New England, so several observers were notified on short notice, and three of us travelled from the Washington, DC, area to central Connecticut to observe it. Several observers bracketed the path well, and in spite of bright moonlight and temperature near -15° C., most were able to follow the star and none saw an occultation. The observers were at Wallace Observatory and Sudbury, MA; Quonochontaug, R.I.; Glastonbury, Wallingford, New Haven, and Stamford, CT; Hartung-Boothroyd Observatory, Ithaca, and Cortland, NY; and Westfield, NJ. Cirrus prevented effective observation from the Washington, DC, area. A few no-occultation observations were made farther south, at Concord, NC; Burns, TN; Clinton and Jackson, MS; and Mountain View, CA. Roger Harvey, observing with a 20-inch telescope at Concord, NC, saw Prokne approach, merge, and again separate from the star, and estimates from the position angles of merge "disappearance" and "reappearance" that the asteroid passed well south of the star. This is in agreement with a prediction by Gordon Taylor based on Royal Greenwich Observatory plates taken on Jan. 16, which indicated a path near 0.″4 south, passing near Houston, TX; Flagstaff, AZ; and Sacramento, CA, with an uncertainty of "±1.5 path widths." Taylor's telex giving this prediction was delivered to Wayne Warren three days after the event, underscoring the need for last-minute telex or telegram messages to start with: "Urgent – Please telephone (number)." Unfortunately, no observations near Taylor's path have been reported; more North American observers should monitor appulses closer than 1.″5 or 2″, regardless of the prediction. Robert Millis wrote, "We knew the distribution of AGK stars on the U.S.N.O. plate was far from optimum. However, we could either use them, or do nothing. This whole fiasco points out the need for additional competent astrometric help. Had Klemola been able to measure a secondary net for us, the occultation probably would have been well observed." Penhallow had taken and measured a plate of the star field, but there weren't enough of his secondary stars for reducing the narrow-field U.S.N.O. plates. Taylor's plates cover a larger area, allowing more AGK3 stars to be used for the plate reduction, which reduces the error in the prediction by reducing the effects of individual catalog star position errors.

(165) Loreley and B.D. +29° 1206, January 20: No occultation occurred at Naini Tal, India.

(46) Hestia and SAO 118733, January 29: No occultation occurred at La Seyne, Sollies-Pont, and Hyeres, France, and at Milan, Italy.

(9) Metis and SAO 119464, February 19: J. Lecacheux, Meudon, sent me telegrams with observations of these objects made with the photoelectric Bordeaux transit telescope on February 11, 13, 14, 15, and 16. I computed a path shift of 0.″34 south ±0.″06 and telephoned the result to Hans Bode, while Wayne Warren sent it by telex to Lecacheux and L. Kristensen in Denmark. Kristensen reports that five Danish observers timed the occultation, with durations ranging from 2.4 to 26 seconds. The event also was timed by at least two observers in northern German Federal Republic. The northern limit was determined by miss observations north of Copenhagen, while the southern limit must have passed just north of Hamburg, where no occultation also occurred. The actual path was within 0.″02 of what I predicted using the Bordeaux data.

(175) Andromache and SAO 80634, February 26: No occultation occurred at Mt. John, Wellington, and Palmerstown North, New Zealand; E. Doncaster, Victoria; and Bickley, Western Australia.

(241) Germania and Sigma Scorpii, March 4: Klemola measured secondary reference stars for this event from an old Lick Observatory plate. Wayne Warren sent them by telex to David Herald in Australia and Joe Churms at Cape Observatory, South Africa. The "last-minute" plates taken for this event hopelessly overexposed the star, in spite of diffraction gratings, but at least we hoped to update the asteroid. March 1 exposures at Perth Observatory gave a path shift of 0.″9 south ±0.″3, but larger errors were possible since Germania was just at the edge of the secondary reference star coverage. In the telex which Warren sent to potential observers, we cautioned that the true path might be near the nominal path. Joe Churms telephoned me a few hours before the occultation with measurements of a plate he had taken only about 10 hours before; a second plate with a spot filter centered on the star was useless because Germania was also behind the spot. This indicated a path 0.″1 south, which I telegramed to observers in Japan, the Philippines, China, and the U.S.S.R. No occultation occurred at Dodaira, Japan; Dagupan and Quezon City, Philippines; and at Naini Tal, India.

(27) Euterpe and SAO 118750, March 13: Penhallow obtained three exposures on March 10. When reduced with secondary star positions supplied by Klemola which he measured from an old Lick plate, I predicted a shift of 0.″20 ±0.″10 south, putting the path over populous parts of Newfoundland. I telephoned Randolph Joyce in St. John's; he later reported that

clouds and snow prevented observation.

Halley's Comet and anonymous A.C. star, March 14: Observations of the comet reported on I.A.U. Circular 3914 indicated a 1".3 north shift from my ephemeris. But Klemola's measurements of two 1983 plates indicated that the star's right ascension was now about 10" greater than the A.C. value, showing that the path would miss the earth's surface.

(9) Metis and B.D. +8° 2579, March 15: Observations with the Bordeaux transit telescope on five nights showed a 1".33 north shift, causing the path to miss the earth's surface by 1".1. Lecacheux identified the star as being in the AGK3.

(10) Hygiea and SAO 163443, March 26: No occultation occurred at Naini Tal, India.

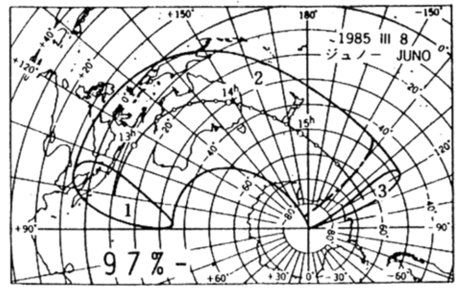
(201) Penelope and SAO 162170, March 27: Astrometric attempts were all cloded out. No occultation occurred in the Miami, FL, area, and probably also in Silver Spring, MD, where thin cloud was just moving in.

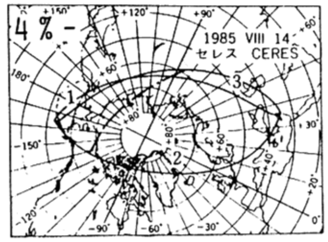
(11) Parthenope and B.D. +6° 2571, March 31: Bordeaux transit observations on eight nights from Feb. 29 to March 17 showed increasing residuals in R.A. when reduced with an ephemeris computed from Herget's orbital elements, but no such trend when EMP 1980 elements were used. The prediction based on the observations was almost exactly the same as the EMP 1980 path shown in *O.N. 3* (6), 145. Warren sent a telex with this prediction to observatories in Japan, China, and the U.S.S.R.

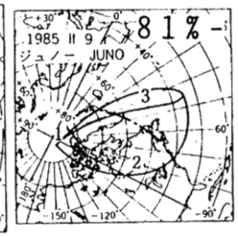
LUNAR OCCULTATIONS OF PLANETS

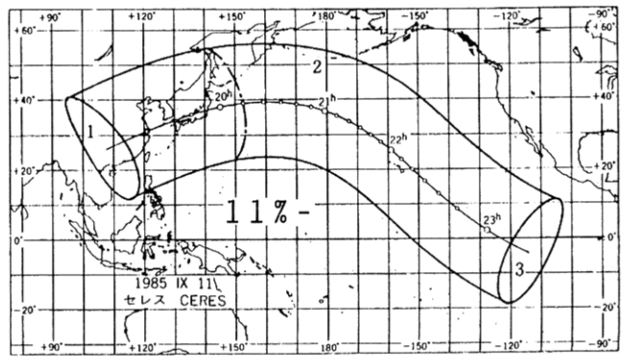
The maps showing the regions of visibility of lunar occultations by planets are reprinted by permission, from the Japanese ephemeris for 1985, published by the Hydrographic Department of the Maritime Safety Agency of Japan. In region 1, only the reappearance is visible; in region 3, only disappearance may be seen. Reappearance occurs at sunset along a dashed curve, while disappearance is at sunrise along a curve of alternating dots and dashes. We have added a legend to each map indicating the phase of the moon at the time of the event.

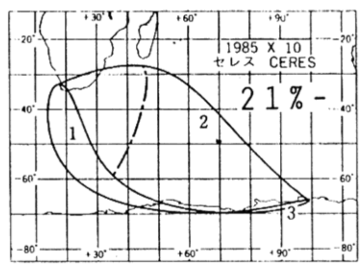
Observers interested in observing partial occultations should request predictions at least three months in advance, from Joseph Senne; P.O. Box 643; Rolla, MO 65401; U.S.A.; telephone 314,364-6233.

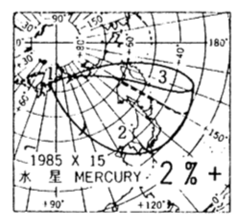


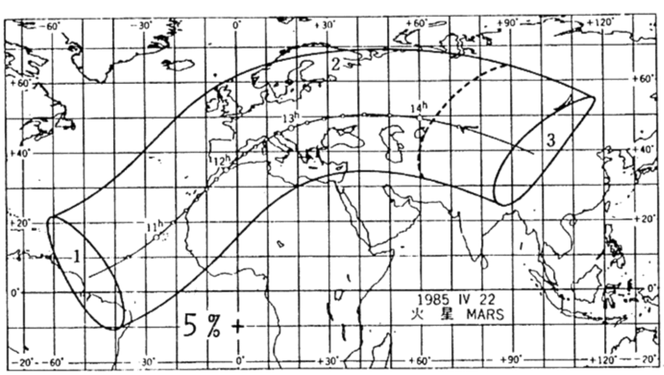


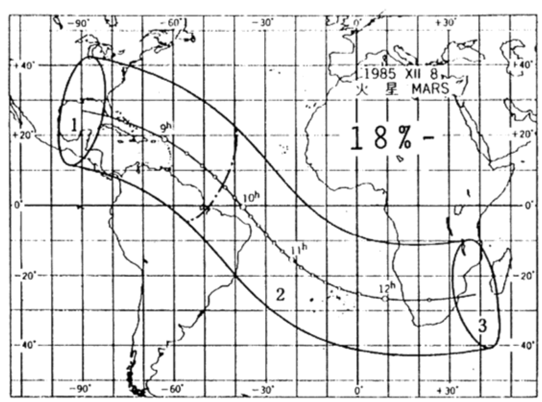


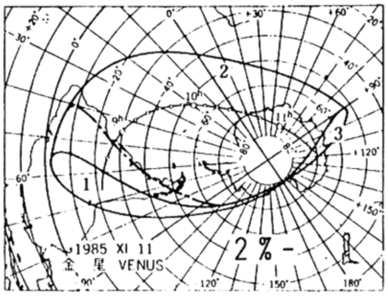


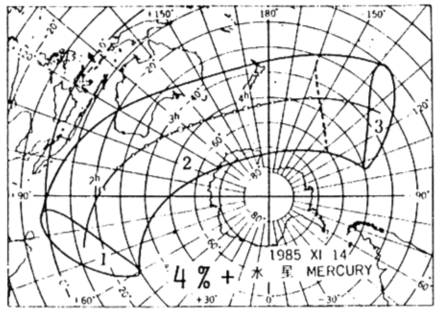


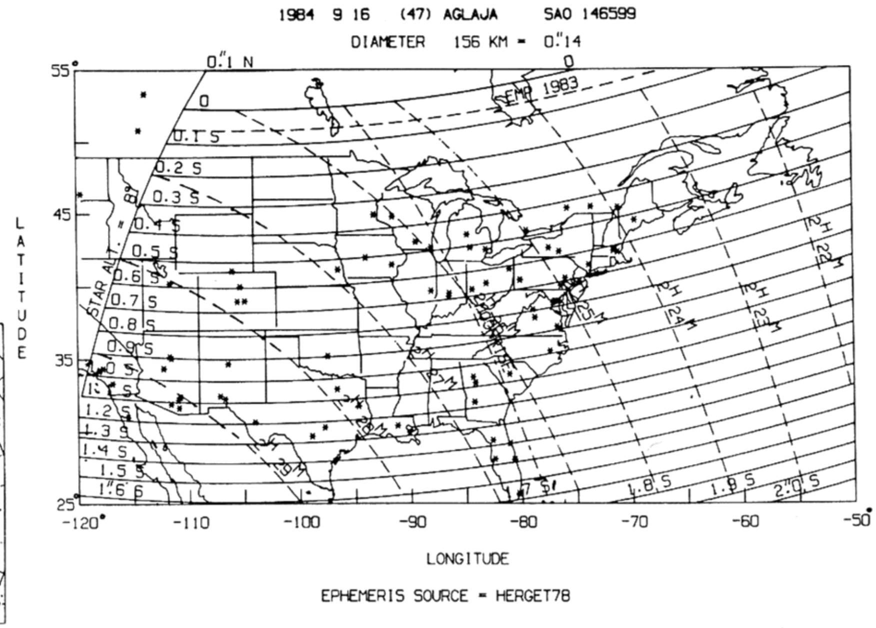






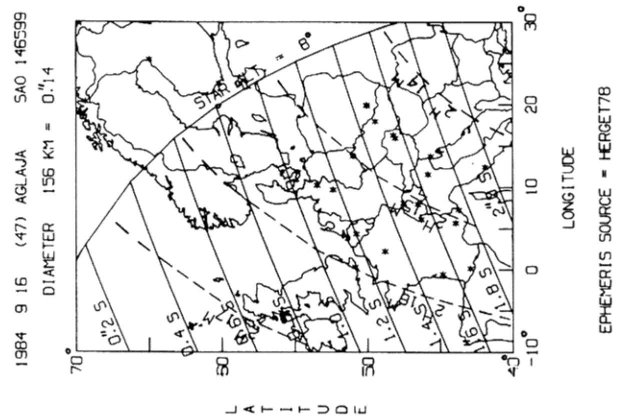


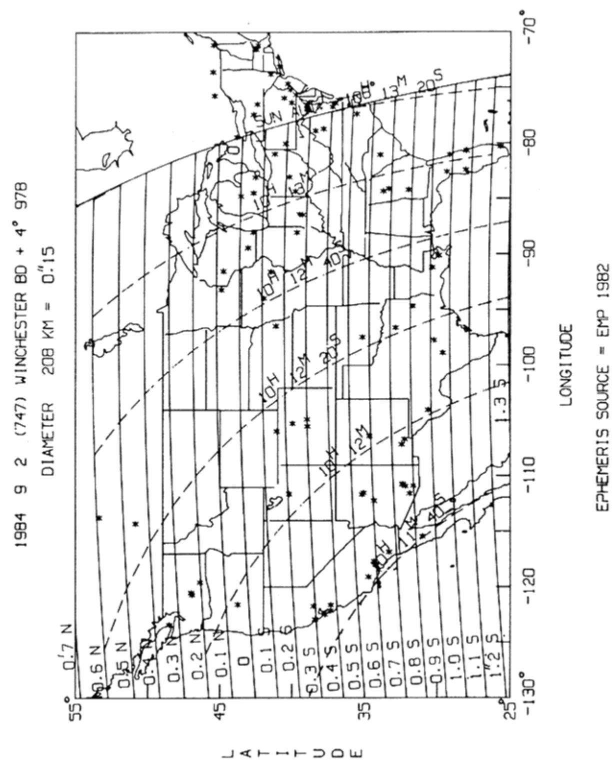


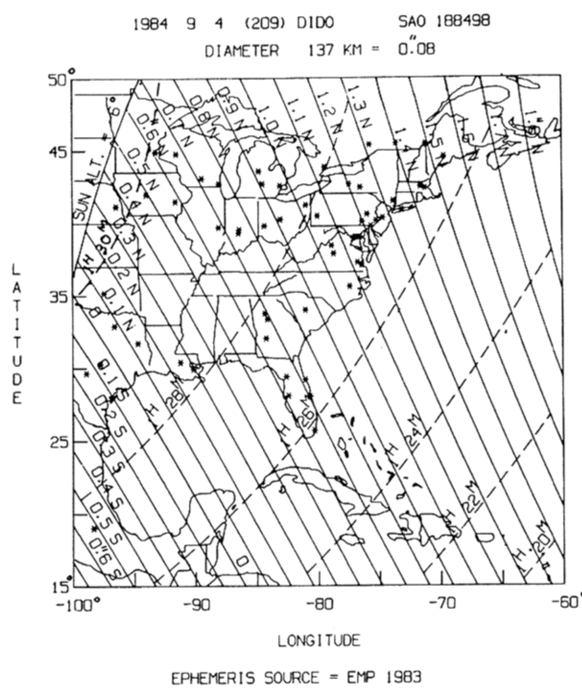


PLANETARY OCCULTATIONS DURING 1984

[The remainder of this issue is a continuation of the article "Planetary Occultations During 1984," by David Dunham, which began in *O.N.* *3* (6), pp. 119-146, and was continued in *O.N.* *3* (7), pp. 151-156. World maps are by Mitsuru Sôma. Regional maps and finder charts are by David Dunham.]







1984 9 15 (6) HEBE "D" ON FINDER CHART

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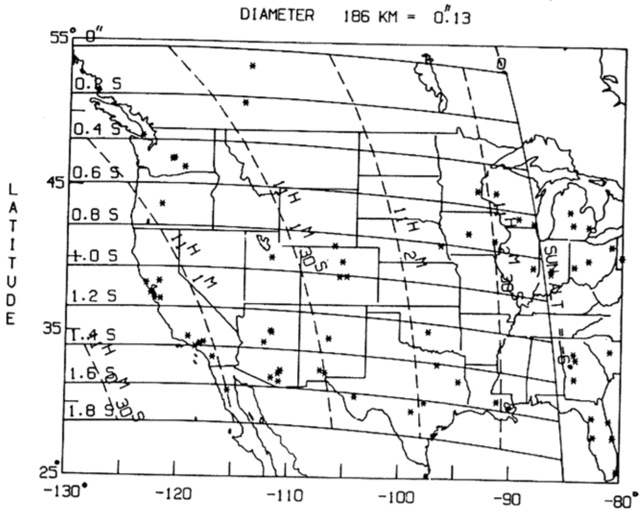

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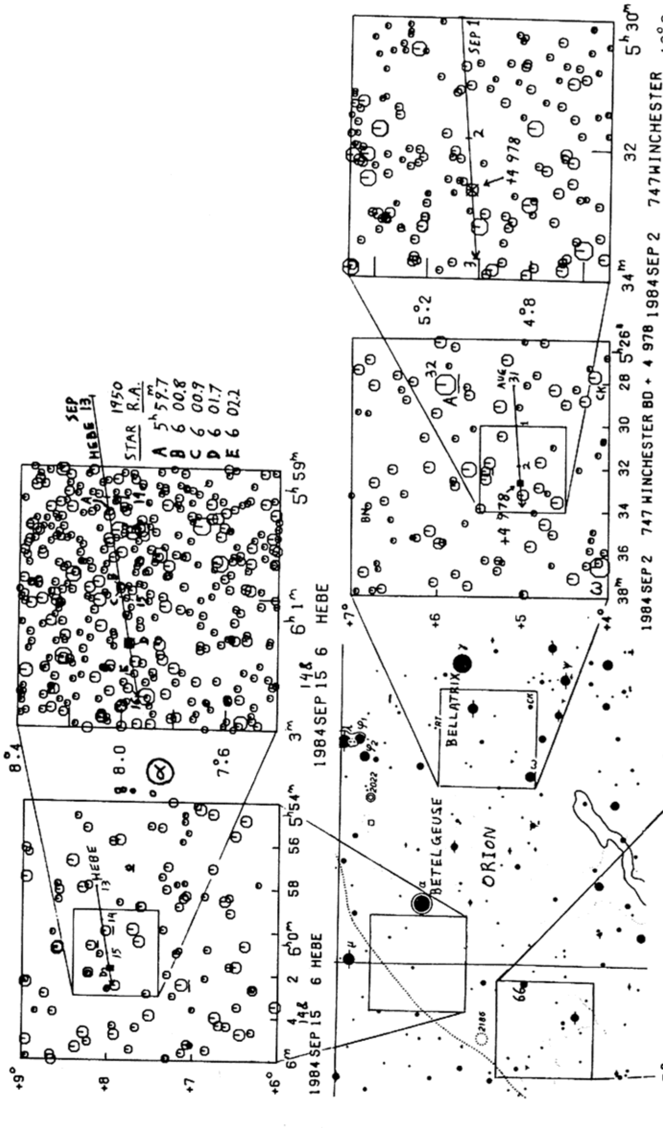
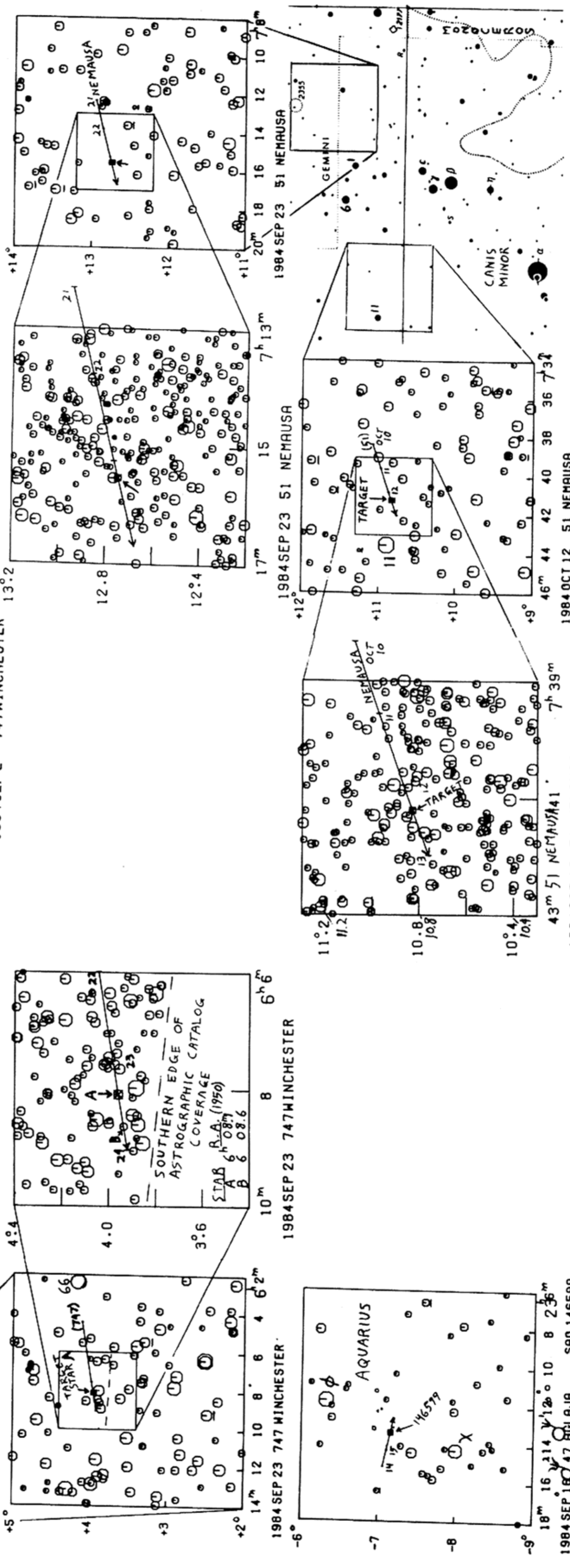
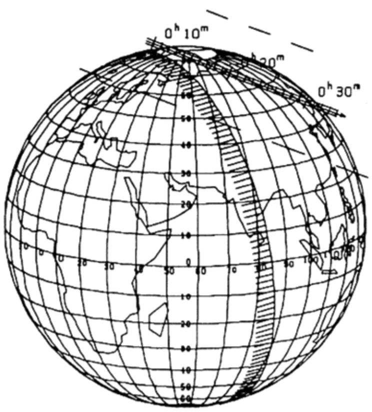
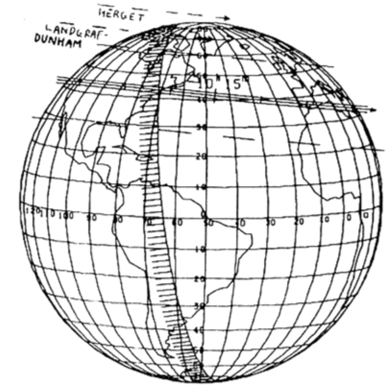




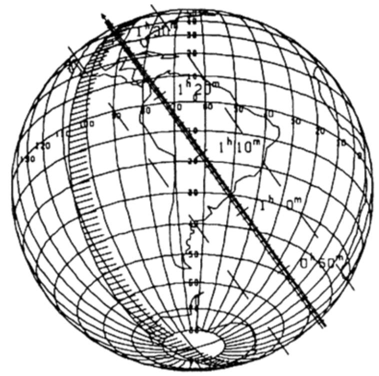


Anonymous by Doris 1984 Sep 1

Anonymous by Hektor 1984 Sep 1



DM +4° 978 by Winchester '84 Sep 2



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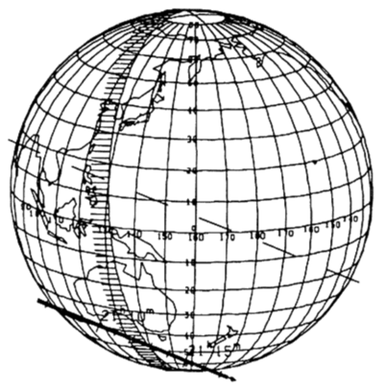

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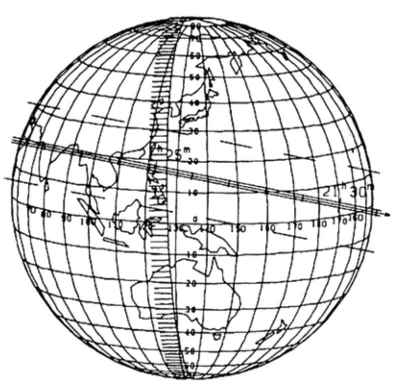
Anonymous by Hebe 1984 Sep 14



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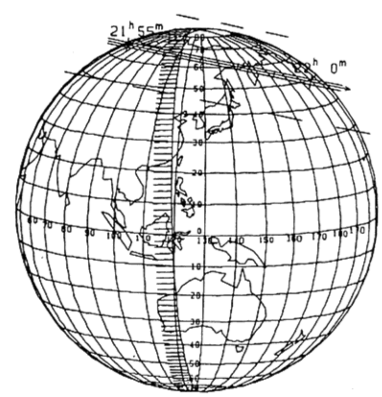

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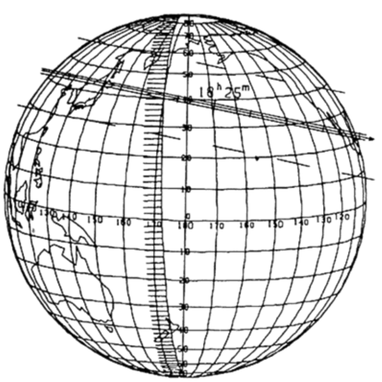

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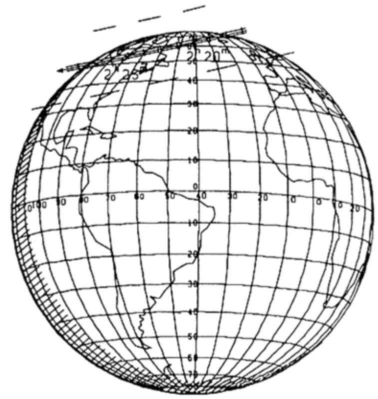

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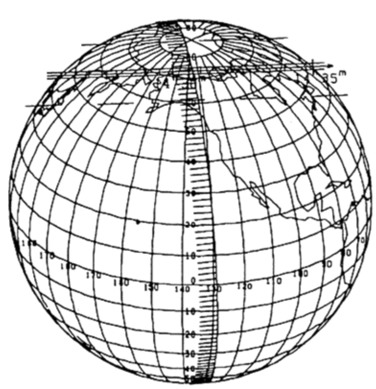
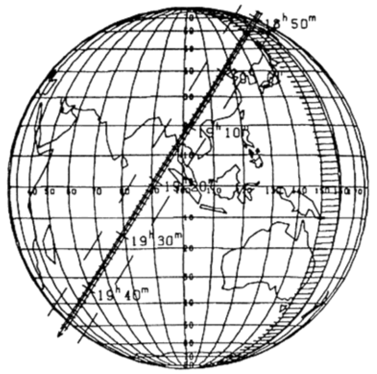
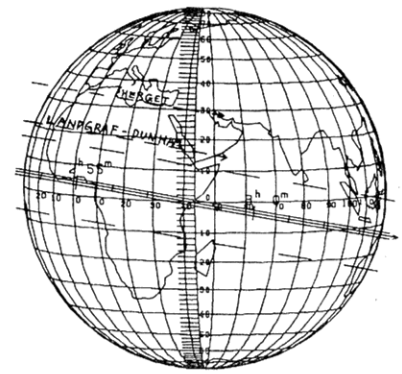


Anonymous by Iris 1984 Sep 17



DM -01° 257 by Flora 1984 Sep 17



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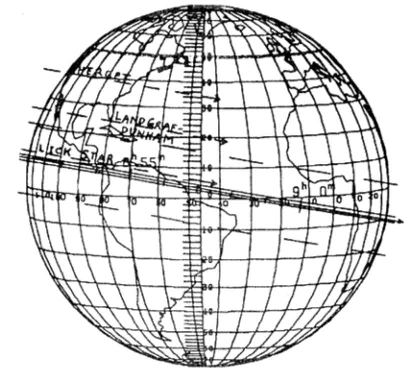

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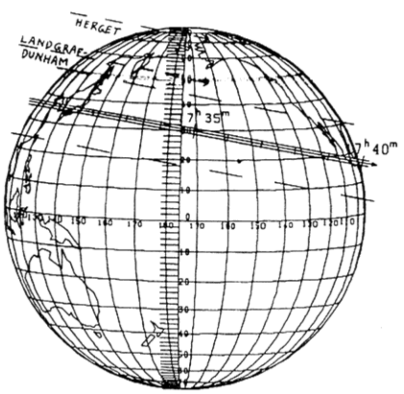
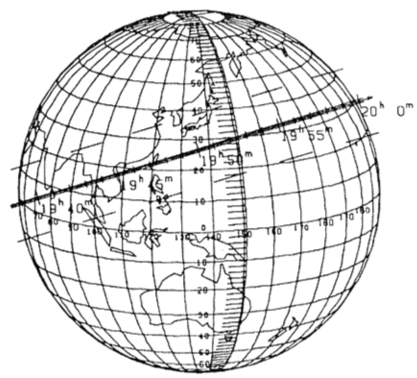
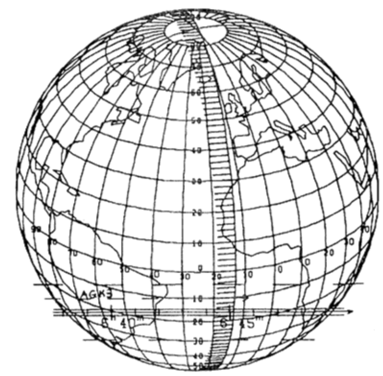


Anonymous by Winchester '84 Sep 23

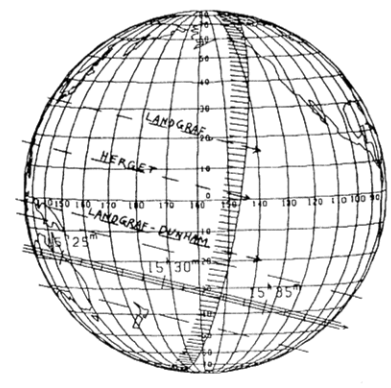


DM +12° 720 by Faina 1984 Sep 23

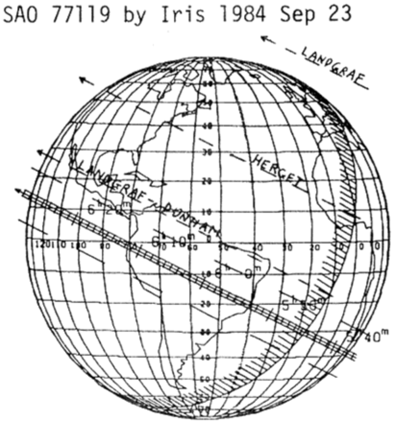


SAO 77119 by Iris 1984 Sep 23

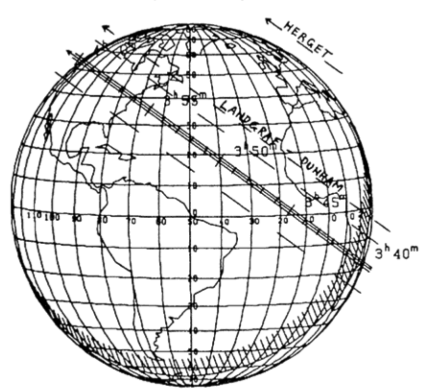
SAO 164723 by Chicago 1984 Oct 2



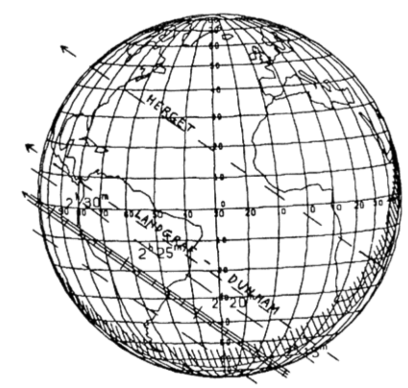
DM+2°1330 by Winchester '84 Oct 15



SAO 114569 by Winchester 84 Nov 28



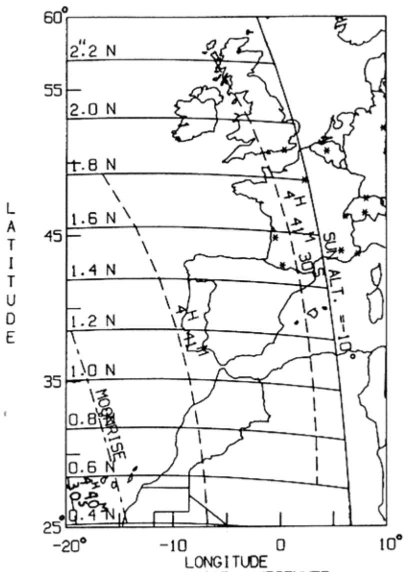
Anonymous by Winchester '84 Dec 22



Anonymous by Winchester '84 Dec 23

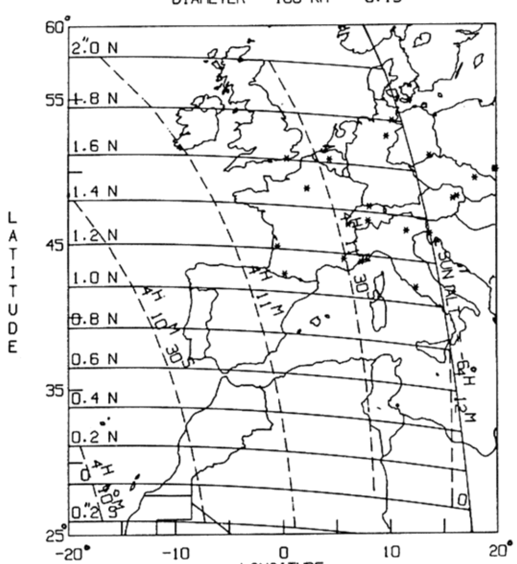
Anonymous by Winchester '84 Dec 23

1984 9 23 (51) NEMAUSA
DIAMETER 153 KM = 0."09

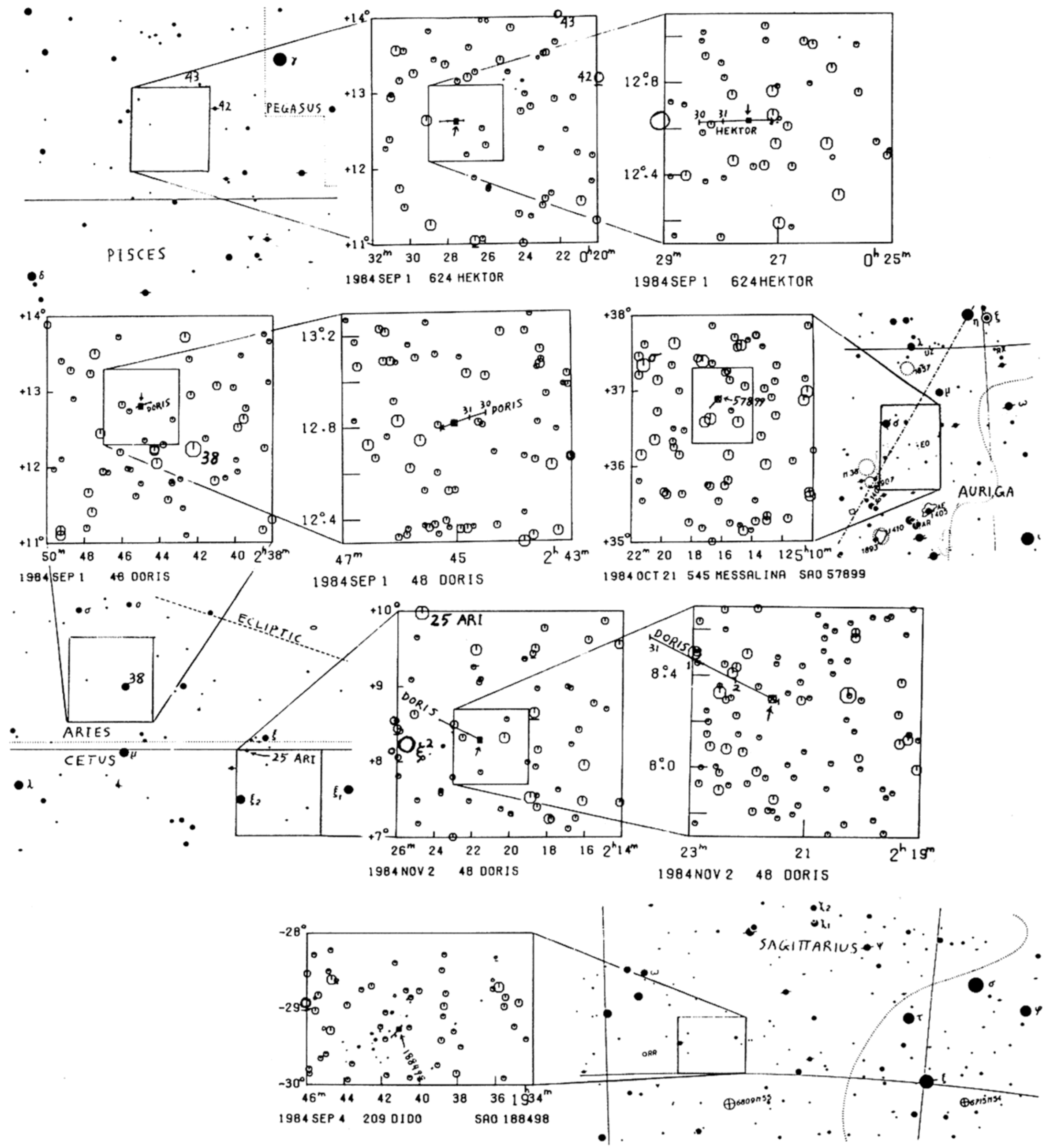


EPHEMERIS SOURCE = KRSTNN77

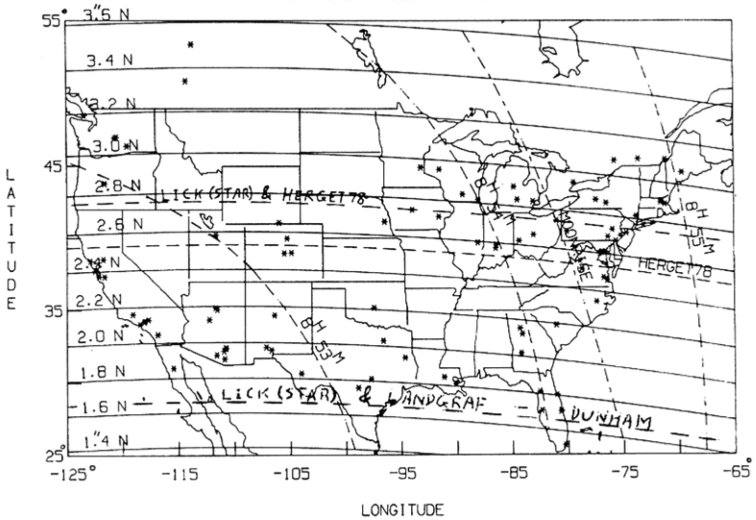
1984 9 14 (6) HEBE "A" ON FINDER CHART
DIAMETER 186 KM = 0."13



EPHEMERIS SOURCE = BRANHAM

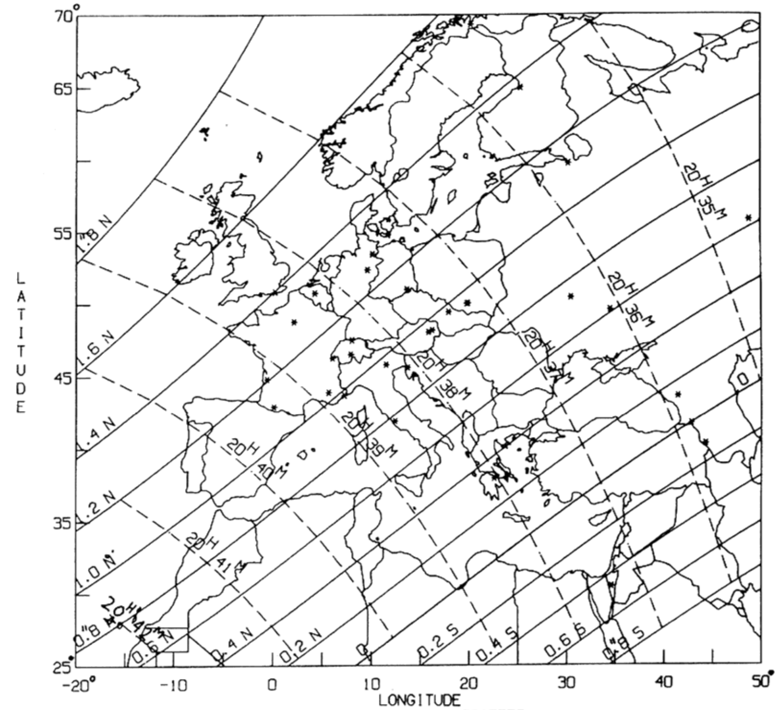


1984 9 23 (747) WINCHESTER "A" ON FINDER CHART
DIAMETER 208 KM = 0."16



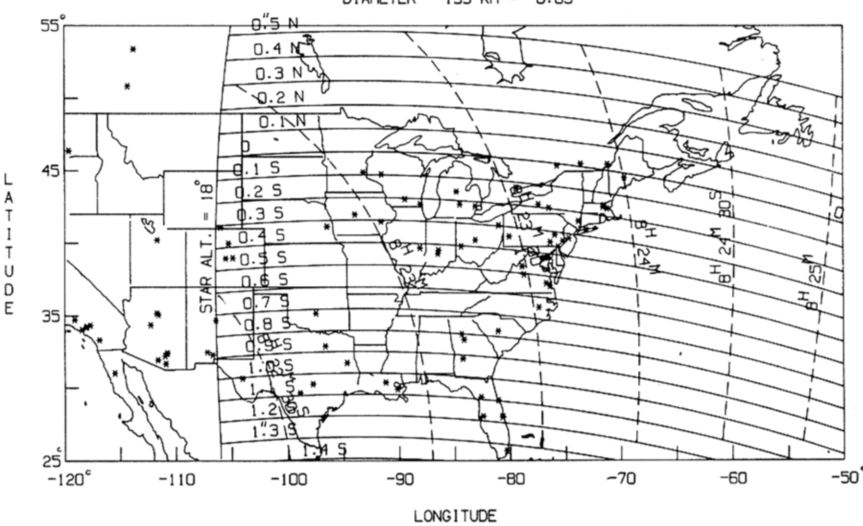
EPHEMERIS SOURCE = EMP 1982

1984 11 2 (48) DORIS
DIAMETER 200 KM = 0."14



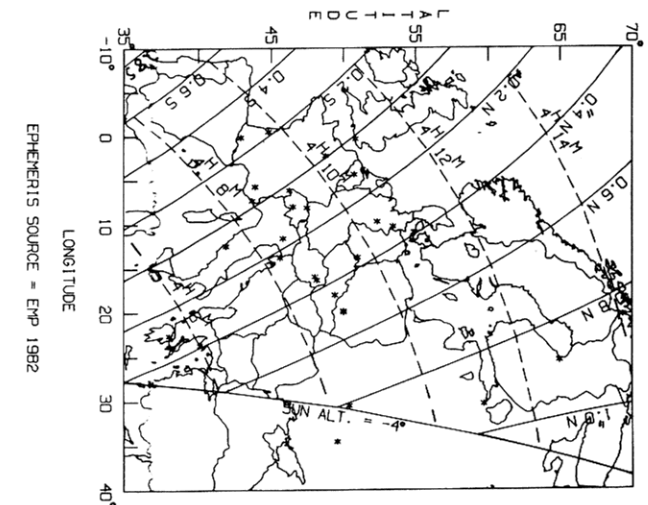
EPHEMERIS SOURCE = HERGET77

1984 10 12 (51) NEMAUSA
DIAMETER 153 KM = 0."09

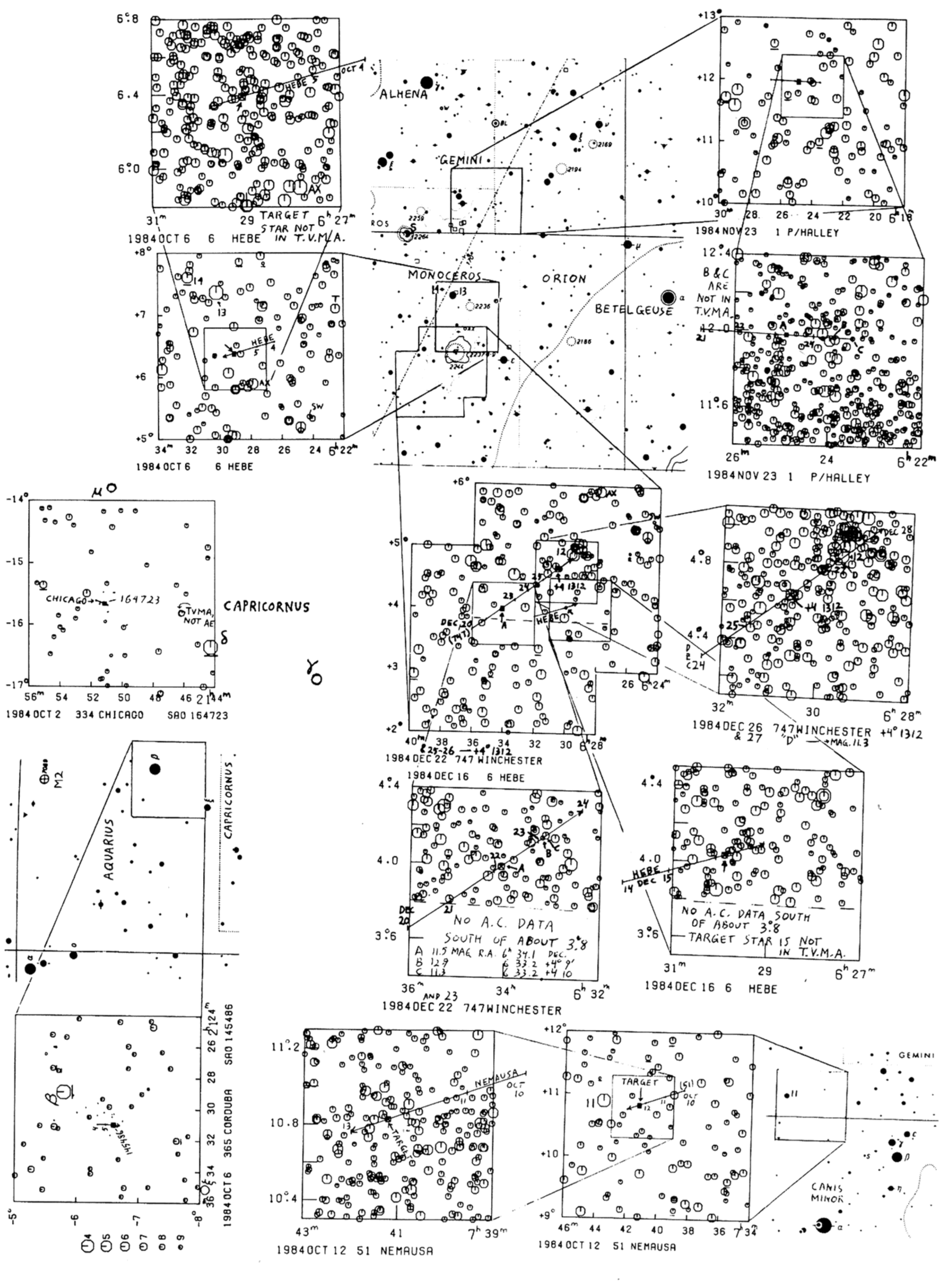


EPHEMERIS SOURCE = KRSTNN77

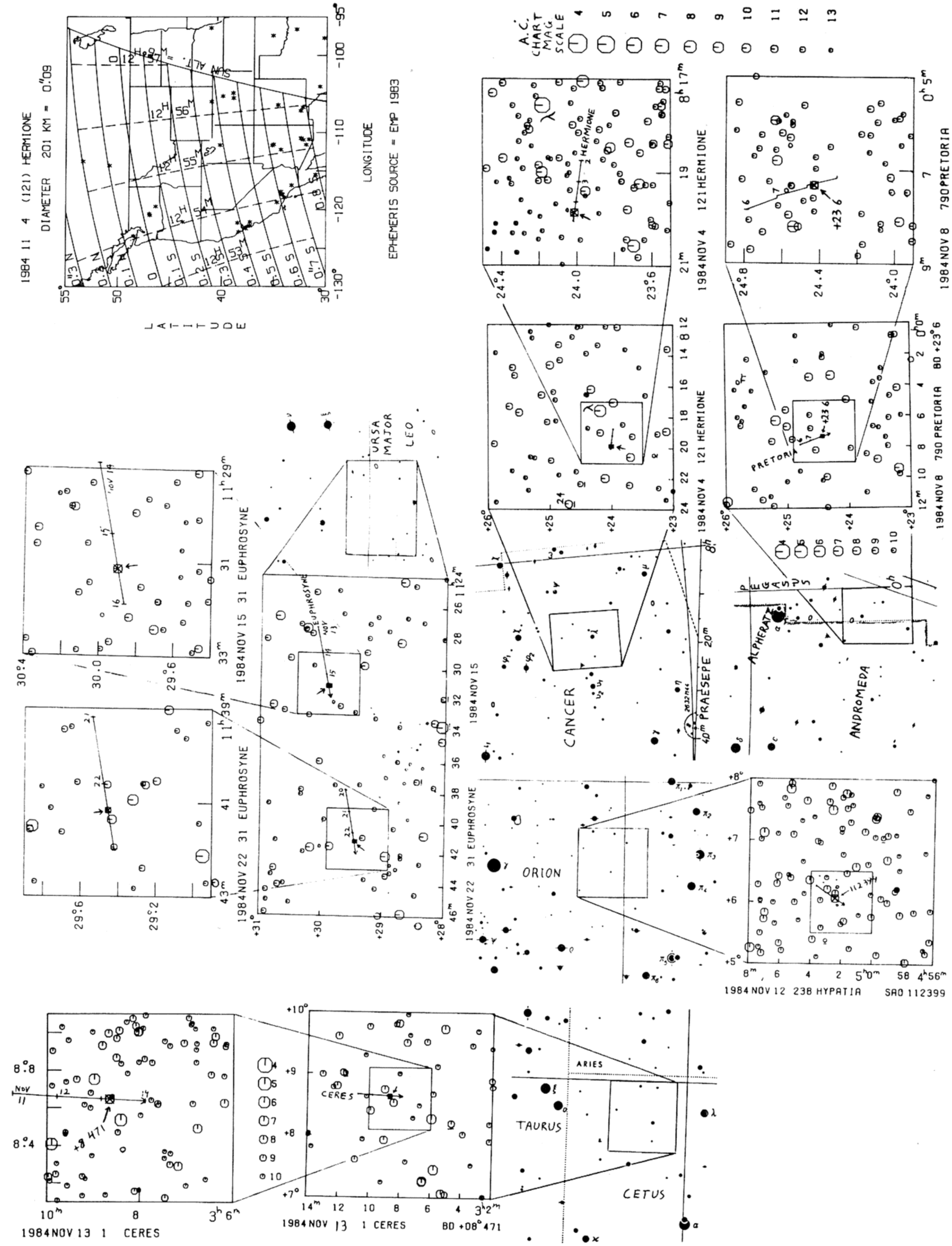
1984 10 21 (545) MESSALINA SAO 57899
DIAMETER 105 KM = 0."05



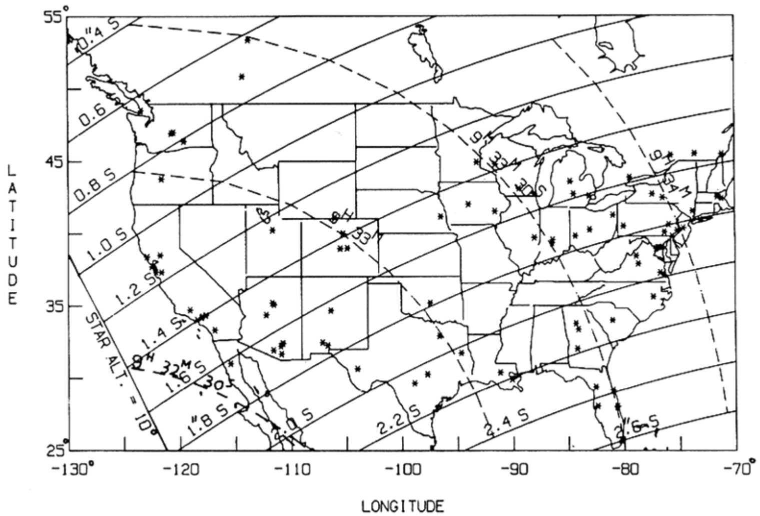
EPHEMERIS SOURCE = EMP 1982



TARGET STAR NOT IN T.V.M.A.
1984 OCT 6 6 HEBE
ALHENA
GEMINI
MONOCEROS
ORION
BETELGEUSE
1984 NOV 23 1 P/HALLEY
B & C ARE NOT IN T.V.M.A.
1984 OCT 6 6 HEBE
1984 NOV 23 1 P/HALLEY
CHICAGO
164723
TVMA, NOT AE
CAPRICORNUS
1984 OCT 2 334 CHICAGO SAO 164723
1984 DEC 22 747 WINCHESTER
1984 DEC 26 & 27 747 WINCHESTER +4° 1312
1984 DEC 16 6 HEBE
AQUARIUS
CAPRICORNUS
M2
NO A.C. DATA SOUTH OF ABOUT 3°.8
NO A.C. DATA SOUTH OF ABOUT 3°.8
TARGET STAR IS NOT IN T.V.M.A.
1984 DEC 22 747 WINCHESTER
1984 DEC 16 6 HEBE
1984 OCT 6 365 CORDUBA SAO 145486
NEMAUSA
TARGET
1984 OCT 12 51 NEMAUSA
1984 OCT 12 51 NEMAUSA
GEMINI
CANIS MINOR

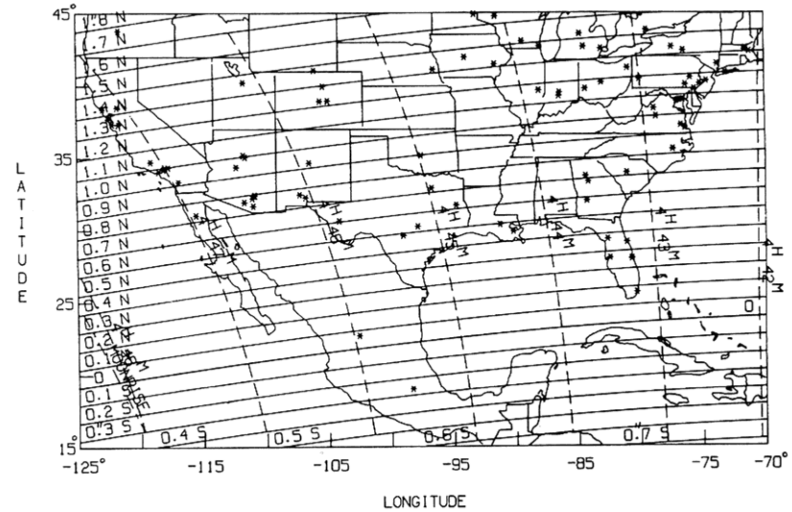

1984 11 4 (121) HERMIONE
DIAMETER 201 KM = 0.″09
LATITUDE
LONGITUDE
EPHEMERIS SOURCE = EMP 1983
A.C. CHART MAG SCALE
1984 NOV 4 121 HERMIONE
1984 NOV 8 790 PRETORIA
BD +23°6
URSA MAJOR
LEO
CANCER
PRAESEPE
PEGASUS
ALPHERATZ
ANDROMEDA
1984 NOV 15 31 EUPHROSYNE
1984 NOV 22 31 EUPHROSYNE
ORION
1984 NOV 12 238 HYPATIA
SAO 112399
1984 NOV 13 1 CERES
BD +08°471
CERES
ARIES
TAURUS
CETUS

1984 11 22 (31) EUPHROSYNE
DIAMETER 270 KM = 0."14



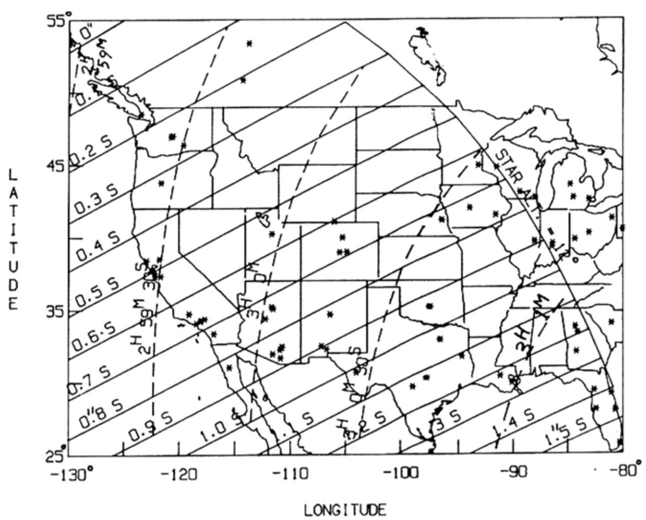
EPHEMERIS SOURCE = HERGET78

1984 11 13 (1) CERES BD +08° 471
DIAMETER 1025 KM = 0."77



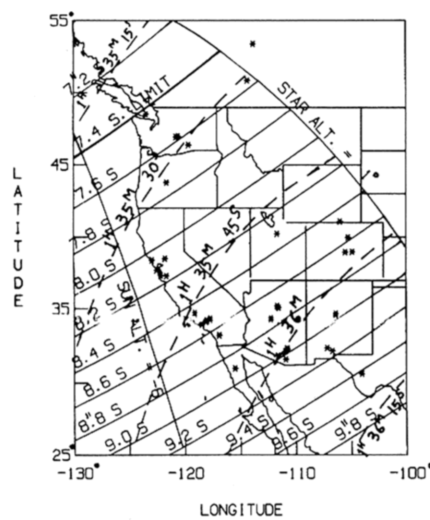
EPHEMERIS SOURCE = APAENAXX

1984 11 17 (10) HYGIEA L946104
DIAMETER 443 KM = 0."19



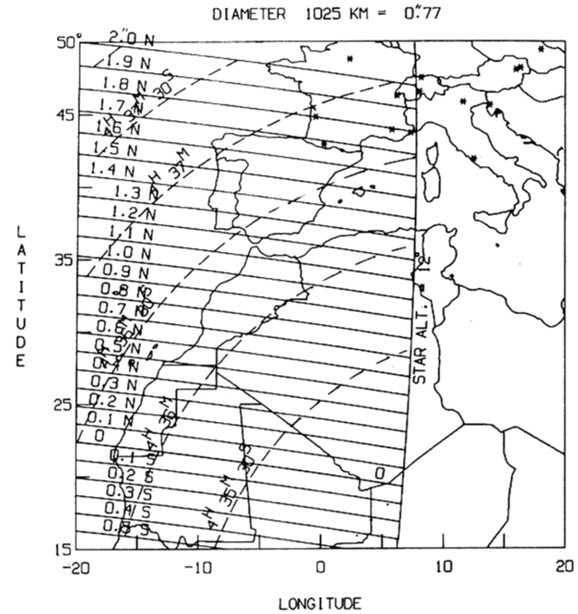
EPHEMERIS SOURCE = SCHMADEL

1984 11 19 (2) VENUS SAO 186841
DIAMETER 12220 KM = 14."81



EPHEMERIS SOURCE = NA0001

1984 11 13 (1) CERES BD +08° 471
DIAMETER 1025 KM = 0."77



EPHEMERIS SOURCE = APAENAXX