Occultation Newsletter

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FROM THE PUBLISHER

This is the first issue of 1987. Some reductions in prices of back issues are shown below.

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(There are 16 issues per volume, all still available)		

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

	Full price	Discount price
Local circumstance (asteroidal appulse) predictions (entire current list for your area)	1.04	1.00
Graze limit and profile prediction (each graze)	1.56	1.50
Papers explaining the use of the predictions	2.60	2.50

Supplements for South America will be available at extra cost through Ignacio Ferrin (Apartado 700; Merida 5101-A; Venezuela), for Europe through Roland Boninsegna (Rue de Mariembourg, 33; B-6381 DOURBES; Belgium), 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), for Japan, through Toshio Hirose (1-13 Shimomaruko 1-chome; Ota-ku, Tokyo 146, Japan). Supplements for all other areas will be available from Jim Stamm (Route 13, Box 109; London, KY 40741; U.S.A.) by surface mail at the low price of 1.23 1.18 or by air (AO) mail at 2.04 1.96

Observers from Europe and the British Isles should join IOTA/ES, sending DM 50.-- to Hans-J. Bode, Bartold-Knaust Str. 8, 3000 Hannover 91, German Federal Republic. Full membership in IOTA/ES includes the supplement for European observers.

[1] Single issue available at ¼ of price shown.
[2] Price includes any supplements for North American observers.
[3] Not available for U.S.A., Canada, or Mexico.
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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.).

IOTA NEWS

David W. Dunham

The main purpose of this issue is to distribute predictions and charts for planetary and asteroidal occultations that occur during at least the first part of 1987. As explained in the article about these events starting on p. 41, the production of this material was delayed by successful efforts to improve the prediction system and various year-end pressures, including the distribution o lunar grazing occultation predictions. Unfortunately, this issue will be distributed after some of these events have occurred. There has not been time to include the Atlas Coeli copies showing the region of the 3° computer-generated plots relative to bright stars. Of course, this is not needed for events included in Goffin's supplement. Some IOTA members have been sent preliminary information on events in early January with their grazing occultation predictions, or with the appulse predictions distributed by Joseph Carroll.

The old rates for *O.N.* subscription and IOTA membership were published in the *Observer's Handbook 1987* of the Royal Astronomical Society of Canada. Their publication deadline was in early September, before we had examined the finances and found it necessary to increase the rates. The correct rates are given in "From the Publisher" on this page, and were first published in the last issue of *O.N.*

We plan to distribute the next issue of *O.N.* (No. 4) at the end of February. It will include detailed charts of the Pleiades generated from U.S.N.O.'s P-catalog. These should be of use to North American members, especially those in the southwestern U.S.A., for the very favorable March 6th Pleiades passage (evening of March 5th, local date). *Sky and Telescope* plans to publish a less detailed chart, which will show the paths of the Moon's center as seen from a few major North American cities. The following issue, No. 5, is tentatively scheduled for late June.

During the last week of November, I travelled to Japan on a business trip to coordinate spacecraft trajectory design work with colleagues at the Institute of Space and Astronautical Sciences (ISAS; their work is described in an article in this month's issue of *Sky and Telescope*). Joan travelled with me. I was able to meet, and have lengthy discussions with, Japanese amateur and professional astronomers who have done work with occultations and eclipses, including ILOC, the Lunar Occultation Observers Group (which is effectively IOTA's Japanese counterpart), and Tokyo Astronomical Observatory. The meetings were very successful and the Japanese were marvelous hosts. Time does not permit describing even the highlights here, but I plan to do so in the next issue. I have another business trip to Japan scheduled for the third week in March.

International Astronomical Union Colloquium No. 98, "The Contribution of Amateur Astronomers to Astronomy," will be held in Paris, France, from the 20th to the 24th of June. It will be hosted by the Societe Astronomique de France (S.A.F.); 3, rue Beethoven; 75016 PARIS, France; during their 100th anniversary. The goal of the colloquium is to bring together amateur and professional astronomers and discuss cooperative projects. The program will include invited and contributed papers on the historical, observational, and educational contributions of amateurs to astronomy. Attendance is by invitation only. If you wish to receive an invitation, you need to complete a form and mail it to the S.A.F. as soon as possible; their nominal deadline was 1986 December 31st. Copies of the form are being sent to European *O.N.* subscribers, and will be provided to others upon request to the editor at the address in the masthead. If you wish to present a paper, please send them an abstract of 20 lines or less as soon as possible. Paul Maley and Charles Herold plan to give papers about the work of IOTA, and I expect to do so, also. There is some possibility that the next E.S.O.P. meeting will be organized so that those attending Colloquium No. 98 could also attend E.S.O.P.

On January 12th to 15th, there will be a meeting of the American Institute of Aeronautics and Astronautics in Reno, NV, which Paul Maley and I will attend. We plan to bring our files of observations and preliminary work with the 1983 May 30th occultation of 1 Vulpeculae by (2) Pallas, and with the 1985 May 4th lunar eclipse grazes of Alpha 2 Librae. We will tie together as many loose ends as we can to develop a schedule, and proceed with final analyses and preparation of papers about these important events, which we hope to have submitted for formal publication during 1987.

In a news release dated 1986 November 18th, Stephen J. Edberg, chairman of the Hubble Space Telescope Amateur Astronomers Working Group, announced the postponement of the deadline for receipt of preliminary proposals by amateur astronomers, from the end of March to 1987 June 30th.

On April 6th to 9th, there will be a Symposium on the Diversity and Similarity of Comets at Brussels, Belgium, which I plan to attend. This should give me a chance to meet with members of IOTA/ES and of the Groupe Europeen d'Observation Stellaire (GEOS), which has done so much good work with asteroid occultations and appulses.

IOTA plans to participate in the super convention being organized in Pomona, CA, in mid July. Also meeting at the convention will be the Astronomical Society of the Pacific, the Western Amateur Astronomers, the Astronomical League, A.L.P.O., and others. Besides a short paper session, IOTA also plans to have a workshop session.

The official annual IOTA meeting needs to be held in Texas. In 1987, we will probably meet in Houston on October 10th, so that those attending might be able to participate in the spectacular grazing occultation of Beta Tauri that will be visible from the Houston area the morning of October 12th.

REPORTS OF ASTEROIDAL APPULSES AND OCCULTATIONS

Jim Stamm

First, a correction: Under the "Notes" column of Table 1, in *O.N. 4* (2), 26, "5" should follow the February 24 entry, and "6" should follow May 10.

The following two tables list additional reports of events and observers for the first half of 1986. The "Observers" for Table 1, and "No." for Table 2 list only the additional data for the entry, and should be added to the information in the tables of *O.N. 4* (2), pp 26-27.

Table 1. Addendum to Table 1 of *O.N. 4* (2), 26 — Additional appulses and occultations observed from January through June, 1986.

Asteroid		Star	Date	Observers
(643)	Scheherezade	SAO 145581	Apr 21	Dj
(247)	Eukrate	SAO 243733	May 04	LdPtBw
(336)	Lacadiera	SAO 185428	May 12	AnSc
(336)	Lacadiera	SAO 185407	May 15	LdPt
(111)	Ate	SAO 183016	May 16	ScAn
(1867)	Diephobus	SAO 209844	May 16	ScAn
(303)	Josephina	SAO 183225	May 18	ScAn
(96)	Aegle	SAO 204909	May 19	Sc
(674)	Rachele	SAO 184424	May 25	Ld
(276)	Adelheid	AGK3 +00 1198	Jun 03	Sc
(399)	Persephone	SAO 157154	Jun 18	Ld
(163)	Erigone	SAO 162290	Jun 24	ScAn
(14)	Irene	AGK3 +07 0278	Jun 29	ScAnHt

Table 2. Addendum to Table 2 of *O.N. 4* (2), 27 — Observers and locations of events recorded January through June, 1986.

Observer	ID	Location	No.
Peter Anderson	An	The Gap, Queensland, Australia	6
Graham Blow	Bw	Wellington, New Zealand	1
Joan Dunham	Dj	The Gap, Queensland, Australia	1
Steve Hutcheon	Ht	Sheldon, Queensland, Australia	1
Brian Loader	Ld	Blenheim, New Zealand	4
John Priestley	Pt	Pukera Bay, New Zealand	1
Charlie Smith	Sc	Woodridge, Qnslnd, Australia	8

Reports of 70 events were submitted by 91 observers for the first half of 1986. There were 195 successful observations. Only 28 observers monitored more than one event.

ECLIPSE SOLAR DIAMETER MEASUREMENTS

David Dunham, Joan Dunham, and Paul Maley

This article was published in the Proceedings of the Astronomical League (40th National Meeting), hosted by the Baltimore Astronomical Society.

Abstract. Timings of Baily's bead phenomena made from locations a short distance inside the northern and southern limits of annular and total eclipse

paths can be analyzed to determine the Sun's diameter accurately relative to the Moon's diameter. Comparison of results from eclipses observed in 1925 and 1979 shows that the solar radius apparently decreased by a few tenths of an arc second between those two eclipses. Results from four eclipses from 1979 to 1984 show a steady increase of the solar radius. Bead phenomena from the most recent eclipses have been videotaped. Records of the 1984 May 30th broken-annular eclipse are quite spectacular. IOTA's plans for both 1987 central eclipses, and probable efforts for total eclipses in 1988 and 1991, will be described.

Baily's bead phenomena are greatly prolonged for observers located a short distance inside the paths of annular and total solar eclipses. Due to the circular shadow geometry, timings of these phenomena near both limits, especially the 2nd and 3rd contacts, provide what is currently the most sensitive measurement of the solar diameter. Since the shadow motion is rapid and the phenomena take place mostly outside of the Earth's atmosphere, the results are virtually unaffected by seeing variations.

Timings made near both limits of 8 central eclipses have been analyzed to determine the solar radius relative to the lunar radius. Apparently useful observations of 6 more eclipses have been located but not yet analyzed. Most of these occurred during the last century, when it was more fashionable to time the contacts and before observers were distracted from this work by photography. In the table below, the correction to the lunar radius is assumed to be zero. The first letter following the number of timings tells whether the eclipse was total (t), annular (a), or broken annular (b). The second letter tells whether the observations were primarily direct visual (d), done visually using a telescopic projected omage (p), or were videotaped (v). The results are the same as those published by Fiala *et al.* (1985), which supersede earlier-published results that included some minor errors.

Date	Number of Timings		Correction to the Mean Solar Radius of 959.″63	
1715 May 3	3	t d	+0.″48	±0.″2
1925 Jan. 24	8	t d	+0.51	±0.08
1976 Oct. 23	43	t p	+0.04	±0.07
1979 Feb. 26	47	t p	-0.11	±0.05
1980 Feb. 16	232	t p	-0.03	±0.03
1981 Feb. 4	153	a p	-0.02	±0.03
1983 June 11	201	t pv	+0.09	±0.02
1984 May 30	51	b v	+0.23	±0.04

There seems to be a clear trend of increasing solar radius since 1979, perhaps related to the 22-year sunspot cycle. There is a continuing need for measurements near both limits of future central eclipses by all three timing methods, to better assess possible systematic differences. Remarks about individual eclipses are given below:

1715: The observations, consisting of observers very close to the limits who reported an "instantaneous" or no eclipse, were organized by Edmund Halley in England. See Dunham *et al.* (1980) for the analysis and other references.

1925: The observations were made in the northeastern U.S.A. following a campaign inspired by Prof. E. W. Brown. The observations and analysis were published by Dunham *et al.* (1983).

1976: The observations were organized by IOTA member David Herald in southeastern Australia.

1979: The observations were organized by IOTA and made in the northwestern U.S.A. and Saskatchewan. The observations and analysis were published by Dunham *et al.* (1983).

1980: The observations were made in India by the Dunhams, A. Fiala (U.S. Naval Observatory), and D. Herald. A super-8 movie showing Baily's beads was obtained at the southern limit. The expedition was supported by the National Science Foundation and the Australian Council for Scientific and Industrial Research.

1981: The observations were organized by D. Herald in Tasmania. Fiala's attempt to videorecord Baily's beads was foiled by clouds.

1983: Java was the site of all observations, most of which were made by D. Herald (augmented by others) using visual projection near the northern limit and by A. Fiala videotaping a projected image near the southern limit. Although there were no videorecordings near the northern limit, and no visual projected-image timings at the southern limit, the results are in good agreement with direct visual observations made at both limits by Indonesians organized by Dr. Parkinson.

1984: This is a preliminary result based on analysis of D. Dunham's video recording of a projected image obtained at Fair Play, South Carolina. One station was sufficient for a solution, since the path was narrow and beads were recorded near both lunar poles. Dozens of other videorecordings were made of this eclipse. Visual observers were unable to keep up with the rapid changes of complex detail during this eclipse. A. Fiala and R. Schmidt are developing a realistic eclipse simulator with computer graphics at the U.S. Naval Observatory. It holds much promise in aiding identification of individual beads in the video records of this eclipse, so that those who made the observations can help with the analysis of their own data. We expect to send instructions, graphic material, and a copy of his own video tape with a 0.01-second time display inserted, to each observer who sent us a video tape.

Plans for expeditions to time Baily's beads near the edges of future eclipse paths have been described in "Eclipse News" articles in previous issues of *O.N.* Paul Maley is organizing the main IOTA tax-deductible efforts to observe the 1987 March 29th and September 23rd eclipses, from Gabon and China, respectively. He is working through Hanssen Tours travel agency; 3705 NASA Road One; Seabrook, TX 77586; telephone 713,326-3115. In early December, Hanssen Tours mailed four pages of information to many IOTA members, including detailed plans for March 29th, a reservation form, and writeups by Maley on his pre-eclipse survey report for the September eclipse in China, and a description of IOTA's solar eclipse science program.

References.

Dunham, D. W., Sofia, S., Fiala, A., Herald, D., and

Muller, P. M., "Observations of a Probable Change in the Solar Radius Between 1715 and 1979," *Science 210*, pp. 1243-1245 (1980).

Dunham, D. W., Sofia, S., Dunham, J. B., and Fiala, A., "Solar radius change between 1925 and 1979," *Nature 304*, pp. 522-526 (1983).

Fiala, A. D., Dunham, D. W., Dunham, J. B., and Sofia, S., "Solar Radius Variations Determined from Eight Solar Eclipses, 1715 - 1984," *Bull. Amer. Astron. Soc. 17*, p. 624 (1985).

GRAZING OCCULTATIONS

Don Stockbauer

Reports of successful lunar grazing occultations should be sent to me at 2846 Mayflower Landing; Webster, TX 77598; U.S.A. Also sending a copy to ILOC is greatly appreciated; their address is International Lunar Occultation Centre; Geodesy and Geophysics Division; Hydrographic Department; Tsukiji-5, Chuo-ku; Tokyo, 104 Japan.

Only five graze reports have been received since *O.N. 4* (2); I will wait until *O.N. 4* (4) to produce a full article and graze table.

A policy matter needs immediate mention, however. ILOC will only accept data on their own forms. David Dunham and I have decided that the person or group making the observations must be responsible for using ILOC's format and transcribing any old, non-standard reports to the ILOC format. I will help by providing ILOC forms and the explanation of their use. The problem exists with only one observer at present, but he is quite active.

GRAZING OCCULTATION PREDICTION CHANGES

David W. Dunham

The most important changes that have been made for the 1987 predictions incorporate empirical corrections that have been determined from graze observations during the past 3 years, and that have been described in previous issues of *O.N.* It is better to apply these corrections automatically, rather than relying on each of you to apply them manually. However, since the basis of the predictions is now a little different, there may be new empirical corrections (very small, I hope) that may need to be applied. Prompt reporting of graze observations during the first few months of 1987 will be important in determining any additional corrections and verifying the new system. Observations of southern-declination stars (especially those in Scorpius and Sagittarius) will be most valuable for this.

Most XZ source catalog information restored. The changes in the XZ catalog and the 80H version of OCC recover much of the stellar source positional data that were previously lost. The main thing to watch for is "position source G.C." The Albany General Catalog (G.C.) is very old and its positional accuracy is now very poor due to accumulated proper motion errors. For most of these stars, somewhat better data might be obtained from the Yale catalogs. If you are planning an expedition with five or more stations for a G.C.-source star, contact me, or Wayne Warren at the Astronomical Data Center, for a comparison with the Yale catalog, so that you might be warned of a possibly large shift. Some improvement can also sometimes be made for southern stars with source Z.C. The other sources are generally the best available for the star. Two new sources were added, including ZP70, where Z.C. and Perth 70 data have been combined, and PLDS, for stars in the Pleiades field (P-catalog), with improved positional information from Eichhorn's Pleiades catalog.

1987 limb correction data; possible problems with southern declinations. For the past several years, the limb correction data have been generated at USNO using the 78A version of T. Van Flandern's OCC program, with the virtually identical CMS 78B version being used since MVT was removed in September. Most of the large errors in the newer 80F and 80G versions of OCC were eliminated with the updated version 80H, which uses a new version of the XZ catalog that includes improved (Eichhorn) positional data for the Pleiades stars and corrects some other widespread star position problems that existed in the old XZ. Consequently, I feel that now is the time to switch to 80H, which is the only OCC version for which the FORTRAN source is available. However, in comparing 80H with 78A and 78B, I notice systematic graze height (profile VPC) differences when the Moon is in the southern sky, in the sense that the 78B Moon is north of the 80H Moon, by about 0.3 arc seconds at the southernmost declinations. This is unfortunate, since observations of grazes of a few southern FK4 stars made during the past couple of years seemed to be in very good agreement with 78A. Some additional datasets would need to be modified before the Pleiades and some other improved star position data could be utilized by the 78B version, so I am still recommending primary use of the 80H version. However, for the time being, we will generate limb correction data for the graze computors using both 80H and 78B versions, so that they might be able to generate 78B profiles for the southern stars, if that turns out to be really necessary. If systematic north shifts are confirmed, I will ask you to apply a north-shifting empirical correction until one can be incorporated into a future version of ACLPPP (the Automatic Computer Limb Profile Printing Program used to generate the profile predictions), possibly for the second half of 1987 predictions.

Specific changes made to the ACLPPP are listed below:

1. Change the empirical profile correction for northern-limit grazes from 0.08 arc seconds per degree of latitude libration to 0.043. This is closer to the 0.057 value for this quantity determined by Appleby and Morrison in "Analysis of lunar occultations – V. Grazing occultations 1964-1977" in *Mon. Not. Royal Astron. Soc. Vol. 205*, p. 62 (1983), and should eliminate the systematic north shifts that have occurred for northern-limit northern-declination grazes during the past few years.

2. Shift all observed graze data in the southern Cassini region between Watts angles 180 and 190 degrees south by 0.5 arc seconds, which will give better agreement with recent observations.

3. Print the observer's name, station, and ACLPPP version date at the top of each profile. This should facilitate the computor's job of separating the profiles for preparing the prediction mailings.

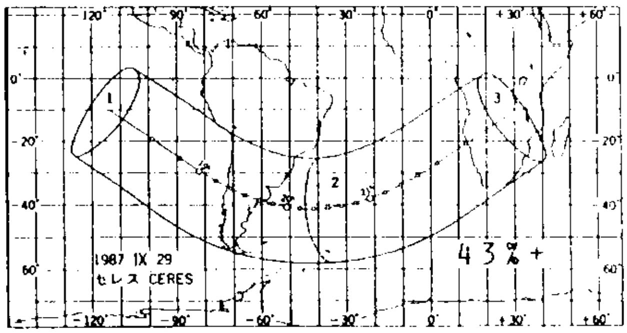
By noting the version, observers can tell which empirical corrections have been applied.

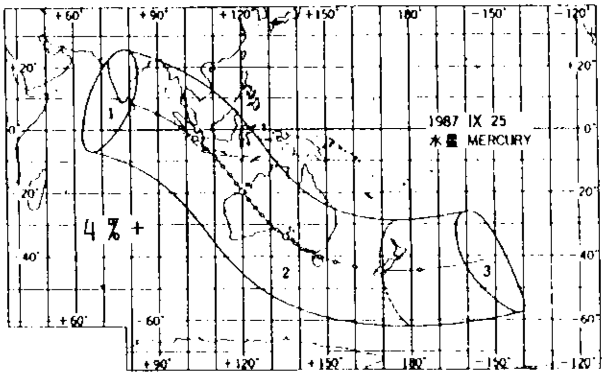
4. Print a message for profiles with special value to the right of the librations in the lower right part of the profile. "VALUABLE ECLIPSE RANGE" is printed if the absolute value of the libration is less than 1.o, and "VALUABLE SIGMA SCO RANGE" is printed when observations of the graze might be useful for determining the profile needed for an accurate analysis of the 1986 March 30th observations of the bright close double star Sigma Scorpii.

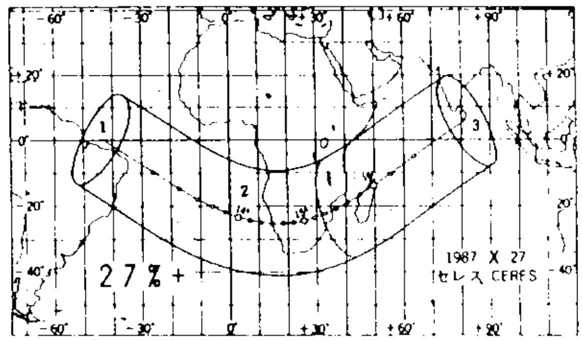
LUNAR OCCULTATIONS OF PLANETS

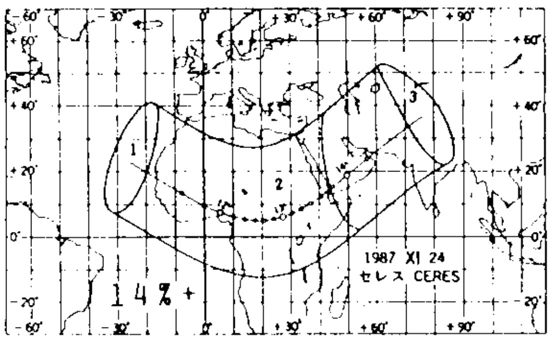
This is the continuation and completion of the article which began on *O.N.* *4* (2), 36. Please refer to that page for further details.

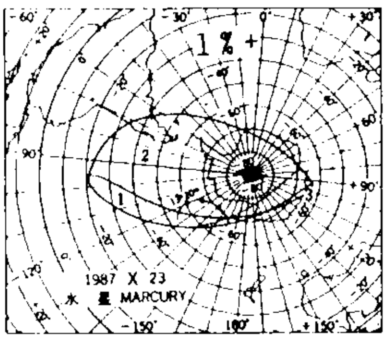
We thank the Hydrographic Department of the Maritime Safety Agency of Japan for permission to reproduce the maps here.

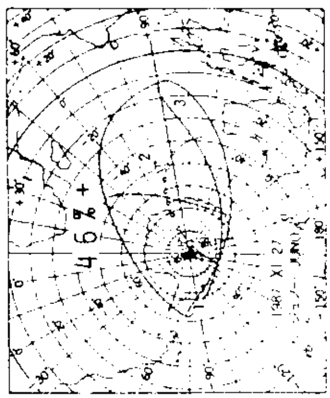












SOLAR SYSTEM OCCULTATIONS DURING 1987

David W. Dunham

Predictions of occultations of stars by major and minor planets, and by Comet Wilson, during 1987 are given in two tables below, which are presented in nearly the same format as those for last year's events published in *O.N.* *3* (14), 302 (December, 1985) and described in *O.N.* *4* (1) (July, 1986). The main difference is that the ephemeris source column has been moved from Table 1 to Table 2. It is now just to the left of the star position source column, S, which seems to be a more logical place for it. The names in the column are no longer in all capital letters. No values are listed under Δm for occultations by the major planets, since the extent of the planet, and the fact that events can occur against its dark side, make it meaningless. Similarly, no value is listed under the Table 2 RSOI column, since this is always greater than 99999 km and previously always overflowed the field allocated for it in the table. The tables are given on alternating pages, so that all data for a given event are available on facing pages. In addition to the data given in the tables, the finder charts, and regional and world maps appearing in *O.N.*, as well as information about local circumstances (appulse predictions) sent to IOTA members, are also described in the article in *O.N.* *4* (1), 6. No information relating to the estimated angular diameters of the occulted stars is given, as was the case for the 1986 events listed in *O.N.* *3* (14), since the effects are rarely observable or used. This information has been computed and is available upon request to me at P.O. Box 7488; Silver Spring, MD 20907; they would be of use for analysis of high signal-to-noise photoelectric records.

Local circumstance/appulse predictions. Joseph E. Carroll, 4261 Queen's Way; Minnetonka, MN 55345, computes the appulse predictions. Carroll's predictions are computed and listed in the same order as Tables 1 and 2 here. In all cases, when data are given for both components of a double star, the data for the primary (A-component) are listed first, regardless of the chronological order of the component appulses. I am considering changing the program for 1988 events, to drop the comparison-star information (which can be calculated, if needed, by adding the comparison data in Table 2 to the main appulse data) and replace it with the star's mag., the DM/ID number, and if space permits, the occultation Δm and duration. This should allow observers to rely more on the appulse list for their location with less reference back to the *O.N.* lists needed. Let me or Joe Carroll know if you have any other ideas about

Table 1, Part A

1987 DATE	Universal Time	PLANET Name	PLANET m_v	PLANET Δ,AU	STAR SAO No	STAR m_v	STAR Sp	R.A.(1950)	Dec.	Occultation Δm	Occultation Dur	Occultation df	P	Possible Area	El Sun	MOON El	MOON %Snl	MOON N Up
Jan 1	0h39m	Jupiter	-2.3	5.26	146607	9.5	G5	23h14m.1	-6°15'		2811s	18	2	e.N.America, S.America	67°	55°	1+	none
Jan 2	2 08-14m	Euterpe	10.3	1.35		10.7	F8	2 16.5	12 23	0.6	18	34	17	Colombia, Venezuela	115	88	6+	w 90°W
Jan 2	22 46-117	Metis	9.4	1.26		12.6		3 47.1	21 28	0.05	76	88	10	S. Africa, se U.S.A.	138	98	12+	w 50 W
Jan 2	23 46	Ada	15.6	3.73	183217	9.2	F0	15 6.1	-20 13	6.4	1	11	123	India	52	92	12+	none
Jan 3	4 57-73	Euterpe	10.3	1.36		10.5		2 17.2	12 28	0.7	17	32	17	Tuamoto Is., Ecuador	114	71	14+	w120 W
Jan 4	4 41	Herculina	9.8	1.98		11.9		12 47.9	11 38	0.15	12	15	13	Europe	96	150	22+	none
Jan 4	13 58	Aemilia	13.6	2.95		11.5		13 29.1	-4 19	2.3	7	16	30	Alaska, w. Canada	81	142	26+	none
Jan 10	6 10-20	Hektor	14.7	4.40	39472	7.3	K2	4 17.0	43 7	7.4	19	33	27	South America?n	136	23	80+	all
Jan 11	0 01	Venus	-4.5	0.64	159738	9.2	K0	16 6.6	-17 8		650	8	1	Indian O., s.cen. Asia	47	172	86+	none
Jan 11	13 21	Mars	0.7	1.43	109035	7.6	K2	0 6.3	0 25		224	8	1	India, eastern Asia	71	70	89+	all
Jan 11	19 57-76	Baptistina	13.6	1.13	59176	8.4	K5	6 28.2	34 54	5.2	2	25	97	Japan, USSR, n. Europe	161	22	91+	all
Jan 12	2 21-36	Victoria	11.4	1.87		10.9		4 6.1	16 1	1.0	40	79	20	Brazil,Bolivia,n.Chile	132	18	92+	all
Jan 12	7 15	Egeria	12.1	2.97	165881	8.6	F8	23 44.8	-10 5	3.6	8	11	18	n. central Siberia	62	89	93+	all
Jan 12	19 06-16	Ianthe	12.6	1.76		10.3		12 40.4	-0 28	2.4	8	20	24	India, Australia	102	103	95+	w125 E
Jan 12	19 47	Doris	12.7	3.20	158317	8.5	K2	14 1.2	-11 2	4.2	9	17	23	s.e. Asia, Philippines	80	125	95+	all
Jan 13	2 05	Alexandra	12.8	2.88	183058A	6.3	A4	14 55.7	-27 27	6.4	5	10	24	Zaire, Zambia, Zimbabwe	63	140	96+	w 30 E
Jan 13	2 04	Alexandra	12.8	2.88	183058B	6.6	A6	14 55.7	-27 27	6.1	5	10	24	Namibia, South Africa	63	140	96+	w 20 E
Jan 13	21 32-40	Meliboea	13.4	2.73	110807A	7.9	B9	2 50.0	6 16	5.5	26	55	26	Zaire, Kenya	109	59	98+	all
Jan 13	21 18-24	Meliboea	13.4	2.73	110807B	7.9	B9	2 50.0	6 16	5.5	26	55	26	South Africa?n	109	59	98+	all
Jan 14	0 07	Interamnia	10.9	2.21		11.2		8 28.2	9 8	0.6	23	20	9	South Africa?n	163	30	99+	all
Jan 19	0 05-13	Geldonia	15.7	2.82	158186	5.0	K0	13 47.1	-17 53	10.7	2	18	102	S. Africa?n; Antarctica	87	51	86-	n 80 S
Jan 20	16 31	Chaldaea	14.2	3.28		11.3		22 52.7	-7 9	2.9	3	9	44	Germany, Poland	42	159	73-	none
Jan 21	23 31-46	Eleonora	10.3	1.85	119356	9.3	K0	12 19.6	7 51	1.4	16	28	17	nw Africa,Mideast,USSR	119	20	60-	all
Jan 24	4 15	Polyxo	13.1	2.59		10.5		14 6.0	-11 49	2.7	8	18	27	Tierra del Fuego	90	16	36-	all
Jan 24	23 34-65	Papagena	10.1	1.63	58556A	8.0	B5	5 51.0	30 29	2.3	24	42	16	Africa,Canaries,ne USA	144	152	28-	e 25 E
Jan 24	23 50-65	Papagena	10.1	1.63	58556B	9.5		5 51.0	30 29	1.1	24	42	16	Pakistan,s.cen.&ne USSR	143	152	28-	e 60 E
Jan 25	6 20	Frigga	14.1	3.07	159089	6.7	K0	15 9.4	-18 55	7.3	3	15	68	Canary Is.; Iberia?n	74	14	25-	all
Jan 25	10 37-53	Urania	10.4	1.37		9.1	K0	8 47.8	17 53	1.6	9	21	21	Bahamas,USA,Amur River	175	117	23-	e110 W
Jan 27	21 26-33	Interamnia	10.9	2.21		11.1		8 15.5	8 53	0.7	22	19	9	USSR, n. Europe, U.K.	169	154	4-	none
Jan 27	21 50-58	Interamnia	10.9	2.21		11.0		8 15.5	8 53	0.7	22	19	9	(n. USSR, n. Europe)?s	169	154	4-	none
Feb 1	11 05	Metis	10.1	1.55		11.7		3 55.9	22 57	0.2	21	27	12	se Australia, N. Z.	110	71	11+	w150 E
Feb 2	1 08-26	Athamantis	10.7	1.47	117251	8.9	F8	8 51.8	1 50	1.9	11	21	16	Africa, S.&Cen.America	165	133	16+	w 65 W
Feb 3	16 07	Euphrosyne	13.5	4.51	228984	9.5	A2	18 20.7	-41 44	4.0	7	11	24	central Pacific; HI?n	43	106	30+	none
Feb 6	15 35-45	Ausonia	11.1	1.58		9.8	G0	10 51.7	8 16	1.6	10	27	24	New Zealand, Australia	156	103	59+	w120 E
Feb 7	9 30-60	Camilla	12.0	2.48		10.9		5 51.4	11 13	1.4	44	55	14	cen.Pacific,e. Siberia	129	27	66+	all
Feb 8	18 18	Vesta	8.3	2.85		12.0		1 24.6	2 48	0.03	18	11	7	northern Africa	62	63	78+	all
Feb 9	3 00-100	Hygiea	10.9	2.85		11.4		5 8.7	23 45	0.5	319	240	9	w.Canada, e.Pacific O.	119	10	81+	all
Feb 11	19 09-21	Herculina	9.2	1.57		12.1		13 22.2	15 15	0.07	25	28	10	w. India, central USSR	126	73	96+	all
Feb 11	19 26-40	Herculina	9.2	1.57		12.0		13 22.2	15 15	0.08	25	28	10	w.Austral.,w.Irian,Guam	126	73	96+	all
Feb 12	7 20-32	Ausonia	10.9	1.55		10.4		10 47.0	8 32	1.1	9	23	24	Portugal,Canada,Alaska	163	35	98+	all
Feb 13	18 50-110	Parthenope	11.0	1.94		9.8		6 5.0	21 37	1.5	63	111	18	India, central USSR	127	53	100-	all
Feb 13	23 58	Venus	-4.2	0.89	187189	7.3	K0	18 40.6	-20 58		398	6	1	Indian O.,India,w.China	45	133	100-	all
Feb 14	2 47-65	Ausonia	10.9	1.54		9.9	G5	10 45.3	8 37	1.4	9	23	24	n.Africa,Canaries,USA	165	13	100-	all
Feb 16	9 42	Venus	-4.2	0.91	187453	9.2	A0	18 52.3	-20 54		388	6	1	Bermuda,W.Indies,nwS.Amer.	44	106	94-	all
Feb 16	17 05-25	Camilla	12.1	2.58		11.9		5 50.9	11 50	0.9	47	59	15	e.Africa,Mideast,w.USSR	120	92	92-	none
Feb 16	22 43-48	Fortuna	11.1	1.89		10.3	F8	3 54.9	18 47	1.2	13	15	12	Nova Scotia, sw. Europe	93	122	91-	e 30 E
Feb 17	7 11-17	Lutetia	11.5	1.84		10.2	A0	10 2.7	16 36	1.6	8	19	23	Azores?s; n. Canada	176	40	88-	all
Feb 19	12 15-16	Venus	-4.2	0.93	187769	8.3	G5	19 7.6	-20 45		376	6	1	Mexico, central U.S.A.	44	70	70-	all
Feb 22	8 23	Hera	12.8	2.57	159817	9.5	F5	16 12.9	-15 19	3.4	5	17	42	se Canada, Maine	89	15	39-	e 80 W
Feb 22	13 49-55	Dunham	17.6	1.80		11.4		9 7.9	17 29	6.2	1	22	200	Australia?n	161	124	36-	e140 E
Feb 22	14 04-20	Hygiea	11.1	3.02		12.2		5 10.5	23 35	0.3	75	58	10	China, Taiwan	106	176	36-	none

this.

Coverage for early 1987. The tables cover events only through late July. Tables including events for the rest of the year will be published in the next issue, scheduled for distribution near the end of 1987 February. Finder charts are included here only for the better North American and European events through March, especially for events not included in Goffin's supplements. Only 1° Astrographic-Catalog-based charts are included for occultations of northern stars fainter than mag. 8.5, if Goffin includes the event in his predictions (almost always the case for these stars; the *O.N.* page reference is given at the bottom of Goffin's large chart). David Werner added constellation boundaries, and Bayer Greek letter and Flamsteed numerical designations for the stars, to all of the small 15° charts, and stellar designations, when appropriate, to most of the large charts as well. We have not received Sôma's world maps for 1987 in time for inclusion in this issue. We expect to publish them in the next issue. In the meantime, when possible, rely on the similar maps in Goffin's supplement. Regional maps for the events

Table 2, Part A

1987	MINOR	PLANET					MOTION		STAR			Ephem.		COMPARISON DATA			APPARENT	
DATE	No.	Name	km-diam.	"	RSOI	Type	°/Day	PA	SAO No	DM/ID No	D	Source	S	AGK3 No	Shift	Time	R.A.	Dec.
Jan 1		Jupiter	140904	18.48			0.158	66°	146607	− 6°6178			XS				$23^h16^m.0$	−6° 3'
Jan 2	27	Euterpe	118	0.12	327	S	0.164	63		+11 317		EMP 1987	XA	N12 244			2 18.5	12 33
Jan 2	9	Metis	190	0.21	707	S	0.066	301				Branham	C				3 49.3	21 35
Jan 2	523	Ada	44	0.02	121		0.295	106	183217	−19 4033	A	EMP 1986	XS				15 8.2	−20 21
Jan 3	27	Euterpe	118	0.12	327	S	0.173	64		A1218038		EMP 1987	C				2 19.2	12 39
Jan 4	532	Herculina	217	0.15	950	S	0.311	84				Herget	C				12 49.8	11 26
Jan 4	159	Aemilia	141	0.07	639	C	0.236	103		L 2 2488		EMP 1982	H				13 31.0	−4 31
Jan 10	624	Hektor	234	0.07	2378	D	0.094	227	39472	+42 939		EMP 1975	RA	N43 453	−0.33	0.6	4 19.6	43 13
Jan 11		Venus	12220	26.51			0.979	102	159738	−16 4229			XS				16 8.7	−17 14
Jan 11		Mars	6782	6.53			0.699	65	109035	− 0 6			RZ	N 0 11	0.03	−0.0	0 8.2	0 37
Jan 11	298	Baptistina	17	0.02	19		0.243	265	59176	+34 1377		EMP 1986	A	N34 708			6 30.7	34 53
Jan 12	12	Victoria	135	0.10	532	S	0.060	247				Herget77	C				4 8.2	16 7
Jan 12	13	Egeria	245	0.11	1307	C	0.351	53	165881	−10 6168		Herget77	S				23 46.6	−9 53
Jan 12	98	Ianthe	106	0.08	308	C	0.245	133		L 2 6		EMP 1986	H				12 42.3	−0 42
Jan 12	48	Doris	200	0.09	1154	C	0.218	104	158317	−10 3812		Herget77	XS				14 3.2	−11 13
Jan 13	54	Alexandra	177	0.08	785	C	0.380	115	183058	C2710148	A	Herget78	PY		−0.22	0.2	14 57.9	−27 36
Jan 13	54	Alexandra	177	0.08	785	C	0.380	115	183058	C2710148	B	Herget78	P				14 57.9	−27 36
Jan 13	137	Meliboea	153	0.08	779	C	0.072	62	110807	+ 5 406	A	EMP 1982	AG	N 6 296	0.28	−5.5	2 52.0	6 25
Jan 13	137	Meliboea	153	0.08	779	C	0.072	62	110807	+ 5 406	B	EMP 1982	A	N 6 296			2 52.0	6 25
Jan 14	704	Interamnia	338	0.21	2534	F	0.222	263				Schmadel	C				8 30.3	9 1
Jan 19	1199	Geldonia	40	0.02	95	C	0.215	113	158186	−17 3937		EMP 1986	F				13 49.2	−18 4
Jan 20	313	Chaldaea	108	0.05	381	C	0.385	73		B 752041		Herget78	C				22 54.6	−6 57
Jan 21	354	Eleonora	156	0.12	623	S	0.170	43	119356	+ 8 2592		Herget78	RA	N 7 1627	−0.13	−0.4	12 21.5	7 38
Jan 24	308	Polyxo	139	0.07	583	DU	0.222	104		B12 271		EMP 1981	C				14 8.0	−12 0
Jan 24	471	Papagena	145	0.12	561	S	0.123	300	58556	+30 1045	A	EMP 1980	G				5 53.4	30 30
Jan 25	471	Papagena	145	0.12	561	S	0.123	300	58556	+30 1045	B	EMP 1980	G				5 53.4	30 30
Jan 25	77	Frigga	66	0.03	204	M	0.253	108	159089	−18 3997		EMP 1986	7P		0.16	−0.4	15 11.4	−19 4
Jan 25	30	Urania	95	0.10	280	S	0.264	282		+18 2056		Herget78	XA	N17 955	−0.08	1.8	8 49.9	17 44
Jan 27	704	Interamnia	338	0.21	2549	F	0.227	268				Schmadel	C				8 17.5	8 46
Jan 27	704	Interamnia	338	0.21	2549	F	0.227	268				Schmadel	C				8 17.5	8 46
Feb 1	9	Metis	190	0.17	710	S	0.194	71				Branham	C				3 58.1	23 4
Feb 2	230	Athamantis	130	0.12	466	S	0.257	281	117251	+ 2 2093		EMP 1980	AS	N 1 1130	0.18	−0.5	8 53.7	1 42
Feb 3	31	Euphrosyne	270	0.08	2202	C	0.273	102	228984	P41 8659		EMP 1980	S				18 23.3	−41 43
Feb 6	63	Ausonia	94	0.08	295	S	0.196	282		+ 8 2428		Herget78	XA	N 8 1429	0.09	0.8	10 53.7	8 4
Feb 7	107	Camilla	252	0.14	1645	C	0.076	328				EMP 1986	C				5 53.5	11 13
Feb 8	4	Vesta	555	0.27	4266	U	0.366	63				APAENAXX	C				1 26.5	3 0
Feb 9	10	Hygiea	443	0.21	4125	C	0.016	63				Schmadel	C				5 11.0	23 48
Feb 11	532	Herculina	217	0.19	943	S	0.185	33				Herget	C				13 24.1	15 3
Feb 11	532	Herculina	217	0.19	943	S	0.185	33				Herget	C				13 24.1	15 3
Feb 12	63	Ausonia	94	0.08	295	S	0.226	283				Herget77	C				10 48.9	8 20
Feb 13	11	Parthenope	155	0.11	660	S	0.042	322		L 1 122		Herget78	HC		−0.73	12.7	6 7.2	21 37
Feb 14		Venus	12220	18.87			1.138	89	187189	−21 5118			H7		0.25	−0.1	18 42.8	−20 56
Feb 14	63	Ausonia	94	0.08	294	S	0.234	283		+ 9 2409		Herget78	XA	N 8 1416	0.17	1.3	10 47.3	8 25
Feb 16		Venus	12220	18.50			1.144	88	187453	−21 5183			XS				18 54.5	−20 52
Feb 16	107	Camilla	252	0.13	1644	C	0.068	10				EMP 1986	C				5 53.0	11 50
Feb 16	19	Fortuna	226	0.17	955	C	0.312	77		+18 565		EMP 1981	XA	N18 303	0.04	−0.1	3 57.1	18 54
Feb 17	21	Lutetia	114	0.09	443	M	0.250	292		+17 2170		EMP 1984	XA	N16 1079	0.06	0.0	10 4.8	16 26
Feb 19		Venus	12220	18.05			1.151	87	187769	−20 5418			XS				19 9.7	−20 42
Feb 22	103	Hera	88	0.05	290	S	0.238	93	159817	−15 4282		Herget78	XS				16 15.0	−15 25
Feb 22	3123	Dunham	13	0.01	17		0.218	289				EMP 1986	C				9 10.0	17 20
Feb 22	10	Hygiea	443	0.20	4115	C	0.065	98				Schmadel	C				5 12.8	23 38

most favorable for Europe and North America through March, especially for those events not included in Goffin's predictions, are reproduced at the end of this article. Goffin's and my calculations are now in rather good agreement; remaining differences in predicted ground tracks are due to different stellar and asteroidal ephemeris data. Only one caution: For Goffin's events in early January and late December, check the year. Two events sequenced in January, 1987, on the 5th, actually occur in 1988, while a few events sequenced in December, 1987, on the 22nd and 23rd, actually occurred in 1986. These have been removed from the 1987 North American supplement.

Table creation. The basic data in the tables were generated with my slightly modified MPOCC program that put the data into a file on a disk attached to

Table 1, Part B

1987 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 Up
Feb 22	23h29m	Venus	-4.2	0.96	188147	8.4	A3	19h24m6	-20°28'		364s	6	1	India, Indian Ocean	44°	26°	32-	all
Feb 23	7 06	Venus	-4.2	0.96	188180	9.1	K0	19 26.2	-20 26		363	6	1	eastern South America	43	22	29-	all
Feb 23	21 46	Ausonia	10.7	1.51		11.8		10 35.7	9 10	0.3	8	20	23	southern Africa	177	121	22-	e 55°E
Feb 25	17 00	Venus	-4.2	0.98	188440	9.2	F8	19 38.1	-20 10		355	6	1	New Zealand	43	13	8-	all
Feb 26	22 44	Venus	-4.2	0.99	188563	8.5	G0	19 44.2	-20 0		352	6	1	southeastern Asia	43	29	2-	e 95 E
Feb 27	0 00	Venus	-4.2	0.99	162984	9.0	K2	19 44.4	-20 0		351	6	1	n. India, s.cen. USSR	43	29	2-	none
Feb 28	2 11-30m	Sylvia	12.8	3.17		12.1		5 38.0	29 5	1.2	47	60	17	Mexico, W. Indies	107	106	0+	none
Mar 6	20 38	Venus	-4.1	1.04	163559	8.1	A2	20 23.0	-18 39		330	5	1	Korea, Japan	42	124	44+	none
Mar 7	8 40	Ceres	8.8	2.79	185847	9.3	G5	17 48.2	-20 57	0.6	42	15	4	southeastern Canada?s	78	165	49+	none
Mar 7	11 26	Hestia	13.5	2.49		11.8		3 59.8	18 15	1.9	5	12	27	Australia?n	76	16	50+	all
Mar 8	23 37-53	Ariadne	12.8	2.09	78208	8.1	K0	6 15.7	21 12	4.8	12	43	39	e. Canada, s.w. Europe	106	7	64+	all
Mar 9	18 56-72	Patientia	11.3	2.18		12.5		12 43.0	19 20	0.3	22	23	11	Austral., India, n.Africa	154	78	71+	w100 E
Mar 10	11 03	Patientia	11.3	2.18		12.7		12 42.6	19 25	0.3	22	23	11	(N.Z., se Australia)?n	155	70	77+	all
Mar 11	8 26-34	Camilla	12.4	2.87		13.6		5 57.5	13 20	0.3	20	27	17	southern Pacific Ocean	100	36	83+	all
Mar 11	14 28	Parthenope	11.5	2.27		10.5		6 11.6	22 22	1.4	16	31	21	(n. Canada, Alaska)?s	103	33	85+	all
Mar 12	12 22-39	Desiderata	11.7	1.64	100323	7.0	K0	12 51.3	19 20	4.7	13	22	16	Easter&Jarvis Is., Sabah	154	50	91+	w130 W
Mar 13	17 47	Ekard	13.7	2.36		11.1		17 34.4	-20 4	2.7	5	14	34	Australia	88	113	97+	all
Mar 14	15 17-25	Psyche	10.6	2.26		11.0		10 37.6	9 41	0.6	19	22	13	Hawaii?s; e. Siberia	164	5	99+	all
Mar 16	9 32-40	Herculina	8.7	1.37	82806	7.5	K0	13 20.0	20 57	1.5	25	27	9	Cook & Solomon Is., Samoa	149	27	99-	all
Mar 16	15 29-42	Davida	11.0	2.30	100625	7.4	K0	13 31.9	14 22	3.7	27	24	10	NZ,PNG,PI,se Asia,India	150	23	99-	all
Mar 21	12 36	Hygiea	11.3	3.40		11.0		5 24.9	23 29	0.9	25	20	11	eastern Siberia	82	171	63-	none
Mar 23	3 54	Fortuna	11.6	2.34		9.8	A5	4 47.4	21 0	2.0	8	10	15	Mexico?n	72	154	45-	none
Mar 23	7 48	Hestia	13.6	2.71		13.3		4 23.4	19 26	0.9	4	11	30	Samoa; New Zealand?s	66	146	43-	none
Mar 24	7 55	Hestia	13.6	2.72		13.6		4 25.0	19 30	0.8	4	11	30	Gilbert & Phoenix Is.	65	133	31-	none
Mar 25	15 27	Mars	1.4	2.03	93396	8.0	A0	3 17.7	19 0		164	7	1	Seychelles, India	48	99	18-	none
Mar 25	21 55	Venus	-4.0	1.17	164761	8.7	G5	21 54.3	-13 13		288	5	1	China, se Asia, Indonesia	38	10	16-	all
Mar 26	10 17-32	Patientia	11.3	2.18		12.4		12 30.6	20 53	0.3	21	22	11	(Mexico,Hawaii,Japan)?n	157	143	12-	e100 W
Mar 26	17 58-67	Hermione	13.1	3.01	158896	8.4	A2	14 52.8	-10 5	4.8	23	39	22	NZ,Austral.,Seychelles	141	106	10-	e135 E
Mar 27	6 53	Victoria	12.6	2.95		11.6		4 52.9	17 37	1.4	5	13	32	southern Pacific Ocean	68	97	6-	none
Mar 31	6 25	Camilla	12.6	3.15		13.3		6 11.3	14 29	0.5	12	17	18	southern Pacific Ocean	83	63	3+	none
Mar 31	7 42	Camilla	12.6	3.15		10.2		6 11.3	14 29	2.5	12	17	18	New Zealand	83	62	4+	w165 E
Mar 31	18 22	Parthenope	11.8	2.55		12.7		6 27.9	22 43	0.4	9	18	24	northern Africa, Arabia	86	59	6+	w 25 E
Apr 3	4 31	Hygiea	11.4	3.57		12.0		5 35.7	23 29	0.5	19	16	12	southern Pacific Ocean	72	17	22+	w122 W
Apr 4	20 41	Venus	-4.0	1.24	146267	8.6	K0	22 40.4	-9 25		272	5	1	seChina,Java,w.Australia	36	110	36+	none
Apr 6	14 46	Sylvia	13.2	3.75		12.6		6 1.2	29 10	1.1	12	17	20	China	75	19	53+	all
Apr 7	4 51	Parthenope	11.9	2.64	78561	7.6	K2	6 34.6	22 46	4.3	8	16	25	Mexico	82	19	58+	all
Apr 7	14 47-60	Psyche	11.0	2.44		13.3		10 24.5	11 11	0.13	37	46	14	Taiwan, China	137	33	62+	all
Apr 7	16 48	Parthenope	11.9	2.64		11.6		6 35.2	22 46	0.9	8	16	25	Tanzania, Seychelles	81	24	63+	all
Apr 7	19 40	Cybele	12.9	3.29		10.7		8 6.8	18 52	2.3	32	50	21	South Africa?n	103	7	64+	all
Apr 7	22 25	Iris	10.8	2.60		10.9		19 41.5	-20 9	0.7	11	15	17	Sri Lanka	83	168	65+	none
Apr 8	15 10-19	Pallas	8.9	2.11		10.2		16 22.8	18 27	0.3	32	17	6	e.Australia,PNG,e.China	25	100	71+	all
Apr 8	17 59	Camilla	12.7	3.26		12.0		6 19.0	14 52	1.1	11	15	19	South Africa?n	77	42	72+	all
Apr 9	8 50	Metis	11.0	2.34		11.2		5 36.7	26 45	0.6	6	10	18	southeastern Australia	66	57	78+	all
Apr 11	5 06	Baptistina	15.1	1.89	79112	8.5	A0	7 6.1	28 8	6.6	1	13	161	eastern Canada, Maine	84	60	91+	all
Apr 11	8 27	Metis	11.0	2.36	77464	9.1	B8	5 40.7	26 48	2.1	6	10	18	Australia?n	65	81	92+	all
Apr 12	11 59-64	Aurora	13.0	2.93	79517	7.4	K2	7 31.6	28 37	5.7	11	19	22	se China,Luzon,Melanesia	89	72	97+	all
Apr 13	1 06	Fortuna	11.8	2.60		9.5		5 25.2	21 53	2.4	7	9	17	(ne Canada, Greenland)?s	60	107	99+	all
Apr 16	1 01	Ceres	8.4	2.28		10.9	A6	18 19.6	-22 11	0.10	144	45	4	southwestern U.S.S.R.	110	45	95-	all
Apr 17	5 17-25	Ceres	8.4	2.27		11.5	F1	18 20.0	-22 14	0.06	154	48	3	Canary Is., w. Africa	112	28	88-	all
Apr 18	17 52	Aeternitas	13.6	2.60		9.5	F8	21 26.8	-25 9	4.1	2	11	57	nw Pacific Ocean?s	72	47	74-	all
Apr 22	2 32-49	Ekard	12.9	1.74	161166	8.1	B2	18 9.0	-15 42	4.8	10	27	25	Brazil,nwAfr.,cen.Europe	118	46	37-	e 20 W

the mainframe computer. I downloaded the file to a PC diskette, and used the PC word processors to change most capital letters to lower case, move some of the column data for clarity, and add the U.T. minutes, predicted location, and "Moon Up" columns. The table was then typed with our daisy wheel printer. The editor then only needed to add underlines and a few symbols to the headings and first lines of each table.

A few changes have been made in the data, imposed by the combined catalog, described below, used for my calculations. The first character in the zone in the DM/ID No. column of Table 2 has the following meaning:

character	identification
+	B.D. (Bonner Durchmusterung)
-	B.D. (usually the southern part, sometimes called S.D.)
C	C.D. (Cordoba Durchmusterung; –)
P	Cape Photographic Duchmusterung (–)
L	Lick Voyager catalogs, see also below.

Table 2, Part B

1987 DATE	No.	MINOR PLANET Name	km-diam.	-"	RSOI	Type	MOTION °/Day	PA	STAR SAO No	DM/ID No	D	Ephem. Source	S	COMPARISON DATA AGK3	No	Shift	Time	APPARENT R.A.	Dec.
Feb 22		Venus	12220	17.57			1.158	85°	188147	-20°5559			7P			0.04	-0.4	19h26.8m	-20°24'
Feb 23		Venus	12220	17.53			1.159	85	188180	-20 5571			XS					19 28.4	-20 22
Feb 23	63	Ausonia	94	0.09	293	S	0.262	283				Herget77	C					10 37.7	8 59
Feb 25		Venus	12220	17.22			1.163	84	188440	-20 5652			HX			-1.25	-0.1	19 40.2	-20 5
Feb 26		Venus	12220	17.06			1.165	83	188563	-20 5705	M		7P			-0.06	-0.0	19 46.3	-19 55
Feb 27		Venus	12220	17.06			1.165	83		-20 5708			HX			-0.83	0.0	19 46.6	-19 55
Feb 28	87	Sylvia	275	0.12	2106	P	0.061	87				Herget78	C					5 40.4	29 6
Mar 6		Venus	12220	16.14			1.176	80	163559	-18 5680			HX			-0.19	-0.3	20 25.1	-18 32
Mar 7	1	Ceres	946	0.47	10362	C	0.266	97	185847	-20 4888		APAENAXX	XS					17 50.4	-20 58
Mar 7	46	Hestia	133	0.07	482	F	0.344	77				Yeomans	C					4 2.0	18 22
Mar 8	43	Ariadne	78	0.05	227	S	0.104	92	78208	+21 1190		Herget77	RX	N21	648			6 17.9	21 11
Mar 9	451	Patientia	281	0.18	1886	C	0.192	305				Herget78	C					12 44.9	19 8
Mar 10	451	Patientia	281	0.18	1886	C	0.193	305				Herget78	C					12 44.5	19 12
Mar 11	107	Camilla	252	0.12	1644	C	0.142	63				EMP 1986	C					5 59.6	13 21
Mar 11	11	Parthenope	155	0.09	664	S	0.140	80		A2247308		Herget78	C					6 13.9	22 21
Mar 12	344	Desiderata	147	0.12	589	C	0.231	292	100323	+19 2614		EMP 1981	RA	N19	1247	-0.15	0.2	12 53.2	19 7
Mar 13	694	Ekard	100	0.06	326	C	0.294	75		B2166509		EMP 1986	C					17 36.6	-20 6
Mar 14	16	Psyche	249	0.15	1633	M	0.195	295				Herget79	C					10 39.6	9 30
Mar 16	532	Herculina	217	0.22	941	S	0.207	323	82806	+21 2519		Herget	RA	N20	1415	0.63	0.8	13 21.8	20 46
Mar 16	511	Davida	335	0.20	2532	C	0.180	311	100625	+14 2636		EMP 1982	RA	N14	1386	0.49	-0.2	13 33.7	14 10
Mar 21	10	Hygiea	443	0.18	4092	C	0.175	90				Schmadel	C					5 27.2	23 31
Mar 23	19	Fortuna	226	0.13	977	C	0.407	82		+20 830		EMP 1981	XA	N20	449	0.05	-0.0	4 49.6	21 4
Mar 23	46	Hestia	133	0.07	488	F	0.374	79				Yeomans	C					4 25.6	19 31
Mar 24	46	Hestia	133	0.07	489	F	0.376	79				Yeomans	C					4 27.2	19 35
Mar 25		Mars	6782	4.62			0.676	74	93396	+18 461	T		AG	N19	259	0.02	0.0	3 19.8	19 8
Mar 25		Venus	12220	14.35			1.194	73	164761	-13 6055			XS					21 56.3	-13 3
Mar 26	451	Patientia	281	0.18	1893	C	0.199	290				Herget78	C					12 32.5	20 40
Mar 26	121	Hermione	201	0.09	1407	C	0.097	289	158896	- 9 4029		EMP 1983	XS					14 54.8	-10 14
Mar 27	12	Victoria	135	0.06	555	S	0.295	83				Herget77	C					4 55.0	17 41
Mar 31	107	Camilla	252	0.11	1644	C	0.212	76				EMP 1986	C					6 13.4	14 28
Mar 31	107	Camilla	252	0.11	1644	C	0.212	76				EMP 1986	C					6 13.4	14 28
Mar 31	11	Parthenope	155	0.08	666	S	0.230	88		A2349406		Herget78	C					6 30.1	22 41
Apr 3	10	Hygiea	443	0.17	4080	C	0.214	90				Schmadel	C					5 38.0	23 30
Apr 4		Venus	12220	13.60			1.199	70	146267	- 9 6037			ZS					22 42.3	-9 13
Apr 6	87	Sylvia	275	0.10	2121	P	0.197	90				Herget78	C					6 3.6	29 10
Apr 7	11	Parthenope	155	0.08	666	S	0.253	89	78561	+22 1410		Herget78	HX	N22	739	0.21	-0.5	6 36.9	22 44
Apr 7	16	Psyche	249	0.14	1642	M	0.091	295				Herget79	C					10 26.5	10 59
Apr 7	11	Parthenope	155	0.08	667	S	0.255	89		A2350548		Herget78	C					6 37.4	22 44
Apr 7	65	Cybele	230	0.10	1637	C	0.072	90				Herget78	C					8 8.9	18 46
Apr 7	7	Iris	222	0.12	1139	S	0.265	74		L 5 832		Branham	H					19 43.7	-20 3
Apr 8	2	Pallas	533	0.35	4456	U	0.261	349				Landgraf	C					16 24.5	18 22
Apr 8	107	Camilla	252	0.11	1644	C	0.237	80				EMP 1986	C					6 21.1	14 51
Apr 9	9	Metis	190	0.11	723	S	0.443	87				Branham	C					5 39.0	26 46
Apr 11	298	Baptistina	17	0.01	19		0.378	105	79112	+28 1320		EMP 1986	XA	N28	756	0.03	0.2	7 8.5	28 5
Apr 11	9	Metis	190	0.11	723	S	0.446	87	77464	+26 925		Branham	X					5 43.0	26 49
Apr 12	94	Aurora	191	0.09	1046	C	0.196	113	79517	+28 1417		EMP 1981	AS	N28	812	-0.02	1.1	7 33.9	28 32
Apr 13	19	Fortuna	226	0.12	992	C	0.437	86		A2241308		EMP 1981	C					5 27.4	21 55
Apr 16	1	Ceres	946	0.57	10482	C	0.095	113		C2212902		APAENAXX	HC			-0.98	-1.4	18 21.8	-22 11
Apr 17	1	Ceres	946	0.57	10485	C	0.090	115		L 3 6421		APAENAXX	HC			0.09	0.2	18 22.3	-22 13
Apr 18	446	Aeternitas	66	0.04	171	A	0.370	81		C2515451		Herget78	Y					21 28.9	-24 60
Apr 22	694	Ekard	100	0.08	308	C	0.185	37	161166	-15 4856		EMP 1986	HS			-0.21	-1.1	18 11.1	-15 41

The five Lick "zones" are as follows; the number within the zone is sequential in 1950 R.A.)

L 1 Lick Jupiter, formerly LJ (Gem, Cnc)
L 2 Lick Saturn, formerly LS (Leo, Vir)
L 3 Lick Uranus pre-encounter (Sgr)
L 4 Lick Uranus post-encounter (Gemini)
L 5 Lick Neptune (Capricornus)

A Northern Astrographic Catalog (AC, +) The first 2 digits usually are the R.A.-sequential plate no. in the zone, while the last 3 are the number on the plate.
B Southern AC (− zones); the number is usually sequential throughout the zone, approximately by R.A.
Q Measured from a Palomar Schmidt plate (only a few in Scorpius, none in 1987)

Table 1, Part C

1987 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 Up
Apr 22	2^h50^m–57^m	Leto	11.5	2.20	188000	8.6	K0	$19^h17^m.9$	−28°36'	2.9	10^s	23	25	Canaries, n.Africa, Kenya	104°	29°	37−	e 10°W
Apr 27	20 33–93	Ceres	8.2	2.15		11.7	K4	18 22.3	−22 41	0.04	299	91	3	India, Antarctica	121	119	0−	none
Apr 28	8 25	Chiron	16.6	13.90		10.5		5 9.2	17 43	6.1	13	25	50	Aleutians; Australia?s	41	38	0+	none
Apr 29	11 57–06	Aemilia	12.7	2.12		12.2		13 21.0	0 34	1.1	13	26	22	(N.Z., Australia)?n	159	142	2+	none
Apr 30	11 23	Hygiea	11.5	3.90		11.1		6 5.2	23 20	1.0	14	12	13	Western Australia	52	25	6+	w115 E
May 2	21 03	Sylvia	13.4	4.11		9.6		6 28.6	29 1	3.8	9	13	22	ne Russia; w.Europe?s	55	1	21+	all
May 3	8 39–61	Alexandra	11.0	1.46	226775	8.6	B8	16 23.6	−40 27	2.5	30	41	12	se USA, e.Mexico, HI?n	146	147	25+	w155 W
May 6	7 31	Com.Wilson	10.	0.65	249745	10.2	A8	7 7.7	−60 46	0.7	2	2	9	e.Antarctica;S.Africa?n	92	85	52+	n 65 S
May 6	11 45	Camilla	12.8	3.62		12.3		6 49.9	15 39	1.1	8	11	21	Kamchatka; Japan?s	58	39	54+	all
May 9	17 54–69	Hera	11.4	1.70	159932	6.8	G5	16 25.7	−13 17	4.6	9	27	28	Antarctica; S.Africa?n	160	67	83+	w130 E
May 11	10 28	Com.Wilson	10.	0.73	219034	5.8	B2	7 47.7	−46 44	4.	2	3	11	S.GeorgiaI.;Antarctica?s	90	78	94+	none
May 12	0 38	Germania	13.6	3.85	78178	9.0	B3	6 13.9	22 13	4.6	5	10	30	Delmarva Pen., Bermuda	43	117	97+	all
May 12	1 22	Camilla	12.9	3.68		11.3		6 56.9	15 43	1.8	7	11	21	Canadian Maritime Prov.	54	107	97+	all
May 12	9 46–56	Dynamene	13.1	2.16	208693	9.5	K0	17 16.7	−32 29	3.6	14	30	23	USA, nw Mexico, HI?s	149	45	98+	w 85 W
May 12	16 33	Com.Wilson	10.	0.75	219144	10.5	A2	7 53.6	−43 45	0.6	2	3	11	swAustral.?s;Indian O.	89	84	99+	all
May 13	3 06	Interamnia	12.3	3.46		11.1		8 16.0	8 22	1.5	15	16	15	southeastern Canada	73	101	100+	all
May 14	19 53–69	Edda	14.1	1.82	159480	7.7	A3	15 42.5	−18 57	6.3	5	23	49	Indonesia,Ind.O.,n.Afr.	175	14	97−	e 5 E
May 15	4 10	Siegena	12.9	3.24		11.9		8 5.0	11 16	1.4	7	13	23	Mexico?n	68	133	96−	all
May 16	4 50	Meliboea	14.3	4.36	94171A	6.6	F5	4 49.0	13 34	7.7	4	10	41	se Caroline Islands	20	157	90−	none
May 16	4 51	Meliboea	14.3	4.36	94141B	8.1		4 49.0	13 34	6.2	4	10	41	e. Papua New Guinea	20	157	90−	none
May 18	6 43	Camilla	12.9	3.75		12.6		7 5.0	15 44	0.9	7	11	22	Hawaii	50	161	71−	none
May 19	23 25	Interamnia	12.3	3.56		12.0		8 22.3	8 5	0.9	13	15	15	Amazon	68	156	52−	none
May 20	2 06	Com.Wilson	11.	0.94	175543	6.4	K0	8 15.9	−29 51	4.	2	4	14	western South America	82	128	51−	none
May 21	23 13	Athor	13.0	2.14	165754	6.7	G5	23 29.8	−11 16	6.3	3	10	31	Tierra del Fuego	71	7	31−	all
May 22	6 02	Cybele	13.2	3.89		11.3		8 35.0	17 52	2.1	9	15	25	Hawaii?s; California?n	67	130	28−	none
May 23	10 47–52	Themis	11.3	2.07	159402	6.8	F2	15 35.5	−19 45	4.5	18	23	13	Antarctica?n	175	136	17−	none
May 25	9 42	Aspasia	12.9	3.46		10.5		6 25.8	17 0	2.5	5	9	26	Caroline Islands	34	59	5−	none
May 25	16 35–43	Themis	11.4	2.08	159377	9.1	G0	15 33.7	−19 39	2.4	19	23	13	(Japan,China,Siberia)?s	172	165	4−	none
May 25	23 10–17	Eleonora	10.7	2.11	82039	8.8	K7	11 51.4	20 46	2.0	16	29	20	South America?n	105	122	3−	none
May 30	19 35	Ausonia	12.2	2.19		11.4		10 24.0	7 24	1.2	5	16	34	Poland, sw U.S.S.R.	87	52	9+	w 45 E
Jun 1	3 58	Camilla	12.9	3.89		12.5		7 23.8	15 36	1.0	6	10	22	(Manitoba,n.cen.USA)?s	41	15	18+	all
Jun 1	7 48	Ceres	7.5	1.87		10.7	M2	18 9.2	−24 38	0.06	87	25	3	(Manitoba,w. U.S.A.)?s	158	150	19+	none
Jun 1	16 48	Camilla	12.9	3.90		9.3	M9	7 24.5	15 36	3.7	6	10	22	Middle East	41	19	22+	all
Jun 16	0 08–23	Pallas	9.2	2.29		12.1		15 36.6	26 11	0.07	54	30	6	Kenya, Zaire, Argentina	123	99	76−	e 40 W
Jun 16	8 48–60	Iris	9.4	1.64		11.5		20 9.6	−16 4	0.15	38	44	11	U. S. A.?s	143	27	73−	all
Jun 17	1 33–88	Lamberta	12.1	1.80	190731	9.4	F8	21 52.4	−28 32	2.8	39	71	18	Iberia,w&sAfrica,Antarc.	123	21	65−	all
Jun 18	9 58	Loreley	12.6	2.57	146423	8.6	F8	22 56.6	−1 27	4.0	19	26	16	n. Chile, Bolivia	101	12	50−	all
Jun 21	6 33	Interamnia	12.5	3.97		10.6		8 56.2	6 0	2.1	10	11	17	Fiji; New Zealand?s	47	102	22−	none
Jun 21	18 06	Patientia	12.5	3.05		11.1		12 13.0	15 11	1.7	15	19	16	central and s.e. Africa	88	135	18−	none
Jun 23	10 11–17	Davida	12.0	3.10		12.1		12 54.3	12 50	0.7	23	24	13	s. Alaska; Hawaii?e	96	124	7−	none
Jun 28	11 04	Lacadiera	14.5	2.77		12.4		2 33.3	17 50	2.3	2	10	58	Mexico?n	54	78	5+	none
Jun 29	11 37	Princetonia	13.8	3.03	119285	7.9	K0	12 12.7	4 48	5.9	7	18	32	southern Australia	84	49	9+	w120 E
Jul 7	1 10	Bamberga	11.2	2.19		11.3		3 6.9	25 19	0.7	6	7	12	Mauritius?n	53	174	77+	none
Jul 7	9 47	Davida	12.1	3.31		12.5		13 0.6	10 57	0.6	17	19	14	se Australia, South Is.	86	47	81+	all
Jul 11	20 07	Roma	13.5	2.45	110578	9.0	F8	2 27.7	0 5	4.5	2	11	74	Australia	74	95	99−	all
Jul 15	19 16	Europa	12.0	3.42		13.1		3 51.6	13 39	0.3	8	10	17	Queensland	54	62	72−	all
Jul 17	9 20	Bamberga	11.2	2.13		11.5		3 32.7	27 34	0.6	7	8	12	Peru, nw Amazon	57	40	55−	all
Jul 17	18 21	Sapientia	14.4	3.04	110026	9.0		1 35.9	5 45	5.4	7	23	40	(China, Japan)?s	90	6	51−	all

Also, there are three new source catalog codes under the S column of Table 2:

R AGK3R, T. Corbin's AGK3 reference star cat.
7 Combined Perth70 - old XZ (SAO or ZC) data.
M Schmidt plate; see Q above. The M-catalog, compiled mainly from southern A.C. data, has the A.C. code C, not M.

New Combined Catalog used for occultation searches. Unfortunately, like last year, this issue of *O.N.* will reach many readers in January, after some of the events in the table have taken place. The data and software changes mentioned in *O.N.* 3 (14), 301 took longer than expected, but were accomplished mainly in September and October. Other projects and pressing responsibilities then delayed creation of the final 1987 prediction database until mid-December. First, a catalog combining many different star catalogs was created with a uniform format. This involved writing several computer programs, each with hundreds of lines of FORTRAN code, to successively merge each catalog, each having a different format and each having various problems that needed

Table 2, Part C

1987	MINOR	PLANET					MOTION		STAR			Ephem.		COMPARISON DATA			APPARENT	
DATE	No.	Name	km-diam.	-"	RSOI	Type	°/Day	PA	SAO No	DM/ID No	D	Source	S	AGK3 No	Shift	Time	R.A.	Dec.
Apr 22	68	Leto	128	0.08	490	C	0.190	103°	188000	C2815695		Herget78	XS				19h20m.3	-28°32'
Apr 27	1	Ceres	946	0.61	10517	C	0.049	159		L 3 6955		APAENAXX	H				18 24.6	-22 40
Apr 28	2060	Chiron	400	0.04	13565	U	0.071	83		A1839319		Marsden	C				5 11.3	17 46
Apr 29	159	Aemilia	141	0.09	665	C	0.172	289		L 2 2016		EMP 1982	H				13 22.9	0 22
Apr 30	10	Hygiea	443	0.16	4054	C	0.276	92				Schmadel	C				6 7.4	23 20
May 2	87	Sylvia	275	0.09	2132	P	0.254	92				Herget78	C				6 30.9	29 0
May 3	54	Alexandra	177	0.17	718	C	0.132	254	226775	P40 7320		Herget78	S				16 26.2	-40 32
May 6	2	Com.Wilson	100	0.21	158		3.293	27	249745	P60 774		MPC11236	S				7 8.1	-60 50
May 6	107	Camilla	252	0.10	1645	C	0.299	87				EMP 1986	C				6 52.0	15 37
May 9	103	Hera	88	0.07	283	S	0.185	284	159932	-13°4437		Herget78	YG		1.18	1.5	16 27.8	-13 23
May 11	2	Com.Wilson	100	0.19	160		2.612	19	219034	C46 3460		MPC11236	PG		-0.42	0.0	7 48.8	-46 50
May 12	241	Germania	187	0.07	1050	C	0.322	93	78178	+22 1254		EMP 1986	XA	N22 673	0.16	-0.1	6 16.2	22 12
May 12	107	Camilla	252	0.09	1645	C	0.308	89				EMP 1986	C				6 59.1	15 40
May 12	200	Dynamene	137	0.09	635	C	0.147	265	208693	C3212617		Herget78	S				17 19.1	-32 32
May 12	2	Com.Wilson	100	0.18	161		2.437	19	219144	P43 1925		MPC11236	S				7 54.8	-43 51
May 13	704	Interamnia	338	0.13	2654	F	0.221	100				Schmadel	C				8 18.0	8 15
May 14	673	Edda	54	0.04	145	C	0.213	287	159480	-18 4152		EMP 1986	7P		0.29	-0.5	15 44.7	-19 4
May 15	386	Siegena	203	0.09	1121	C	0.289	85		+11 1756		Landgraf	A	N11 939			8 7.0	11 9
May 16	137	Meliboea	153	0.05	837	C	0.325	84	94171	+13 728	A	EMP 1982	AG	N13 384	0.44	2.0	4 51.1	13 38
May 16	137	Meliboea	153	0.05	837	C	0.325	84	94171	+13 728	B	EMP 1982	A	N13 384			4 51.1	13 38
May 18	107	Camilla	252	0.09	1646	C	0.317	90				EMP 1986	C				7 7.1	15 40
May 19	704	Interamnia	338	0.13	2660	F	0.238	101				Schmadel	C				8 24.3	7 57
May 20	2	Com.Wilson	100	0.15	165		1.566	17	175543	C29 5897		MPC11236	YG		-1.05	0.2	8 17.4	-29 58
May 21	161	Athor	100	0.06	264	CMEU	0.449	67	165754	-11 6098		MPC11041	PY		0.04	0.3	23 31.8	-11 4
May 22	65	Cybele	230	0.08	1622	C	0.219	102				Herget78	C				8 37.2	17 44
May 23	24	Themis	228	0.15	1368	C	0.197	283	159402	-19 4165		Herget78	YG		2.66	-1.4	15 37.7	-19 52
May 25	409	Aspasia	194	0.08	932	C	0.396	94		A1748359		Herget78	C				6 27.9	16 59
May 25	24	Themis	228	0.15	1369	C	0.194	283	159377	-19 4157		Herget78	XS				15 35.9	-19 47
May 25	354	Eleonora	156	0.10	643	S	0.153	132	82039	+21 2373		Herget78	RA	N20 1305	0.36	-0.7	11 53.3	20 34
May 30	63	Ausonia	94	0.06	277	S	0.268	114				Herget77	C				10 26.0	7 13
Jun 1	107	Camilla	252	0.09	1647	C	0.334	93				EMP 1986	C				7 25.9	15 32
Jun 1	1	Ceres	946	0.70	10616	C	0.192	251		C2414034		APAENAXX	H				18 11.5	-24 38
Jun 1	107	Camilla	252	0.09	1647	C	0.334	93		L 4 1082		EMP 1986	H				7 26.7	15 31
Jun 16	2	Pallas	533	0.32	4702	U	0.144	242				Landgraf	C				15 38.2	26 4
Jun 16	7	Iris	222	0.19	1075	S	0.117	284		L 5 2829		Branham	H				20 11.7	-15 57
Jun 17	187	Lamberta	143	0.11	552	C	0.068	160	190731	C2817507		Herget	S				21 54.6	-28 21
Jun 18	165	Loreley	228	0.12	1306	C	0.154	42	146423	- 1 4365		Herget78	XA	S 1 2790	-0.74	-1.1	22 58.5	-1 15
Jun 21	704	Interamnia	338	0.12	2687	F	0.294	106				Schmadel	C				8 58.1	5 51
Jun 21	451	Patientia	281	0.13	1925	C	0.202	138				Herget78	C				12 14.9	14 58
Jun 23	511	Davida	335	0.15	2658	C	0.154	146				EMP 1982	C				12 56.2	12 38
Jun 28	336	Lacadiera	69	0.03	172	C	0.411	73				EMP 1982	C				2 35.4	17 60
Jun 29	508	Princetonia	139	0.06	655	C	0.214	131	119285	+ 5 2602		Landgraf	RZ	N 4 1594	-0.11	-0.0	12 14.6	4 36
Jul 7	324	Bamberga	256	0.16	938	C	0.608	68				EMP 1981	C				3 9.1	25 28
Jul 7	511	Davida	335	0.14	2675	C	0.194	136				EMP 1982	C				13 2.5	10 45
Jul 11	472	Roma	48	0.03	102	S	0.374	86	110578	- 0 375		EMP 1986	AS	N 0 213	0.10	-0.3	2 29.7	0 15
Jul 15	52	Europa	291	0.12	1877	C	0.338	81				EMP 1982	C				3 53.6	13 46
Jul 17	324	Bamberga	256	0.17	943	C	0.591	70				EMP 1981	C				3 35.0	27 42
Jul 17	275	Sapientia	110	0.05	476	C	0.162	78	110026	+ 5 219		EMP 1981	XA	N 5 180	-0.06	-0.1	1 37.8	5 56

to be addressed to obtain uniform output with suitably merged data for matched stars. The resulting combined catalog includes data from the 1984 version of the SAO catalog, magnitudes from SKYMAP, and positional data from AGK3, Yale, Perth 70, the AGK3R, Eichhorn's Pleiades catalog, all five Lick-Voyager catalogs, and several catalogs used for lunar occultation work at USNO, including the XZ, B, C, E, J, and M catalogs. The last five catalogs consist mainly of Astrographic Catalog (A.C.) data covering various eclipse star fields and the Milky Way regions. The northern data were taken from my programs that read the C.D.S. machine-readable French and Oxford zones of the A.C., while the southern areas were mainly compiled by David Herald, especially from IOTA's Southern Astrographic Catalog project. The Lick catalogs are based on Arnold Klemola's measurement of Lick astrographic plates to form special catalogs covering parts of the Zodiac to support the four outer-planet flybys of the Voyager 2 spacecraft. The final version of the Uranus catalog, created from the Lick data and processed mainly by William Owen as part of his job at Jet Propulsion Laboratory (J.P.L.), was received at the Astronomical Data Center near the time of the Uranus encounter. It consists of two parts, one for pre-encounter centered on Sagittarius, and one for post-encounter centered on Gemini, and overlapping the Jupiter catalog. Klemola kindly sent me a copy of the Neptune catalog, centered on Capricornus, shortly after he created it last August. Although the magnitude system is uncalibrated, the positional data for this pre-released catalog are accurate. The five Lick catalogs each had a different format and included different data, so I wrote a special program to combine them, eliminating a few stars whose data were taken only from the AGK3 or SAO catalogs, and the data for many Jupiter-catalog stars that were replaced by Uranus post-encounter data. Wayne Warren, Astronomical Data Center at Goddard Space Flight Center, was instrumental for the success of creating my combined catalog, since he provided current versions of most of the non-USNO catalogs.

No attempt was made to include in my combined catalog the nearly one million stars in Fresneau's version of the machine-readable A.C. (F.A.C.), which has no stellar identification numbers. I made separate computer searches using the combined catalog and F.A.C., with nothing listed under DM/ID No. for the latter. The F.A.C. searches were limited to several of the larger asteroids. In some cases under S of Table 2, "CC" is listed. In this case, the primary source is my A.C. position, simply taken from the plate whose center is closest to the star, and an "A" identification is given. The comparison source is F.A.C., which averaged the stellar data from all plates (most A.C. stars appear on 2 or more plates). In some cases, two sources are listed in the S column, but no shift or time values are given. This signifies that the positional data are the same for the two separate sources, one of which is usually an "X" or a "Z" indicating that the star can be occulted by the Moon and may have some history of lunar occultation observations. In early October, I modified my F.A.C. search program to read the combined catalog. I can now automatically search ephemerides against both catalogs to produce the individual occultation datasets, which are sorted on Julian date with another program to impose chronological order (with the exception of components of doubles requiring manual separation, discussed above). Although the catalog work took a lot of my time in 1986, delaying my 1987 predictions, the process of actually generating the predictions is now much easier for me than a year ago.

Major planets. For 1987 predictions, I searched ephemerides of the major planets against the combined catalog, with the exception of Mercury (rarely far enough from the Sun for effective occultation observation), Uranus, Neptune, and Pluto. The source for my planetary ephemerides is the NA0001 computer disk at USNO; no source is listed for the planets in Table 2. In late 1985, Larry Wasserman, Lowell Observatory, provided me with lists of occultations by Mercury through Saturn for 1986 and 1987. He found several occultations by Mercury, but none of the stars are brighter than 8th mag. when the solar elongation is greater than 10°. The best event he found involved an 8.6-mag. star at solar elongation 20°. But even for it, the geometry was such that the Sun was never more than 10° below the horizon in the region of visibility of the occultation. His predictions for Venus to Saturn predate my calculations and confirm them.

Predictions for the outer three planets through 1990 have been published by D. Mink and A. Klemola in *Astron. J. 90* (9), 1894 (1985 December). The brightest star listed by them to be occulted during 1987, by Uranus on April 16th around 2 and 3 hours U.T., is magnitude 11.8. All of the events involve small magnitude drops, and are well beyond the range of capabilities of most *O.N.* readers. The few exceptions have ready access to the *Astron. J.* article.

Minor planets. For the asteroids, I computed ephemerides for combined-catalog searches for all with diameters larger than 150 km and angular diameters greater than 0."08, as well as many smaller asteroids for which occultations were listed for 1987 by Wasserman, Bowell, and Millis in *Astron. J. 90* (10), 2124 (1985 October). Other small asteroids suspected of having companions, or those identified as having some special physical significance or value for reduction of the Viking lander tracking data by James Williams at J.P.L., were also used, usually with relaxed angular diameter restrictions. I also searched the catalog with ephemerides for asteroids smaller than 0."08 which occulted relatively bright stars, especially in North America, as identified from Goffin's data. Many events that could possibly be seen only from areas with no known occultation observers, such as most oceans, Antarctica, and remote parts of Siberia, were deleted unless the asteroid was large or the star brighter than about 7th magnitude. I have not computed ephemerides from second-choice orbital elements to produce a Table 3 of ephemeris differences, as I have done during the last few years. I also searched the latest ephemeris of Comet Wilson and found four possible occultations in May. The magnitudes are very rough estimates for the near-nuclear region. I hold little optimism for the Comet Wilson events, considering the sparse dimming reports during the Comet Giacobini-Zinner and Halley appulses in 1985 and 1986.

Astrometric updates. Note that the "prediction updates" telephone number given for Silver Spring in *O.N. 4* (1), 10 (1986 July) has been changed to the IOTA Occultation Line, 301,495-9062, as noted on p. 31 of the last issue. I also use this line for modem communications when I use our PC to access and use a remote computer, so the line will sometimes be busy for a few hours at a time on weekends and weekday evenings. The 301,585-0989 number is still available, and should be used instead if you want to talk to me, rather than just obtain the prediction update. There is an answering machine on that number, also, which has only a short message if Joan or I can't answer when you call; you can also leave reasonably long messages on it.

Lists of 1987 priority occultations worthy of concerted efforts to obtain astrometric updates and observational coverage have been identified by Robert Millis, chairman of the I.A.U. Working Group on Occultations (by major and minor planets) at Lowell Observatory, and by Roland Boninsegna, Groupe Europeen d'Observation Stellaire (GEOS; astrometry suggested for Uccle and for the photoelectric meridian circle at Bordeaux). These have been combined below:

Date	Asteroid	Star	Millis	GEOS
Jan 21	354 Eleonora	SAO 119356	x	x
Jan 24	471 Papagena	SAO 58556	x	x
Jan 25	30 Urania	SAO 98160	x	
Feb 13	11 Parthenope	L1(LJ) 122	x	
Feb 14	63 Ausonia	BD +9° 2409		x
Feb 16	19 Fortuna	BD +18° 565	x	x
Mar 16	511 Davida	SAO 100625	x	
Mar 26	121 Hermione	SAO 158896	x	
Jul 26	74 Galatea	SAO 145932	x	
Aug 8	56 Melete	SAO 92414	x	
Sep 8	74 Galatea	SAO 145609	x	x
Sep 14	161 Athor	SAO 128919	x	
Oct 8	20 Massalia	SAO 76842	x	
Nov 17	55 Pandora	BD +33° 1391	x	
Dec 8	324 Bamberga	SAO 41263	x	
Dec 19	481 Emita	SAO 59964	x	x
Dec 23	52 Europa	BD +12° 613	x	

The only event listed by GEOS but not by Millis is the one on Feb. 14, noted as "for North America" by Boninsegna. Millis probably rejected it since the full Moon will be only 13° away from the 9.9-mag. star, a considerable observational hindrance. But *Sky and Telescope* plans to publish a finder chart for it in the February issue.

Since there are several new events in my list that are included in neither the Lowell *Astron. J.* article nor in Goffin's predictions used by Millis and Boninsegna, I hope that some of my better new events will be added to the priority list.

Astrometrists can telex observations to me at Computer Sciences Corporation, 8728 Colesville Rd., Silver Spring, MD 20910, U.S.A., telex number 7108259636, answerback CSC SS MD. Unfortunately, since my employment does not involve occultations directly, I can not send telex messages giving improved paths based on astrometric data. But Wayne Warren, Astronomical Data Center, can send such messages for important events, so if you have access to a telex, let me know the number. Last year, I sent telegrams on a few occasions, but costs of these are very high, and I plan to send few, if any, in the future. Overseas regional coordinators interested in receiving these updates are encouraged to provide telephone numbers (if not already provided to me or to IOTA) where someone who knows English and some astronomy is likely to be available.

Future improvements. For 1988 predictions, I need to process the combined catalog to remove/merge the approximately 2% of duplicate entries (these were easy to spot and eliminate by scanning a preliminary prediction run) and possibly expand to include A.C. data from F.A.C., the Algiers zone of the A.C. processed by Robert Elliot in Wisconsin to provide good AGK3-based plate constants and equatorial coordinates (R.A.s and Dec.s) of the stars, possibly the San Fernando zone of the A.C. (this has been keypunched, and Tom Corbin at USNO is working to compute improved plate constants for conversion of the rectangular plate measures to equatorial coordinates), and, I hope, more of the S.A.C., at least the part that has been keypunched but never incorporated into the lunar occultation catalogs. I hope to change my ephemeris program to use the new H and G magnitude parameters given in M.P.C. 11095 (1986 September). I plan to start the process in April or May, so that I can get the predictions out in reasonable time.

L. Kristensen prefers that data be published giving the geocentric time and angular separation at closest approach. One can calculate a local appulse prediction, or an accurate ground path, from these data and the other listed data, although the position angle of motion needs to be given to greater accuracy. There is not time to incorporate this in the current predictions, but it could be considered for 1988. I have sent Kristensen listings of these data for 1987. Those interested in obtaining this information, especially if formulae are published showing how to use it, should let me know. I suspect that most readers are content to rely on the published maps and J. Carroll's appulse predictions for this information. However, lists of the data suggested by Kristensen could be distributed, at least separately to regional coordinators and any others who want them. Kristensen feels that asteroid occultation updates could be better given in terms of geocentric distance and time of closest approach, rather than shifts and time corrections from a nominal prediction, my current procedure.

Notes about individual events. Wayne Warren supplied some important information, especially for double stars.

Jan. 1: Since only the southern part of the virtually fully sunlit disk of Jupiter will cover the star, dimming by the ring is unlikely. Also, the actual duration will be 12 to about 20 minutes shorter than the central duration listed in the table. Large telescopes will be needed to see the star merge into the atmosphere.

Jan. 2, (523) Ada and SAO 183217: The star is the double star Burnham 1774. Only the primary is occulted. The 11.3-magnitude companion is 5".2 away in position angle (P.A.) 330°. Its path misses the Earth's surface by 0".35 above Antarctica.

Jan. 11, Venus and SAO 159738: Venus' disk will be 49% sunlit, with the position angle of the center of the bright limb (PACBL, or direction to the Sun) 103°. This is nearly the same as Venus' motion, so disappearance will be on the sunlit side and reappearance on the dark side. The central line (where a central flash might be seen) crosses the Seychelles and the northern limit crosses southwestern Siberia and northwestern China.

Jan. 11, Mars and SAO 109035: The star is Z.C. 16. Mars will be 88% sunlit, with disappearance against the dark crescent, which will have a maximum width (called the defect of illumination) of 0".8. The event will be central along a line extending approximately from Alma Ata to Irkutsk. The southern limit crosses southern India and Hainan Island.

Jan. 13, (54) Alexandra and SAO 183058: The star is 59 Hydrae = Aitken's double star (ADS) 9453, separation 0".96 in position angle (PA) 346°. Since observers will probably not be able to directly resolve the stars, one component will remain visible while the other is occulted, so the effective magnitude drop will be only 0.95 for an occultation of A and 0.65 for one of B. The secondary's (B component's) path will be 0".20 south of that of the primary (A component), and B will be occulted 1.9 minutes before A.

Jan. 13, (137) Meliboea and SAO 110807: The star is ADS 2193, separation 2".67 in PA 279°. The combined magnitudes given in both the SAO and AGK3 (and in both Lowell's and Goffin's predictions) are much too bright, perhaps because they are photographically determined from an image exaggerated by the duplicity. Wayne Warren provided me with a photoelectric combined magnitude of 7.14 from a reference obtained from the SIMBAD on-line stellar database in France. If seeing is bad so that the stars can not be directly resolved, the effective magnitude drop will be only 0.8 if either component is occulted. B's path will be 1".61 south of A's, with closest approach to B occurring 11.7 minutes before A.

Jan. 19: The star is Z.C. 1982 = 89 Virginis.

Jan. 24, (471) Papagena and SAO 58556: The star is ADS 4483, with a combined mag. of 7.7. The separation is 5".0 in PA 232°. B's path is 4".67 north of A's, and closest approach to B will occur 6.2 minutes after A's. The regional map for this event includes the transition from January 24th to 25th. Unfortunately, the plotting program got confused by this and drew spurious straight lines that connect the ends of the individual shift curves, and the ends with the point at 0 hours (or 24 hours) U.T. Taking time to fix the program would cause further unacceptable delays in producing this issue, so we are forced to publish the map for this event, potentially one of the best of 1987 for North America, as is. At least, the spurious lines are much lighter than the shift curves.

Jan. 25, (77) Frigga and SAO 159089: The star is Z.C. 2171.

Feb. 9: This is the longest-duration asteroidal occultation during the year.

Feb. 14, Venus and SAO 187189: The star is Z.C. 2717. Venus will be 67% sunlit with PACBL 88°. A central flash might be seen in northern India.

Feb. 16, Venus and SAO 187453: Venus will be 64% sunlit with PACBL 87°. The central line crosses northern Peru and western Brazil.

Feb. 19, Venus and SAO 187769: Venus will be 65% sunlit, with PACBL 85°.

Feb. 22 and 23, Venus: Venus will be 66% sunlit with PACBL 83°. On Feb. 22, the northern limit crosses northern India.

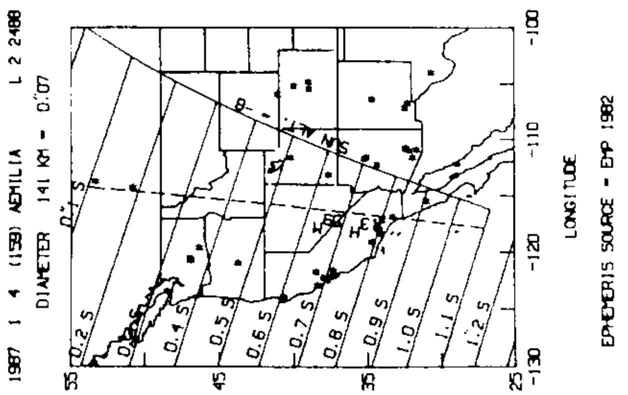
Feb. 25, 26, and 27: Venus will be 68% sunlit with PACBL 82°. On the 25th, the northern limit crosses s.e. Australia and North Island. On the 26th, the star is ADS 12909, with component mags. 8.7 and 9.6, separated by 0".7 in PA 12°. The northern limit crosses n.e. India and s.e. China. On the 27th, the southern limit crosses northern India.

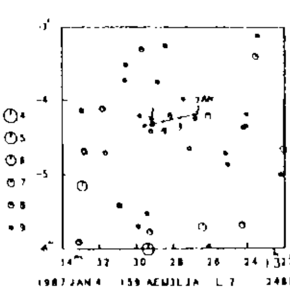
March 6: Venus will be 71% sunlit with PACBL 77°. Reappearances will still be on the dark side. The southern limit crosses eastern China and southern Japan.

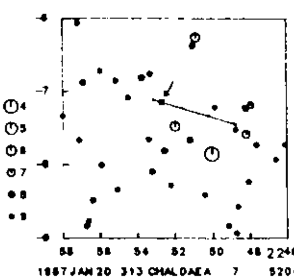
March 25, Mars and SAO 93396: The star is ADS 2478. The main components are mag. 8.8 and 9.2, separated by 1".1 in PA 115°. An 11.8-mag. third component 25" away in PA 221° will not be occulted. Mars will be 94% sunlit with PACBL 255°. The defect of illumination will be a negligible 0".28.

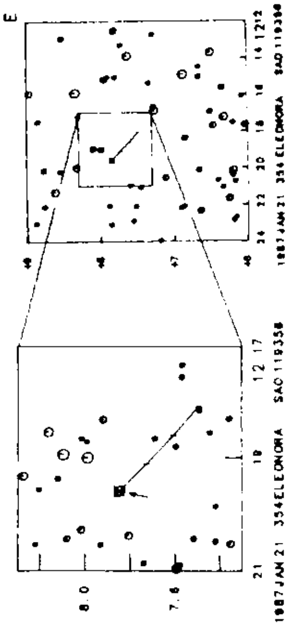
March 25, Venus and SAO 164761: Venus will be 79% sunlit with PACBL 67°.

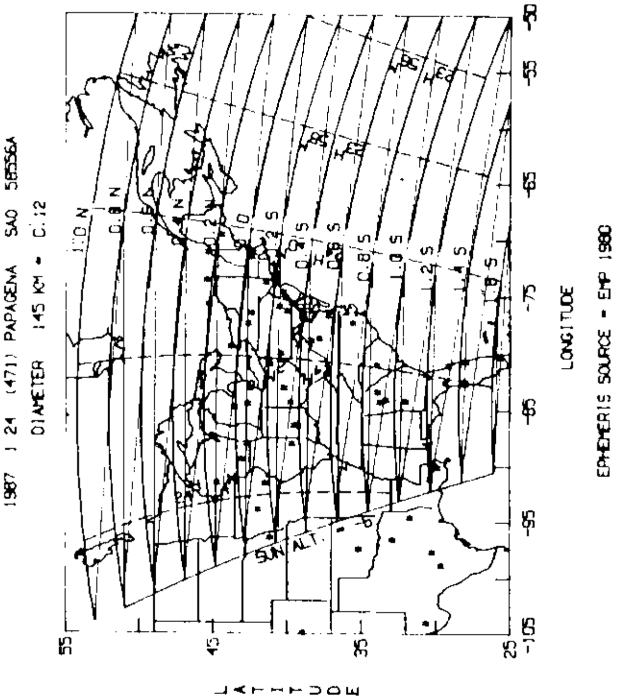
Notes for events after March will be published in the next issue.










1987 1 24 (471) PAPAGENA SAO 58556A
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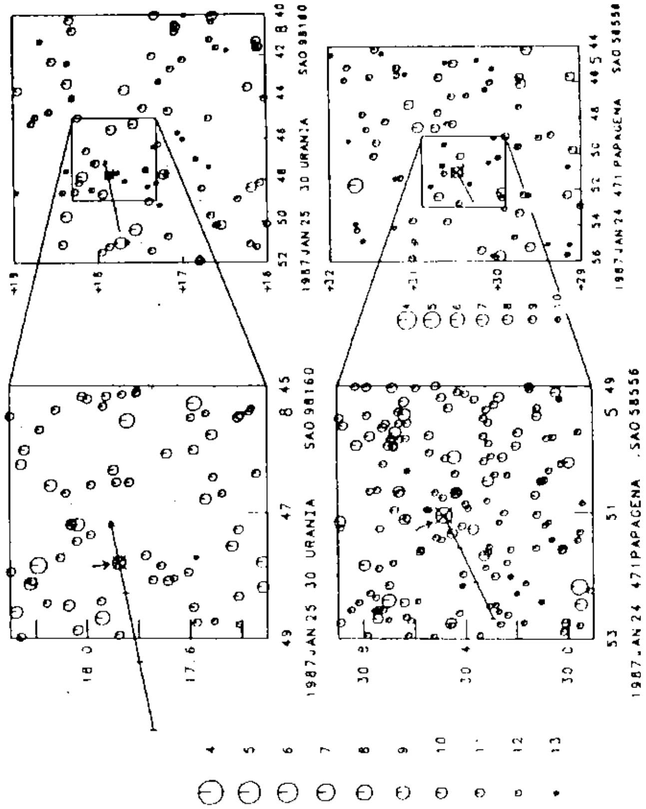
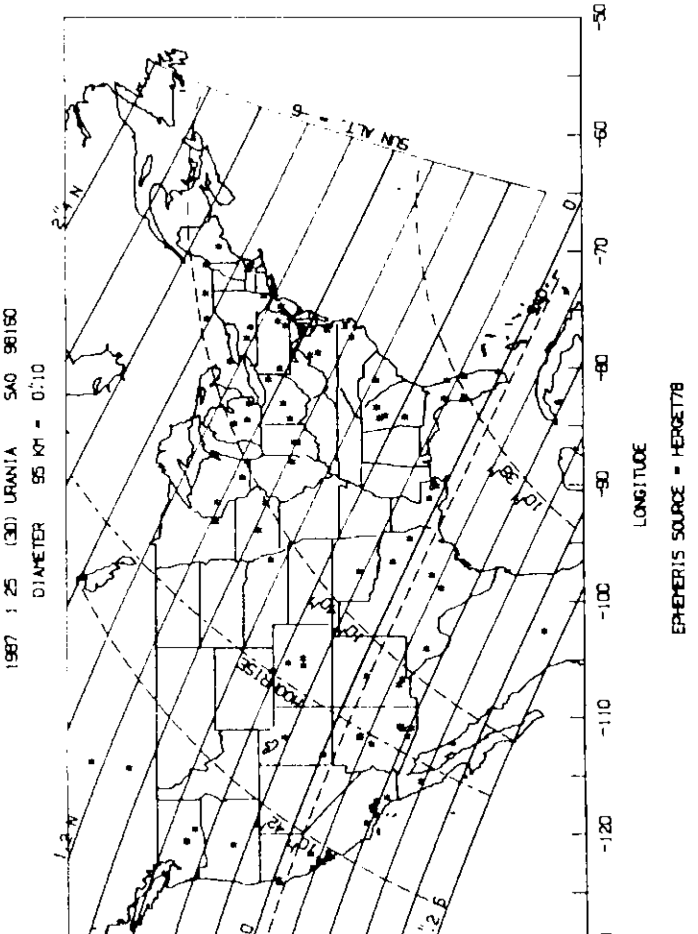
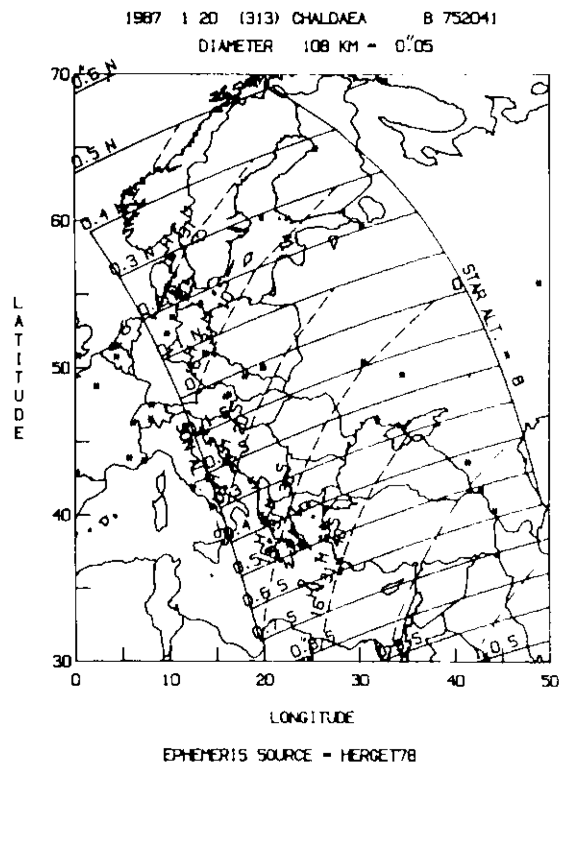
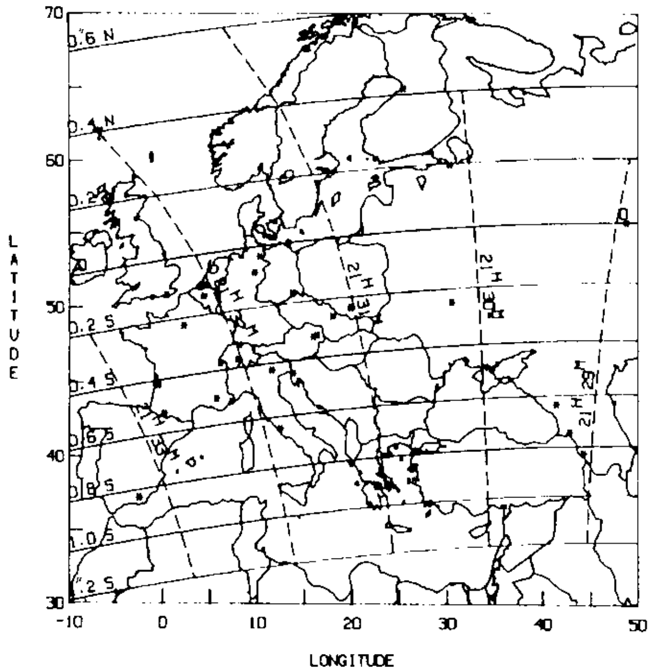
LONGITUDE
EPHEMERIS SOURCE - EMP 1980
LATITUDE
SUN ALT.


1987 JAN 25 30 URANIA SAO 98160
1987 JAN 24 471 PAPAGENA SAO 58556


1987 1 25 (30) URANIA SAO 98160
DIAMETER 95 KM - 0".10
LONGITUDE
EPHEMERIS SOURCE - HERGET78
SUN ALT.


1987 1 20 (313) CHALDAEA B 752041
DIAMETER 108 KM - 0".05
LATITUDE
LONGITUDE
STAR ALT.
EPHEMERIS SOURCE - HERGET78

1987 1 27 (704) INTERAMNIA
DIAMETER 338 KM = 0".21



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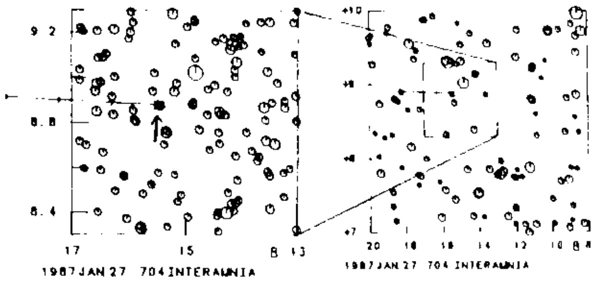
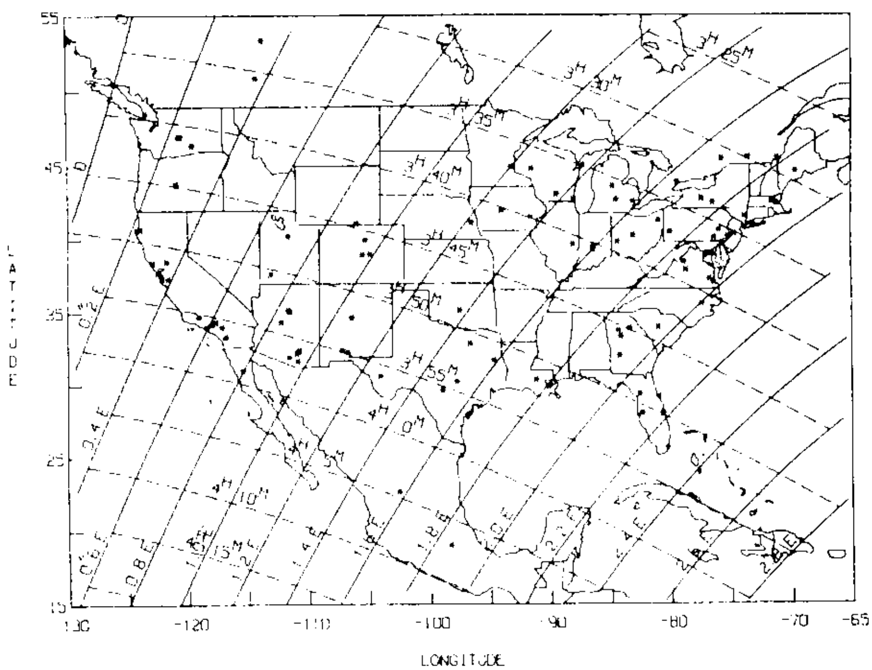


1987 2 9 (10) HYGIEA
DIAMETER 443 KM = 0".21



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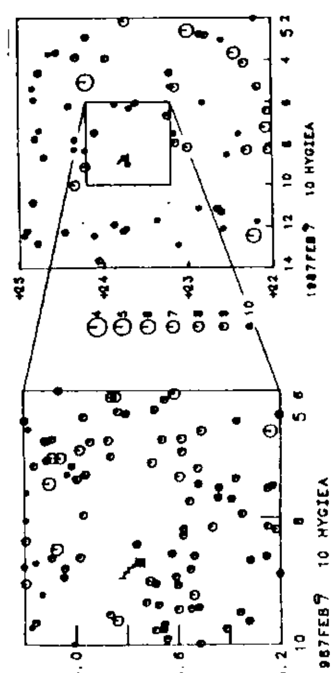
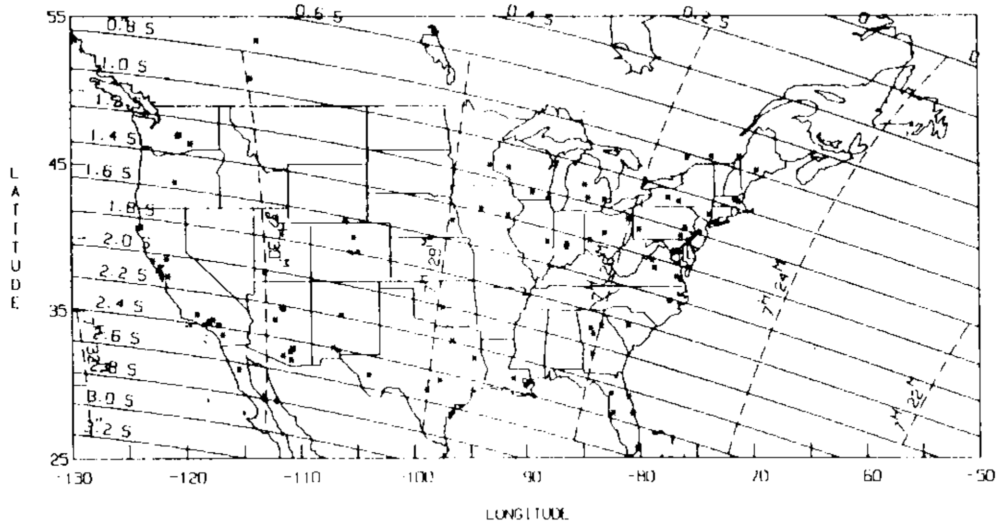
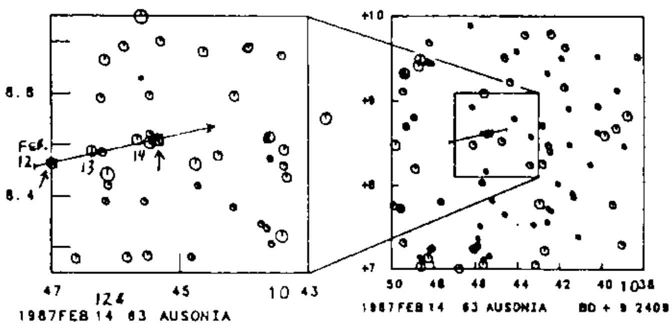


1987 2 12 (63) AUSONIA

DIAMETER 94 KM = 0".08

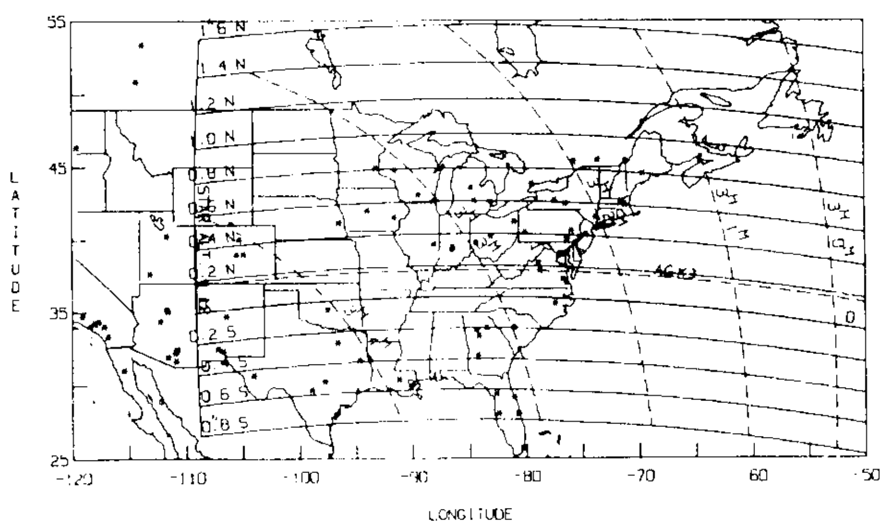


EPHEMERIS SOURCE = HERGET77

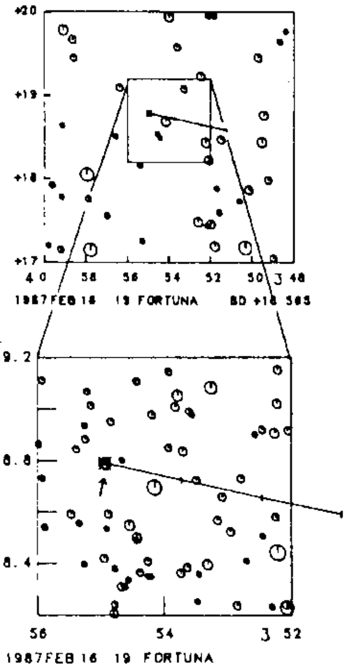


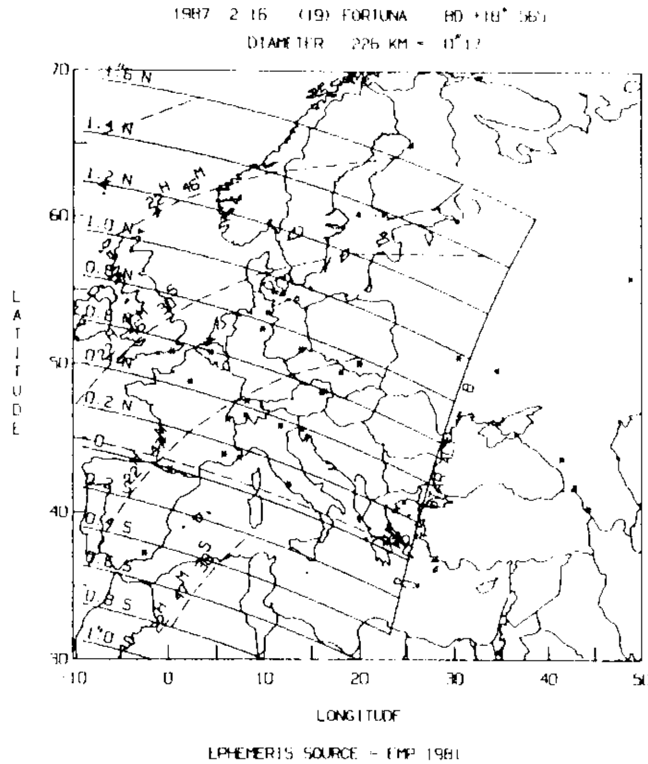
1987 2 14 (63) AUSONIA BD + 9°2409

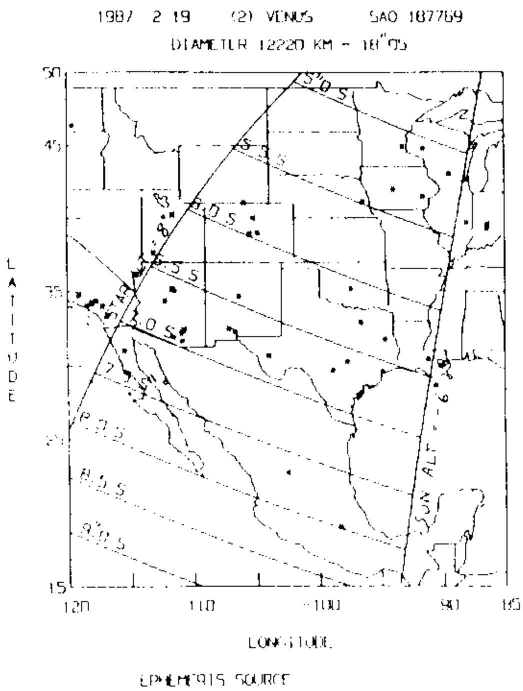
DIAMETER 94 KM = 0".08

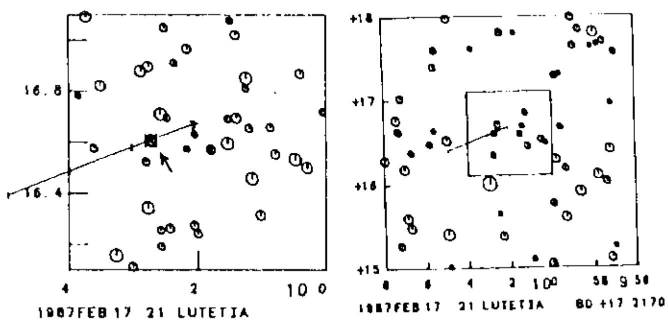


EPHEMERIS SOURCE = HERGET78

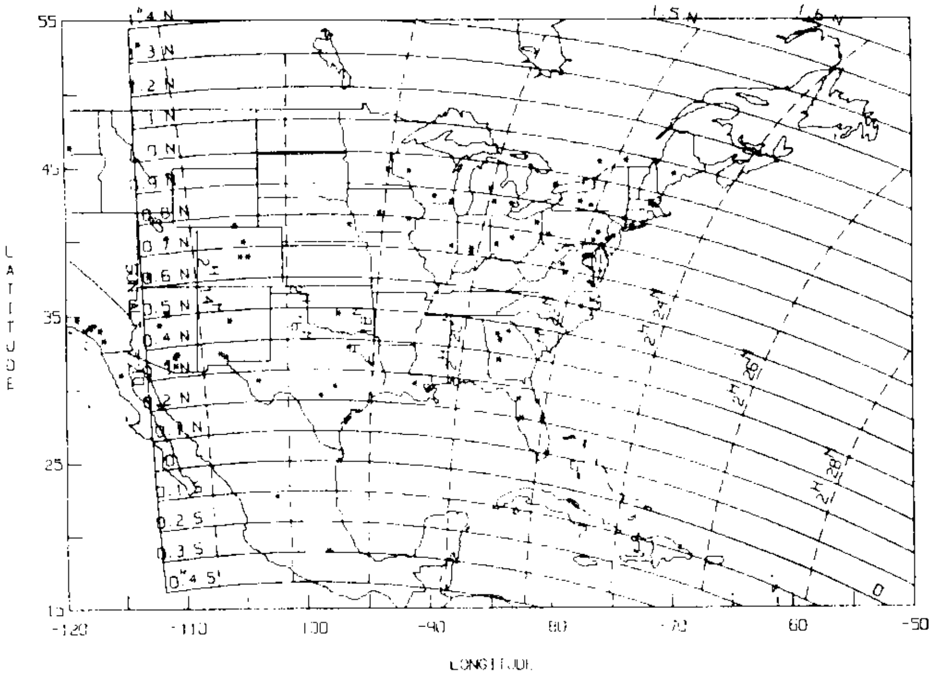

1987FEB16 19 FORTUNA BD +18 565
1987FEB16 19 FORTUNA


1987 2 16 (19) FORTUNA BD +18° 565
DIAMETER 226 KM = 0".17
LATITUDE
LONGITUDE
EPHEMERIS SOURCE - EMP 1981

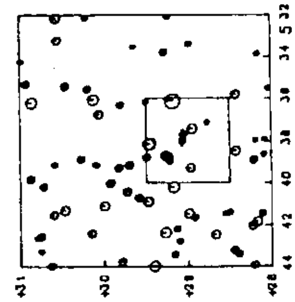

1987 2 19 (2) VENUS SAO 187769
DIAMETER 12220 KM = 18".05
LATITUDE
LONGITUDE
EPHEMERIS SOURCE

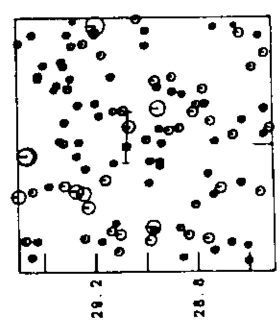

1987FEB17 21 LUTETIA
1987FEB17 21 LUTETIA BD +17 2170

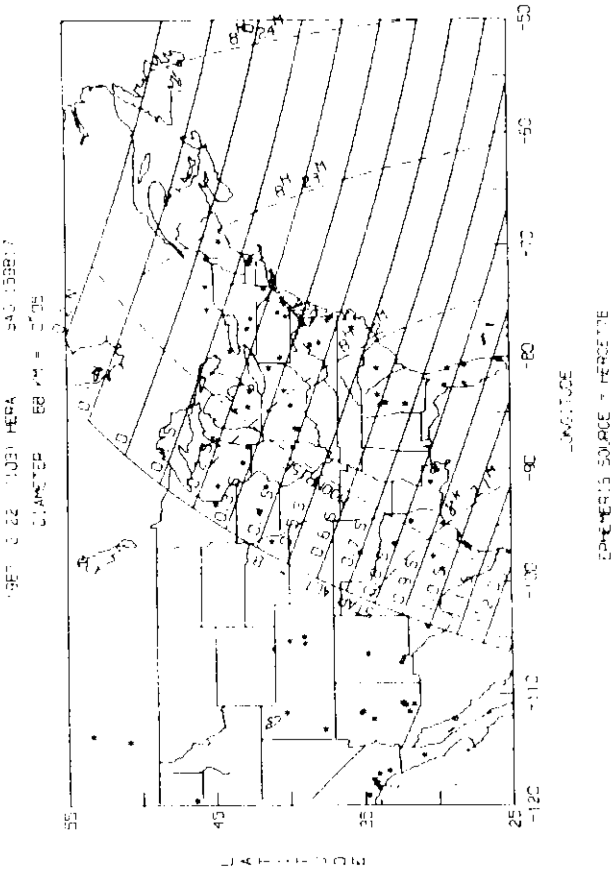
1987 2 28 (87) SYLVIA
DIAMETER 275 KM = 0".12



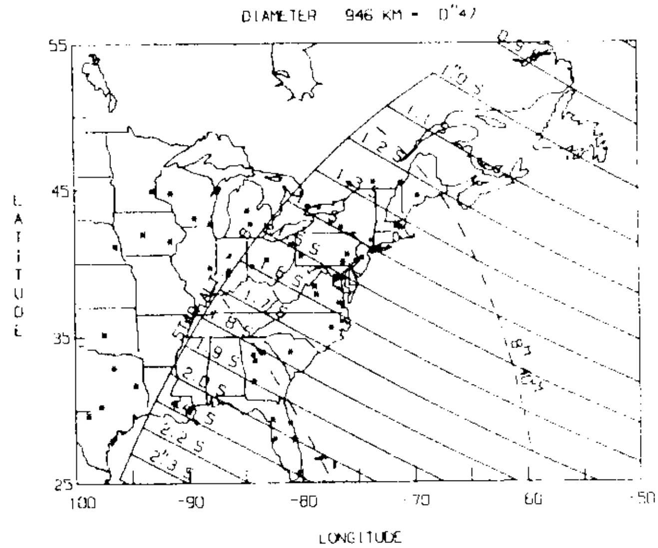
EPHEMERIS SOURCE = PERGEL78



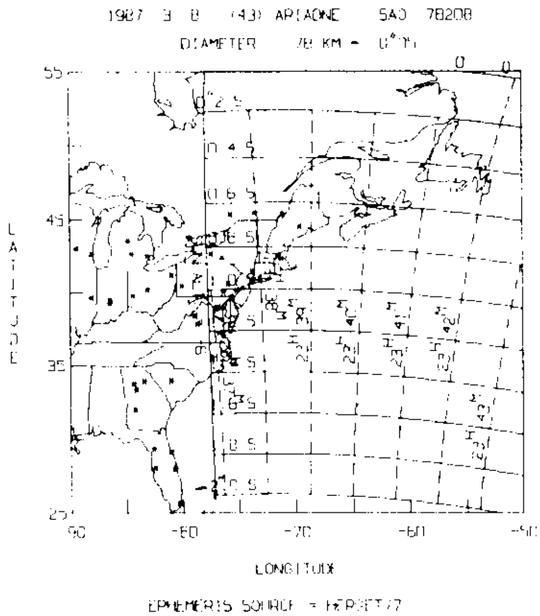


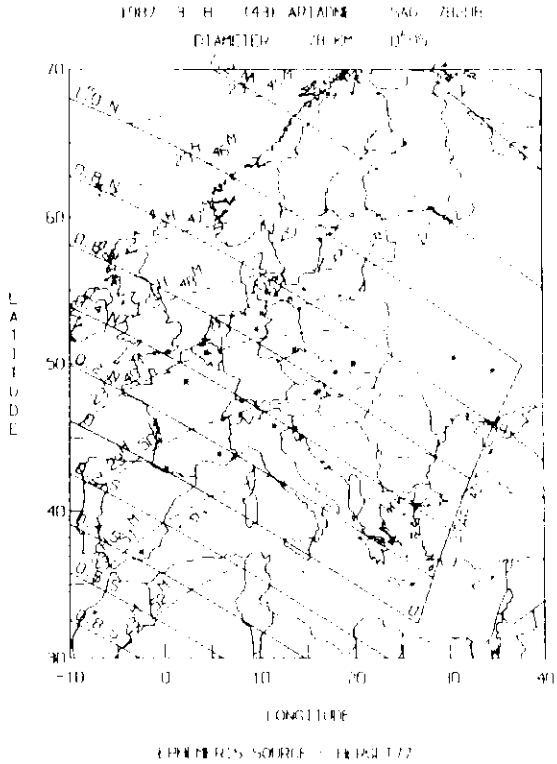


1987 3 7 (1) CERES SAO 185847
DIAMETER 946 KM = 0".47



EPHEMERIS SOURCE = APAENAKK





INVITATION TO A DOUBLE-HEADER

Henk J. J. Bulder

Two grazing occultations of main Pleiades stars from one place!

As most of you know by now, in the next few years we will be able to see the Moon pass in front of the Pleiades cluster several times. During these passages, we will be able to make hundreds of occultation timings.

Only very seldom will we see a graze of one of the main stars. Even less often can we see two grazes during one passage. But really unique is the prospect of seeing both a northern-limit and a southern-limit graze of two of the brighter stars from one place within one hour's time.

Well, this is going to happen during the passage of 1988 January 27, when at 19:12 U.T. we will see a northern-limit bright-limb graze of Taygeta (mag. 4.4) and at 20:10 U.T. we will see a southern-limit dark-limb graze of Alcyone (mag. 3.0) from Menen, a Belgian town near the French border.

As we visualise it now, some 40 observers will attempt to observe this phenomenon, making it a record-breaking European graze expedition. We invite all serious observers who would like to participate in this action to write to one of the following addresses describing the telescopes they are planning to use and their observation experience in the field of occultation timing. All participants will get personal invitations in due time, giving details about the event and information as to how to get to the observing site.

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2717 CS Zoetermeer
The Netherlands

Pierre Vingerhoets
Blokmakersstraat 20
2758 Haasdonk
Belgium

THE MAGNITUDE OF X05643 IS 7.6, NOT 5.4

David W. Dunham

The magnitude of X05643 is wrong in the AGK3, the source catalog for this star. Apparently, its magnitude was confused with nearby Chi Tauri = Z.C. 647 = SAO 76573 = B.D. +25° 707, whose magnitude is 5.5. The pair is Aitken's Double Star 3161. X05643 is 19".4 from Chi in P.A. 24°. All graze and detailed total occultation data at USNO for 1987 have the wrong magnitude, which is two magnitudes too bright.