Occultation Newsletter

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FROM THE PUBLISHER

This is the first issue of 1986.

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for U.S.A., Canada, Mexico	$11.46	$11.00
for all others (to cover higher postage costs)	16.67	16.00
Occultation Newsletter subscription[1] (1 year = 4 issues)		
by surface mail		
for U.S.A., Canada, Mexico[2]	7.28	7.00
for all others	7.12	6.84
by air (AO) mail[3]		
for area "A"[4]	8.91	8.56
for area "B"[5]	10.32	9.92
for all other countries	11.75	11.28
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O.N. 1 (1) thru *O.N. 2* (13), each	1.04	1.00
O.N. 2 (14) thru *O.N. 3* (13), each	1.46	1.40
O.N. 3 (14) and later issues, each	1.82	1.75
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O.N. 1 (1) thru *O.N. 2* (13), each	1.51	1.45
O.N. 2 (14) thru *O.N. 3* (13), each	1.93	1.85
O.N. 3 (14) and later issues, each	2.29	2.20
(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:		
Local circumstance (asteroidal occultation) predictions (entire current list for your area)	1.04	1.00
Graze limit predictions (each)	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, Mexico.
[4] Area "A" includes Central America, St. Pierre and Miquelon, Caribbean islands, Bahamas, Bermuda, Colombia, and Venezuela. If desired, area "A" observers may order the supplement for North American observers by surface mail @ 1.23 1.18
or by air (AO) mail @ 1.56 1.50
[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 fourth annual meeting of IOTA will be held in conjunction with the Texas Star Party at the Prude Ranch, Fort Davis, Texas, on Saturday, May 10th, the last day of the star party. This will be a business and election meeting, and will probably be held late in the morning. In addition, a scientific session is planned, to be held on Thursday, May 8. There will be some scientific discussions during the Saturday meeting, if time permits. The fastest way to get to Fort Davis is to fly to Midland-Odessa airport, and rent a car. Details for those interested in attending can be obtained from the organizer of the 1986 Texas Star Party: Carol Rodgers; 128 North Commerce; Burleson, TX 76028; telephone 817,295-1026. If you want to give a presentation or have a suggestion for an agenda item, contact me at P. O. Box 7488; Silver Spring, MD 20907; U. S. A.; phone 301,585-0989.

Election. Enclosed with this issue, for IOTA members, is a ballot, and envelope for sending it to the Executive Secretary, Charles H. Herold; 9207 Kirkmont; Houston, TX 77089; U.S.A. You do not need to send the ballot if you plan to attend IOTA's meeting, described above, on May 10th. If you send the ballot to Mr. Herold in Houston, he needs to receive it by May 7th. Although there is again essentially no choice on the ballot, members are urged to complete and send them to Herold, since we need to have ballots cast by 30% of the membership for the election to be valid. The candidates on the ballot are unchanged from the 1983 ballot, except that the offices of the Treasurer and Corresponding Secretary have been combined, with H. F. DaBoll the nominee for Secretary-Treasurer.

IOTA/ES's Fifth European Symposium on Occultation Predictions will be held in Poland, probably in September. Until more information becomes available, inquiries about it should be addressed to Hans Bode, whose address is given in the paragraph preceding the footnotes of "From the Publisher." Mr. Bode now maintains a telephone line with an answering machine to serve as message center for IOTA/ES; the language will be English and the number in Hannover, German Federal Republic, is: City code 511,424288. The main purpose will be to provide last-minute prediction updates for asteroidal occultations, but it can be used to exchange other observational data and information about meetings or other IOTA/ES business, and to leave messages.

Membership cards. Except for several who already have received them, membership cards [Ed: either membership cards or expiration notices] are enclosed for IOTA members. The cards were designed [Ed: Incorporating an emblem designed by the late Raymond F. DaBoll] and produced by Tony Murray in Georgetown, GA. Mr. Murray also prepared a one-page handout briefly describing lunar grazes; it may be copied and used for public contacts during expeditions and advance-planning field work.

Grazing occultation predictions. The 78A version of OCC is still operational with the MVT operating system at the U. S. Naval Observatory. One of the CalComp disk drives failed in January, but it is still possible to run T. Van Flandern's 78A OCC by not using a scratch disk that is no longer needed. However, processing IOTA data to generate our final graze predictions via the profiles is now virtually the only reason for maintaining MVT. Sometime during the next few months, the CalComp disk drives will be removed, after which it will no longer be possible to run MVT and 78A OCC. There may then be a period of a few, or even several, months during which it will not be possible to process any profile calculations, until the CMS 80G version of OCC is fixed. This will be my primary concern after occultations by Halley's Comet are over with at the end of April; see p. 321. I have now converted all of my important occultation programs to run under the CMS operating system at USNO. In the meantime, I sent magnetic tapes and listings of the graze and ACLPPP computer programs to IOTA members in Baltimore and Houston who expressed a willingness to try to alleviate the computor shortage discussed in *O.N. 3* (13), 277.

Occultation Manual. Unfortunately, I haven't had time to work on this since the last issue; it will be another post-Halley high-priority project. In the meantime, a somewhat incomplete but useful preliminary version is available upon request to H. F. DaBoll (address in masthead), free for IOTA members and costing $2.50 (discount price) for non-members. The preliminary version is reduced 50% so that four pages of text fit on one page of the copy (actually, eight pages per two-sided sheet). Although harder to read, this saves considerable expense until the more readable, more complete, version is ready, perhaps by the time the next issue of *O.N.* is distributed in June or July.

Lunar eclipse occultations. This is my last call for anyone needing predictions of total or grazing occultations of faint stars during the total lunar eclipse of April 24 (see above for my address and telephone); of course, there is more time for the eclipse in October. Dust from the Colombian volcanic eruption in January will probably make the northern part of the eclipsed moon abnormally dark, permitting timings of occultations of very faint stars. But the southern part of the moon, also being farther from the center of the shadow, will probably remain rather bright.

Equipment. Peter Manly, Tempe, AZ, informs me that the RCA Ultricon TC-2055 television camera, which a few other IOTA members and I have used to record grazes, asteroidal occultations, eclipses, and other events, is no longer being manufactured. This is unfortunate, since the only comparable camera is a CID camera by G.E. that is much more expensive, costing about $5000. The Ultricon is one of the few video cameras that have detachable lenses (in fact, it is sold with no lens) so that it can be connected to a telescope. Some video equipment dealers may still have a few Ultricons in stock. Mr. Manly has also made some tests that show that an Ultricon recording of an instantaneous artificial occultation produces an event that takes four frames to fade from view. He checked with RCA engineers and found out that the Ultricon tubes are manufactured with a time constant built in, to produce more pleasing images of motion. He was going to propose that a special limited production of the Ultricons be made with the time constant removed when he learned that they were no longer being manufactured.

Delta Cancri graze video. The first video recording of a grazing occultation was made by Alan Fiala, USNO, and involved 4.2-mag. Delta Cancri on 1981 May 10, as described in *O.N. 2* (12), 167 and *3* (4), 84. In *O.N. 3* (10), 206, I noted that showings of the videotape at astronomical meetings had always generated considerable interest, and I lamented my inability to persuade anyone, up to that time, to publish a sequence of slides that I had made from the videotape. Through the efforts of Herve le Tallec, the sequence has finally been published, along with an article entitled "Occultation rasante" written from other material that I supplied, on pages 283-285 of the 1985 November-December issue of *Pulsar*. *Pulsar* is published by the Societe d'Astronomie Populaire and is widely distributed within France. Herve le Tallec; 15, rue Perchepinte; F-31000 Toulouse, France, might be able to provide information about obtaining a copy of that issue, or possibly an offprint of the article.

MINUTES OF 1985 IOTA MEETING

Date: 1985 November 16
Time: 10:15 C.S.T.
Place: Clear Lake City, Texas, U. S. A.

There were nine members present. Three of them were officers of IOTA; the President, Dr. Dunham; the Executive Vice President, P. Maley; and the Executive Secretary, C. Herold.

At 10:15, Dr. Dunham opened the meeting and introduced everyone in attendance. Business items were considered first.

1) The continuation of our tax-exempt status for IRS purposes was discussed. See *O.N. 3* (14), 295.

2) The process for reporting expenses seems adequate, providing one uses information given in *O.N. 3* (11), 223 and *3* (13), 272.

3) The IOTA secretarial position is being taken on by H. DaBoll. This will make it easier for dues processing, mailing labels control, and expense report verification.

4) The 1986 meeting of IOTA is now being planned for May, to coincide with the Texas Star Party in west Texas. Tentative plans call for some lectures and displays of IOTA events by some of its members.

5) Financial report. An increase in the price of *O.N.* to $7.00 is necessary. The size of the newsletter and mailing costs have increased to a point where it is necessary to do this at this time.

6) IOTA membership cards were discussed next. Some suggestions were made.

7) Grants for research. Some funds from the NSF (National Science Foundation) have been requested in

the past, but none have been approved yet. This happens because there is not enough lead time to process these applications by the NSF. They consider a fast processing time to be approximately nine months. This makes it difficult for IOTA to apply, since some worthwhile events are only discovered with a few months lead time (sometimes only one week, from "last-minute" astrometry).

Break for lunch at 12:20

Resumed meeting at 13:30

Scientific portion of meeting.

1) A preview of asteroid and comet occultations for 1986, mainly preprints of material for the January issue of *Sky and Telescope* and for *O.N.*

2) A preview of grazes for 1986 was next.

3) Past expeditions, with some results.

A) May 4 Alpha Librae graze in Sudan and South Africa. There were twelve sites in the Sudan, and about forty sites in South Africa. A video of the event was shown.

B) Many video recordings of other occultations and eclipses were also shown (reductions of these events will appear in future *O.N.* issues.

4) Possible amateur-professional cooperation in use of the Hubble Space Telescope was discussed; see p. 296 of the last issue. We speculated that this may have been partly a result of IOTA Executive Vice President P. Maley's discussions with Dr. R. Giacconi at the AIAA meeting in Arizona in 1983; also see Maley's Space Telescope proposal in *O.N. 2* (2), page 20.

5) Discussion of Russian dimming reported during a Pallas occultation in 1983 [Ed: see p. 325].

6) Videotapes and close duplicity of Delta Scorpii from a graze observed in Arizona in July.

7) Probable solar eclipse expeditions.

A) Mar. 29, 1987, Gabon, Africa.

B) Oct. 27, 1987, China (attempt for joint IOTA/Chinese Academy of Science expedition).

C) Mar. 18, 1988.

8) ILOC seems to be two to three years behind in reducing data.

9) IOTA has installed a bulletin board for computer users; see *O.N. 3* (13), 272.

10) Observational hardware: Costs of photomultipliers, CCD's, image intensifiers, etc., are still expensive, but are becoming less expensive. It's too bad these costs don't come down as rapidly or as frequently as computers have done recently.

Respectfully submitted,
Charles H. Herold, Jr.
Executive Secretary, IOTA

WHERE ARE THE GOOD ANTARES GRAZES DURING 1986?

David W. Dunham

On Easter morning, March 30th, at 11:50 U.T., a graze of 1.2-magnitude Antares (Z.C. 2366 = Alpha Scorpii) occurs at Gakona, Alaska. This is the first graze of a 1st-mag. star in nearly 5 years, the last previous one having involved Aldebaran on 1981 April 8, according to Jean Meeus in *Astronomical Tables of the Sun, Moon, and Planets*, p. 5-51. Any observers at Gakona will have trouble seeing the graze, since the altitude will be only 1° above the southern horizon. The southern-limit path moves rapidly south, passing over Cape Suckling on the southern coast (altitude 3°), then passes southeastward across the northwestern Pacific Ocean. The path bends eastward and reaches land again shortly before sunrise in Oregon, where Richard Linkletter is organizing an IOTA expedition to observe the event near Klamath Falls. I hope that they will be successful. Although this is being written before the event, readers will receive this issue afterwards.

Last September and October, I prepared the North American grazing occultation map and text for my annual article, "Lunar Occultation Highlights for 1986," that was published in *Sky and Telescope 71* (1), 72 (1986 January). For the map, I have a computer program that scans the magnetic tape of grazes for the year generated earlier at the U. S. Naval Observatory, selecting grazes of stars brighter than 5th magnitude in regions A – F, XB, and XR that cover those parts of North America shown on the *S&T* map. Of these, I manually selected about 25 of the best events, and used the Meeusmap program, described in *O.N. 3* (9), 188 (1984 November) to generate plots from which *Sky and Telescope* artists drew the published map.

Of the selected grazes, four of them involve Antares, occurring on March 30 (southern limit, moon 75% sunlit, waning, maximum altitude along track 17°), May 24 (s. limit, 100% waning, max. alt. 21°), July 18 (s., 85% waxing, 36°), and October 7 (n., 22% waxing, 27°). Curiously, only the last event was included on the ILOC-based graze maps for North America published on pages 93 and 94 of the Royal Astronomical Society of Canada's *Observer's Handbook 1986*, and then only the daytime portion of the October 7th northern limit. It turned out that the events that were not included all occurred on the moon's sunlit (bright) limb, except part of the March 30th path in Oregon, where the cusp angle is small enough that some graze contacts will be against sunlit lunar mountains. The International Lunar Occultation Centre apparently rejects all bright-limb grazes, even those of first-magnitude stars that are in fact observable, especially with a star like Antares, whose red color contrasts well with the moon.

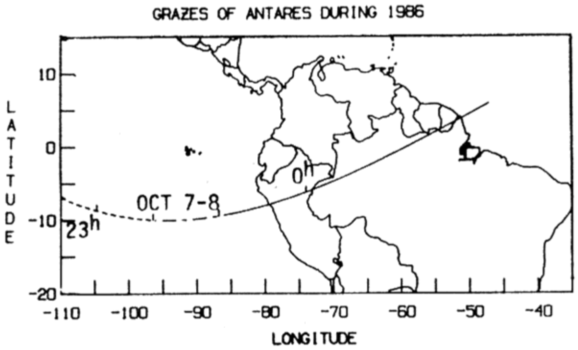
The best grazes are the ones that occur on the dark limb at night, when relatively long dimmings, partial blinks, and faint flashes are most readily apparent due to the large angular diameter, 0".04, of Antares. The only stars with larger angular diameters occulted by the moon are the Mira variable R Leonis (0".067) and the sun. Events involving Antares' greenish fifth-magnitude companion can be seen during dark-limb southern-limit grazes at night. As the *S&T* map and article show, the four North American Antares grazes are unfavorable for seeing the companion, with daylight or the sunlit limb interfering substantially for each. So I wondered, where are the spectacular dark-limb nighttime Antares grazes this year?

In order to answer this question, I used Meeus' Table II on pages 5-56 and 5-57 of his *Astronomical Tables* to select the dates and times of all 1986 events outside of North America (North American events are adequately covered in my *S&T* article), except for an unobservable one on December 1, where the elongation of the new moon from the sun is only 5°. I used T. Van Flandern's OCC program at U.S.N.O. to generate the basic input data for each graze, and then produced a world map of all the paths using the Meeusmap and Grazemap computer programs. Two maps are shown here, one for the Eastern Hemisphere, and one showing the Oct. 7-8 southern limit crossing northern South America (the rest of that path crosses no islands in the Pacific Ocean, passing about 200 miles north of Hawaii near moonrise). The southern map boundaries are -20°, since the southernmost path (the southern limit of the last event on Dec. 29) dips down to latitude -10° 17'. None of the paths shown are north of latitude +60°, although the first graze of the series, on March 30, starts at +64° with Antares on the southern horizon in Alaska. The maps are "false" projections, since the latitude and longitude scales are both linear. The longitude scale is compressed by a factor of cosine(22°), so that the best representation of the shapes of countries and landforms are in the tropics. The 1986 date of the graze is given near the southernmost part of each path. Time ticks are given at 20-minute intervals along each path, with U.T. indicated at each hour. Time always increases from west to east, and the ticks are more widely spaced near the ends of the path, where the altitude is lower and the motion of the moon's shadow is most rapid. The time ticks are on the side of the limit with an occultation, or north of southern limits and south of northern limits. At the ends of the path, Antares is between 0° and 1° altitude above the horizon. Conditions are represented by four different types of lines:

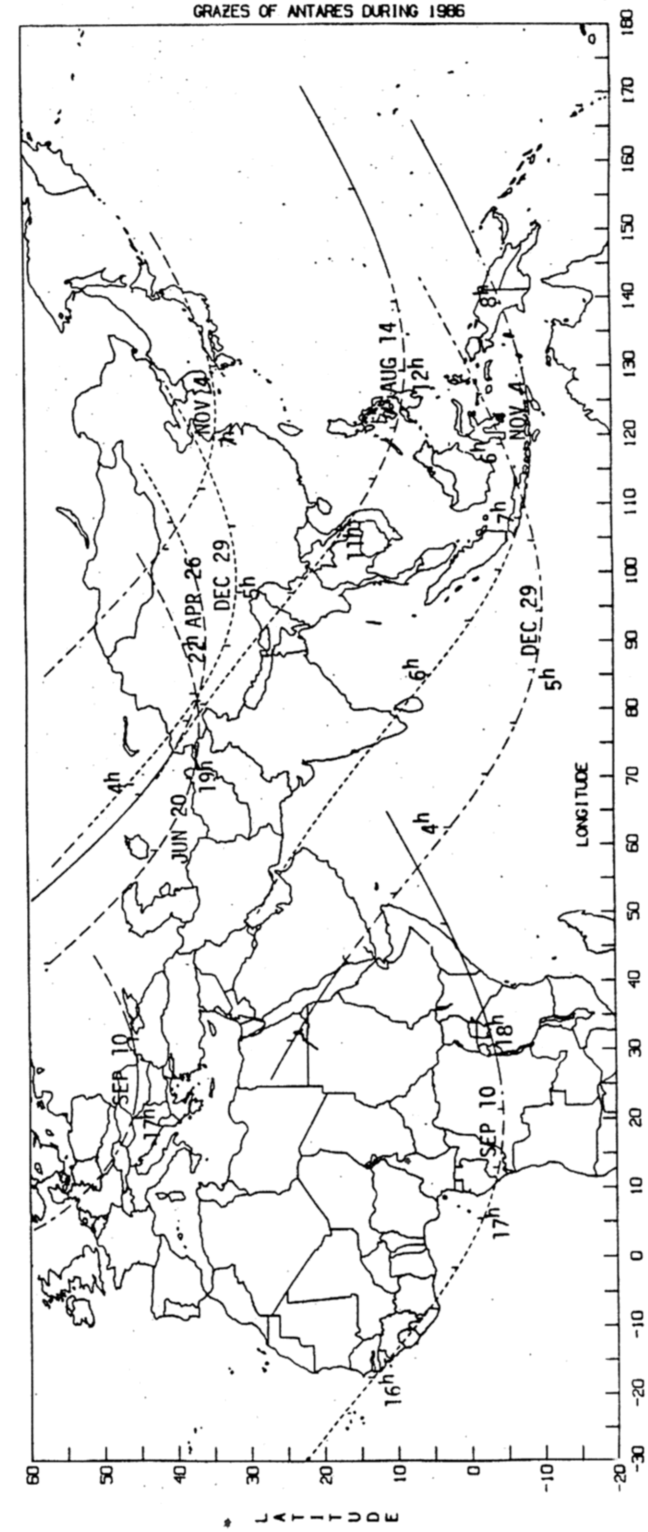
- ———— Solid, dark-limb, night.
- – – – – – Long dashes, bright-limb, night.
- ---------- Short dashes, bright-limb, day.
- -·-·-·- Alternating long and short dashes, dark-limb, day.

Some information about the limits shown on the map is listed in the table below. In the column after the date, labelled L (for limit), the northern or southern limit is specified. Next, the percent of the moon's disk that is sunlit is given, with + for waxing and - for waning. Under "Max. Alt." the star's altitude (Al), the sun's altitude (Sun), and the cusp angle (CA) are given at the point in the limit where the star's (and moon's) altitude is maximum. This point is in the center of the path, always a little west of the southernmost point of the smile-shaped paths. The altitude of the star at either sunrise (waning phases) or sunset (waxing phases) is given under the AS column. Finally, the longitude (Lng, east positive, the same as labelled on the map, but the opposite of the convention used in the computer predictions), latitude (Lat), and cusp angle (CA) are listed at the western and eastern ends of the paths. When the moon is waxing, the western end is in daylight and the eastern end in nighttime, while the reverse is the case when the moon is waning. For predominantly Northern-Hemisphere paths (the case for all of these), there is

GRAZES OF ANTARES DURING 1986



GRAZES OF ANTARES DURING 1986



no northern limit (it misses the earth's surface to the north) if the maximum altitude along the path is less than 62°.9. You can draw a diagram to show that this is the case; 1 − cosine(62°.9) = 0.545, which is the ratio of the moon's diameter to the earth's radius.

1986		%	Max. Alt.				Western End			Eastern End		
Date	L	Snl	Al	Sun	CA	AS	Lng	Lat	CA	Lng	Lat	CA
Apr 26	S	92−	24°	−22°	−2°	12°	52°	60°	1°	117°	45°	−9°
Jun 20	S	97+	23	−29	−23	1	42	58	−26	104	45	−12
Aug 14	S	66+	51	−29	−12	46	69	43	−15	171	22	5
Sep 10	N	43+	14	−1	4	14	4	59	7	44	51	−1
Sep 10	S	43+	64	6	−10	63	46	32	−14	65	11	8
Oct 7	S	22+	69	31	−6	51	−163	28	−11	−47	6	11
Nov 4	N	6+	27	26	−2	11	85	58	1	150	43	−12
Nov 4	S	6+	68	55	1	26	50	29	−6	166	7	16
Dec 29	N	6−	28	16	−20	7	57	57	−22	128	41	−7
Dec 29	S	6−	70	61	22	23	26	27	23	143	6	1

Write to me at P.O. Box 7488; Silver Spring, MD 20907; U.S.A., requesting detailed predictions, if you want to try to observe any of these events and do not have predictions for them in your normal IOTA grazing occultation prediction coverage. Specify the region where you hope to observe, so that a predicted profile can be prepared. Since the position angle of central graze changes rapidly along most of these paths, the profile changes also, so specify the longitude(s) of possible observation sites to less than 1°, if possible.

In general, the paths move southward during 1986. During 1987, the Antares grazes will move farther south, primarily into the tropics and southern temperate zone. But northern observers will have plenty of action, since a series of Spica occultations will begin from the north, the first being on 1987 February 18 in Canada and the U.S.A. A series of Pleiades passages will start late this year in the Southern Hemisphere. Passages will occur in Australia and New Zealand on October 20, and in South America on December 14, but the moon will be highly gibbous. Better passages will occur in 1987, as they migrate into the tropics and northern temperate zone late in the year. I plan to use the Meeusmap and Grazemap programs to generate maps of the northern and southern limits of occultations of Antares, Spica, and Alcyone during 1987.

Basic information about occultations of first-magnitude stars and the major planets during the rest of this century are given in Chapter 5 of Jean Meeus' *Astronomical Tables of the Sun, Moon, and Planets*, available from Sky Publishing Corp. and elsewhere. I highly recommend the book, since rather detailed predictions can be computed with the Besselian coordinates that are tabulated for each event. Formulae are given for using the Besselian coordinates to compute the times of disappearance and reappearance at a given place, or the northern and southern limits of the occultation. It should be easy to program the formulae in basic for personal computers; Meeus lists programs for HP-67, HP-41C, and TI-59 calculators. Meeus' other book, *Astronomical Formulae for Calculators*, is useful for auxilliary computations, such as the sun's position at any time; rising and setting times; and altitudes and azimuths. It also contains many other useful formulae that can be used to calculate an ephemeris from orbital elements, and approximate formulae, including major perturbations, for calculating the positions of the moon and major planets, but it does not cover occultations.

OCCULTATIONS AND APPULSES BY HALLEY'S COMET

David W. Dunham

This article is in three parts. The first discusses observations of previous events. The second discusses prediction updates based on astrometric and spacecraft observations. The third describes plans, as I know them in late March, for observing a few of the better occultations that will occur in April.

Observations of Previous Events. Predictions of these events were given starting on p. 302 of the last issue, and in *O.N. 3* (13), 281 and *3* (12), 253, where the star involved is identified (the star is also specified below only by its magnitude, unless it is in the SAO catalog). For the European events, only a summary list, sent to Jim Stamm, is available; presumably, all their observations are of appulses with no substantial dimming due to the comet noticed. All of the events occurred during 1985. The first four, in September, involved Comet Giacobini-Zinner (G-Z), while all the others involved Halley's Comet.

Sep 13, mag. 11.8 "J" (G-Z): J. Lecacheux observed this from Mt. Chiran, as did P. Rousselot at Besancon, both in France.

Sep 18, mag. 8.9 SAO 95515 (G-Z): A video record was obtained at Pic du Midi Observatory, France (other video records at Pic du Midi are indicated simply with "PdM" for other events below).

Sep 20, mag. 9.9 "N" (G-Z): J. Lecacheux at Bagneres, France.

Sep 21, mag. 10.6 "S" (G-Z): J. Barthes at Castres, France; observations were also made at Mt. Chiran Observatory, France.

Oct 30, mag. 11.6: PdM.

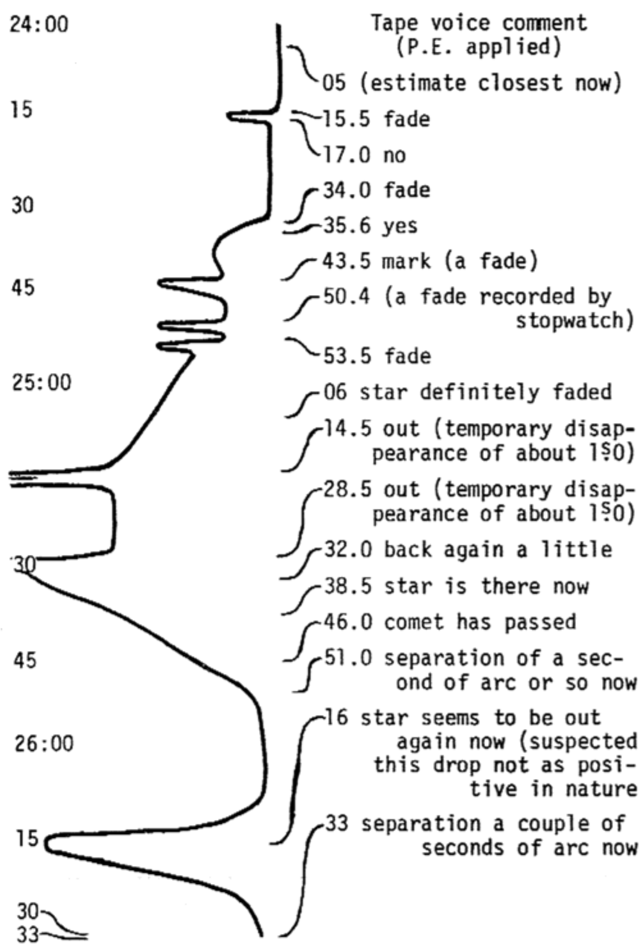
Nov 10, mag. 11.6: I observed this appulse at Silver Spring, MD. I estimate that the innermost (almost stellar-appearing) part of the coma was about 10th-mag., making it impossible to tell what happened to the star when they merged together, which lasted less than a minute due to Halley's rapid motion. Other than that, from 3:59.0 (when thin clouds parted, giving a good view) to 4:02 UT, no significant variation in the star's brightness was noticed.

Nov 12, mag. 9.0 SAO 76535: Observed by R. Heidmann and P. Mazalrey, Vernon, France; S. Maksymowicz, Mezieres s. Seine, France; and C. Blanchart and Y. Thirionet, Brussels, Belgium.

Nov 15, mag. 11.2: P. Anderson, Taylor Range Observatory, The Gap, near Brisbane, Queensland, estimated closest approach at 10:43.6 U.T., when the images appeared elongated, with the nucleus brighter than the star. The nucleus seemed to pass about 1" north of the star.

Nov 15, mag. 10.9: PdM and J. Vialie, La Rochelle, France.

Nov 19, mag. 8.2 B.D. +20° 531: P. Anderson observed substantial dimmings of this relatively bright star for about two minutes while the objects appeared merged together. Sky transparency and atmospheric seeing were good; a 41-cm f/6 Newtonian reflector was used visually at 198 power with VNG time signals and a tape recorder for timing. Anderson estimated that the nucleus passed about 0".8 south of the star; later astrometric updates to the IHW28 prediction are in good agreement with this, but with considerable uncertainty. Anderson "felt inadequate attempting something as complex as this without a photometer." Anderson's taped remarks and "guesstimated" light curve are shown in the figure.



The event was also observed by Charlie Smith in Woodridge, about 25 km s.e. of Anderson's location. Smith used a 25-cm f/6 Newtonian at 250 power and described sky conditions as "fair." He reports: "No occultation was observed, but the star did seem at times to (1) drop in magnitude; (2) appear "fuzzy"; and (3) be difficult to see." He also felt that the nucleus passed south of the star. His record is in rough agreement with Anderson's, with specific pertinent remarks as follows:

14:24:15.6 (U.T.) Star appears dimmer
:24:47 Star appears "fuzzy"
:24:56.7 Images merged, star in halo of comet
:25:11.3 Star still seems dimmer
:26:20.6 Difficult to see star

Smith remarked: "Eye strain could have been a factor involved, but the duration of concentrated observation was relatively short, and I am inclined to discount this. It seems to me that the star did fade during the observation and varied in appearance in quite a strange manner." Halley's motion was 0".10/second or 50 km/second in the sky plane at the time.

Nov 26, mag. 10.5: This event was listed in *O.N. 3* (12), 256, using orbit IHW24, but not in *3* (13), 282 because the IHW28 orbit shifted the path off the earth's surface to the south. But IHW33 would have moved it back north again (probably to Antarctica), and an A.C. star position error could easily have moved it farther north. P. Anderson observed this with the same equipment used for the above event, under similar conditions. He estimated that the nucleus passed 1" south of the star, remarking: "no events seen – comet passed to the south – not much more distant (if at all) than on Nov 19 – star was visible throughout."

Nov 28, mag. 9.0, B.D. +14° 228: PdM; E. Nezry, Bagneres, France; R. Boninsegna, Dourbes, Belgium; and Y. Thirionet, Brussels, Belgium.

In conclusion, faint stars usually seem to get overwhelmed by the brightness of the near-nuclear regions, making it impossible to tell what happens. The only star substantially brighter than the nucleus where a close appulse occurred was the Nov 19 event, the observations of which imply that significant dimmings might be seen hundreds of kilometers from the nucleus.

Prediction Updates. As this is being written, the latest available orbit is #45, utilizing observations made through March 10. It includes an 1100-km center-of-light correction at perihelion, which significantly reduced the residuals for recent observations. Don Yeomans notes that it predicted Giotto's target-plane miss distance to within about 50 km, with a 300-km along-path error. But even so, there has been little change in Halley's path since IHW33, mentioned in the last issue. From now on, I will use my YEOIHW31 prediction, which was used to produce all world and regional maps of Halley's Comet occultations in this and the last issue. The path shifts and time corrections, in the sense, IHW45 – IHW31, taking into account Yeomans' more accurate representation of the earth's orbit, are listed below:

1986 Date	Shift (IHW45 –IHW31)	Time Correction
March 29	0".14N	$0^m.33$ early
April 7	0.39N	0.16 early
April 14	0.71N (max.)	0.05 early
April 19	0.42N	0.02 late
April 24	0.45N	0.07 late

Subsequent updates will probably change these values by less than 0".5, and they are probably accurate to ±0".3. Yeomans continues to produce new orbits, and I may phone new corrections to H. F. DaBoll just before he types this article. [Ed: As this is being compiled, Dunham telephoned the results of a new orbit by Yeomans, IHW46, that includes observations through March 19th. It is very similar to IHW45. During April, the IHW46 – IHW45 path corrections are all north, by 0".02 from April 1 – 4, 0".03 from April

5 — 10, and 0".04 from April 11 — 27; the time correction is $0^{m}02$ early throughout. The April 24th path then shifts about 20 km farther north.] Yeomans will probably not include the spacecraft flyby results directly in his solutions until about April 10, but in the meantime, he can use his orbits to calculate target-plane miss distances, which can be used to check his calculations. Star position errors may now be more significant, since they typically exceed ±0".5 at the current epoch, and often exceed ±1".0 for G.C. stars (which are the only ones available for the events on April 4 and 17). I have sent letters to Southern-Hemisphere astrometrists, asking if they might be able to improve these star positions using recent plates and Perth 70 reference stars. If any significant improvements are sent to me, I will try to inform regional coordinators in the areas affected, and will put the results on my answering machine, where they can be obtained by calling 301,585-0989.

I will check with Neil Divine at J.P.L. to see whether his models, discussed on p. 307 of the last issue, should be modified based on the spacecraft flybys (it may be difficult to translate the spacecraft data into optical extinction factors). The damage suffered by the VEGAs and Giotto clearly shows that Halley has a much higher dust production than Giacobini-Zinner. The spacecraft experiences and the Nov. 19 observations described above seem to indicate considerable clumpiness to the dust near the nucleus, perhaps organized in jets, so that significant dimming might be seen at distances hundreds of kilometers from the nucleus. [Ed: Dunham talked with Divine, who said that it will take some time to incorporate the spacecraft data into his dust model. He noted that the spacecraft experiences were "within the expected (uncertainty) bounds" of his preflyby dust model. The spacecraft showed that the nucleus was at least twice as big as that used for the models, so that the near-nucleus extinction may be larger by a similar factor.]

Plans for Some Upcoming Occultations. Although the spacecraft flybys obtained much more accurate information than we can hope to gain from occultation observations, I believe that the latter can be valuable for determining dust production and possible jet structure at times a few to several weeks from the times of the spacecraft encounters. Especially, the experience with G-Z events demonstrated the need to obtain observations from pairs of stations a kilometer or more apart in the along-path direction, in order to obtain confirmed observations of cometary dimmings.

The predicted path for the April 7th occultation of SAO 226884 now crosses southern Baja California (where the altitude will be rather low), passes near Manzanillo and just southwest of Acapulco [very similar to the path for the lunar graze of Sigma Scorpii on March 30th, as shown in *Sky and Telescope 71* (1), 72] along the southwest Mexican coast, and then crosses northern Costa Rica, northern Colombia, northwestern Venezuela, and Martinique in the Lesser Antilles. Plot the April 7th correction on the map on p. 316 of the last issue. The uncertainties are such that observers in Mexico City and elsewhere in southern Mexico, and in the northern half of Venezuela, may see substantial dimming phenomena. I will keep Guillermo Mallén, Mexico City (telephone 595-6368) informed of prediction updates. Observers as far away as Texas and Florida are encouraged to monitor the appulse, since they may see some dimming phenomena.

Some IOTA/ES members, led by Hans Bode, will be observing Halley's Comet from Windhoek, Namibia. Their best opportunity will involve 9.6-mag. SAO 224173 on April 14, but the brightness of the near-nuclear regions may make it difficult to observe dimmings of the star.

SAO 179904, at mag. 6.8, is the brightest star that will be occulted by Halley. The event occurs on April 24th, the last occultation predicted by the comet at least through mid-1987. Regional maps in this issue show the updated IHW45 path, which now crosses the Australian Cape York Peninsula, passing close to Weipa, about 40 km north of Coen (where the paved road ends), 40 km north of Cooktown, 130 km north of Cairns, and about 200 km north of the northern tip of New Zealand. The uncertainties are such that the occultation by the nucleus could occur anywhere in the Cape York Peninsula area from Thursday Island and Bamaga to Cairns, and even the northern tip of New Zealand. But I believe that observers throughout New Zealand, eastern Australia, New Guinea, the Philippines, and southeastern China have some chance of seeing some dimmings by cometary material.

During 1835 and some other apparitions of Halley's Comet (but not 1910), there apparently were major outbursts that caused Halley to brighten by about 3 magnitudes about 70 days after perihelion. If that happens this time, the comet will be much more interesting to observe on April 24th than early in April, and there may be a lot more dust to dim the star. But the near-nucleus region may also brighten so much that it would interfere with monitoring SAO 179904, though this is unlikely.

Hiroki Yokota, Institute of Space and Astronautical Science, Tokyo, was able to obtain for me copies of infrared photoes taken with the Himawari ("Sunflower") weather satellite at 12^h U.T. on April 24 and 25 of 1984 and 1985. One shows no cloud over virtually all of eastern Australia, two show very thin cloud over $^1/_2$ to $^2/_3$ of the Cape York area, and the other is similar, but with some thick cloud (about 10%) as well. Steve Hutcheon inquired about ground weather observations in the area. At the time, the rainy season has normally ended, with about a 90% chance of clear sky at 12^h U.T. Thick cloud is fairly common during the early morning hours after 14^h U.T.

I plan to videorecord the appulse from the Cape York Peninsula, along with Steve J. Hutcheon; 41 Campbell Rd.; Sheldon, Queensland 4157 (near Brisbane; telephones area 07, 2064338 home and 3775297 office). Hutcheon will serve as the message center for the event, since David Herald will be on Norfolk Island (also near the path) at the time. My schedule currently is to leave the U.S.A. on April 19, arrive Sydney and fly on to Brisbane on the 21st, travel to Cairns late the 22nd, travel to the planned observation site the morning of April 24th, return to Sydney late the 25th, meet David Herald returning from Norfolk Is. the 26th, leave Sydney the evening of the 28th, and arrive back home the 29th. Anyone living in, or interested in travelling to, northern Queensland to increase his chances for seeing an occultation or large dimmings, should contact me or Mr. Hutcheon so that we can coordinate coverage of the occultation. The total eclipse of the moon occurring just after the cometary occultation will add interest to the endeavor, and we may try to set up at the limit of a lunar graze that occurs during the eclipse.

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; Cho-Ku; Tokyo, 104 Japan.

The number of reports received recently seems far below average. Possibly it is due to attention paid to Comet Halley; it is also possible that interest in grazes is waning in general. I hope that the mail system is not a factor. If your report does not show up in the graze list within a reasonable length of time, please send another copy to me with a note explaining the situation.

The nine stations for ZC 442 on 1986 Feb. 15 consisted of a five-member expedition to Oak Grove, MD, plus four backyard observers. Rather than list the effort as five separate expeditions, David Dunham and I have decided that for such situations, all stations should be combined into one entry in the list. The article will always individually name the ones who observed at home; for this graze they were Stephen Shervais of Dale City, VA; Stephen Ritger of Occoquan, VA; Bob Bolster of Alexandria, VA; and Brad Schaefer of Bowie, MD.

limit prediction, and it should be determined for the longitude of the actual site. Also, "Sky St" (the sky stability) and "Ap Cm" (aperture in centimeters) have some people confused. Sky stability is the best (lowest numerical) value reported by anyone in the expedition. Aperture in centimeters is the smallest aperture optics which achieved that best stability. #Sta, #Tm, Sky St, and Ap Cm should be given for the entire expedition, not for each separate report form.

Here in Houston, we have noticed (as have others) that, at times, no useful WWV signal can be received at 5, 10, or 15 MHz, probably due to sunspot minimum. This makes a backup for the Timekube essential; proper use of a digital watch can save the day in such a dire situation. If you are considering a short-wave radio as a source of time signals, the ability to receive 2.5 MHz is a real advantage; it usually comes in quite strongly when the higher frequencies fail.

On May 14, 1985, an expedition led by David Herald netted two grazes within five minutes without moving sites. Such double grazes have been done before, but this is a first (unless someone can inform me of a precedent) in that the two grazes were at opposite cusps of the moon! One was a 5.2-magnitude bright southern limb event, while the other star was mag. 4.6 on the north limb.

Citizen band (CB) radios, while receiving a lot of bad press in the past, are ideal as an expedition coordination tool. It just makes sense for each observing station to have the ability to communicate with all the others. Besides, they're quite a bit of fun in general.

Thank you for the reports received. May the skies be clear for all your graze expeditions.

The information about the graze of ZC 2912 observed in Luxembourg was mailed to David Dunham, and then phoned to me; the organizer's name was lost in the process. I will include the name in the next issue of *O.N.* Graze reports sent to Dunham suffer delays, cost IOTA extra postage, and stand an added chance of loss in the mail. It is fine to send David a copy of the report, but please send a copy to the primary recipient (me) at the same time.

I believe that the "POSITION ANGLE OF CUSP" printed on the limit predictions should be removed, since some people have been reporting it as their cusp angle. The correct cusp angle is listed as the last column of data on the

Yr Mo Dy Vp	Star Number	Mag	% Snl	CA	Location	# Sta	# Tm	S S	Ap Cm	Organizer	C St	WA	b
791223	3173	5.3	19+	2S	Sapporo City,Jap.	8	46	2	5	Kanya Kusano		177	-4
800122	0036	7.2	27+	1S	Akashi City,Japan	3	7	3	6	Masaki Ikada		181	40
800805	0729	7.2	26-	6N	Mukawa Town,Japan	8	26	2	6	Hidetoshi Yoshida		350	69
800806	0871	6.9	17-	5N	Osatsu Town,Japan	6	30	2	6	Kanya Kusano		349	62
801228	1758	7.0	55-	5S	Yono City, Japan	6	20	3	5	Toshio Hirose		184	-49
810312	0692	1.1	41+	10S	Honjyo, Japan	1	2	3	13	Isao Sato		170	64
811016	0653	4.8	86-	16N	Nakasatsunai,Jap.	3	14			Hidetoshi Yoshida		348	56
811016	0653	4.8	86-	16N	Shizunai Town,Jap	4	6	1	7	Hidetoshi Yoshida		348	56
811017	0837	6.1	76-	6N	Kisakata, Japan	4	8	2	13	Isao Sato		354	39
811117	1370	6.8	60-	6N	Fukushima, Japan	3	10	2	7	Yoshihiro Musashi		352	
820201	0398	6.7	49+	0N	Yaezu City, Japan	1	3	2	7	Yasuji Suzuki		0	67
820527	1277	5.5	24+	4N	Shimada City, Jap	4	12			Toshio Hirose		2	-18
821010	1215	6.9	40-	8N	Teshio City, Jap	12	40			Masayuki Tateno		351	-19
821012	098916	8.9	20-		Sakata City, Jap.	1	5	1	13	Isao Sato		349	-47
821024	188098	8.0	40+	6S	Porto Alegre,Brzl	1	6	1	15	L. A. L. da Silva		175	11
821029	3536	4.7	89+		Sakata City,Japan	1	7	1	13	Isao Sato		170	70
821103	0668	3.6	94-	20N	Fukutawara,Japan	15	52	1	5	Toshio Hirose		344	36
830925	0354	5.5	91-	22N	Arrow Bear, CA	1	6	2	26	Stephen Dale		342	49
850908	0840	6.5	42-	17N	Porto Alegre,Brzl	1	2	3	6	L. A. L. da Silva	0	342	-51
851020	2912	4.6	49+	1S	Luxembourg,Luxem.	8	24	1	10			178	
851115	2721	3.3	16+	-11N	Porto Alegre,Brzl	5	24	1	5	L. A. L. da Silva	5N	354	56
851119	164654	7.9	47+		Powhatan, NC	1	6	1	28	Mark Lang			
851206	1728	6.9	38-	10S	Damascus, TX	6	20	1	6	Don Stockbauer	0	193	-43
851215	189406	7.2	12+	18S	Tucson, AZ	1	4	1	15	R. Nolthenius	2N	169	71
860106	2172	4.7	21-	17S	Summerville, LA	2	10	1	20	Don Stockbauer	2S	197	20
860120	0489	7.2	70+	8S	Eden, MS	1	10	1	33	Benny Roberts	0	172	-20
860215	0442	6.9	42+	13S	Oak Grove, MD	9	45	1	20	David Dunham	2S	165	-15
860302	183654	7.6	62-	9S	Glastonbury, CT	4	21	1	10	Philip Dombrowski		192	38

OBSERVATIONS OF ASTEROIDAL APPULSES AND OCCULTATIONS

Jim Stamm

All asteroidal appulse reports should be sent to me at Rt 13 Box 109; London, KY 40741; U.S.A.

The reports of 1986 asteroidal occultations and appulses will appear in *O.N.* in two parts. Summaries of the first six months' events will be published in *Vol. 4*, Number 1 (if all of the foreign reports are in), while the rest of the 1986 events should be covered in *Vol. 4*, Number 3.

The new format will consist of two tables followed by a series of remarks. Table 1 will be a list of all events that were observed, with the number of stations submitting reports, and a notation if any of the reports were positive. Table 2 will be a list of all observers, their locations, and the events that they reported on. The remarks will cover noteworthy events.

Even though the times of the events will not normally be included in the summaries, they are as important as the location, and should be included in all reports. They will be used for analysis of possible occultations, and will be available to anyone interested in them.

Reports of positive observations that were confirmed, and certain other events, will be written up separately before the summary, so it is still important to get results to me (Rt. 13, Box 109; London, KY 40741; U.S.A.) as soon as practical. Once again I need to emphasize that negative observations are very important to us. Besides their use in analysing positive observations, they are critical for determining the existence of asteroidal satellites. And it does not matter how far from the path that the observation is made. Any event observed from anywhere on earth should be reported to us.

Unless stated otherwise, negative observations were made of the following events:

(386) Siegena and BD +06°1468, Mar 23, 1982: (*O.N. 2* (14), 192 and *2* (15), 204) David Dunham sent last-minute charts to the University of Washington to encourage coverage of the event, and an extinction was recorded from 05:44:36.33 to 05:44:47.49 (all times UTC) at Manastash Ridge Observatory. About 5 km north, Bob Mitchell at Ellensburg recorded an occultation from 05:44:38.8 to 05:44:49.2. Joe Palmer and Dick Linkletter did not see any event from Goldendale (about 60 km south).

(15) Eunomia and SAO 77636, Mar 30, 1982: M. D. Overbeek at Edenvale, South Africa, recorded a 12.5-sec. occultation beginning at 17:17:15.6 and ending at 17:17:28.1. The sky was hazy, and the seeing fair, but unocculted stars were visible throughout the observing period.

(2) Pallas and SAO 104751, May 4, 1983: (*O.N. 3* (8), 167) The details of the observation of this event from Engel'gardt Observatory at Kazan', USSR (which was originally reported to IOTA only indirectly) are published in *Sov. Astron. Lett. 10* (1), 26 (p. 67 of the untranslated version) (Jan.-Feb. 1984) by V. B. Kapkov. Figure 1 displays the tracing recorded during the occultation. The 23.49-sec.

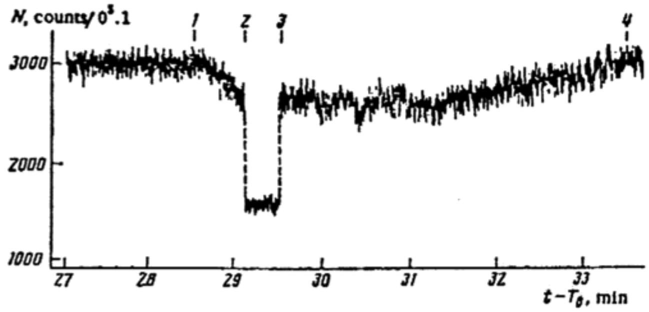


FIG. 1. The occultation curve. T_0 = 1983 May 4^d22^h UT.

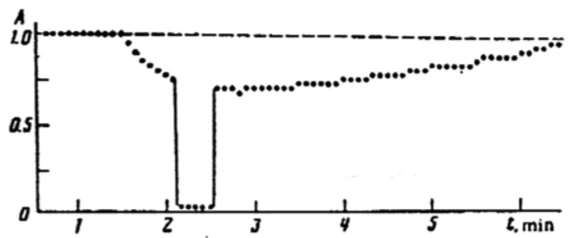


FIG. 2. A computer model of the occultation of a $9^m.2$ star by a $10^m.5$ asteroid accompanied by a cloud of gas and dust. Model parameters: a = 2000 km, cloud eccentricity ε = 0.68, particle density $3 \cdot 10^4$ m^{-3}, grain radius R = 1 μ, constant r_0 = 2400 km, F = 0°. The ordinate A is the normalized star brightness.

event began at 22:29:09.23 and ended at 22:29:32.72. Kapkov noted the dip in the signal both before (interval 1 − 2 in Fig. 1) and after (interval 3 − 4) the event. To test the hypothesis that absorbing material may surround the asteroid, Kapkov considered two computer simulations of the occultation. A good example of a model fit is shown in Fig. 2. Kapkov suggests that the cloud may be dust grains and gas resulting from meteorite impacts.

(564) Duddu and SAO 76544, Feb 18, 1985: Jost Jahn at Molin, West Germany.

(2613) 1979QE and SAO 75757, Jul 24: Peter Manly, Thomas McGrath, and Bob Bryant from central Arizona.

(47) Aglaja and SAO 76790, Jul 24: Peter Manly, Thomas McGrath, and Bob Bryant from central Arizona.

(14) Irene and SAO 191052, Aug 7: Don Stockbauer and Don Oliver from Texas.

(230) Athamantis and SAO 108346, Sep 1: Peter Manly, Thomas McGrath, and Bob Bryant from central Arizona.

(606) Brangane and SAO 128195, Sep 5: Joaquim Fort at Maia De Montcal, and V. B. Esteller and V. B. Beltran at Benicarlo, Spain.

(196) Philomela and SAO 189888, Sep 30: A. Schott and W. Palzer at Wiesbaden, West Germany. P. Baruffetti and C. Raffo at Massa, Italy. Collurania Observatory at Teramo, Italy. J. Cano and J. Gomez at Mollet, Spain. French observers J.-C. Royer and F. Vaissiere at St. Genest-Lerp; J. Vialle at La Rochelle; and the Meudon Observatory.

(18) Melpomene and SAO 96175, Oct 5: N. Wunsche and H. Lorenz at Berlin, West Germany.

(602) Marianna and AGK3 +22°0048, Oct 6: A. Schott

at Wi.-Freudenberg and H. Lorenz and N. Wunsche at Berlin, West Germany. Y. Thirionet at Philippeville, Belgium. J. Ribas at Mataro, J. Gomez at Mollet, Diego Rodriguez at Villalba, and Jordi Miralda at Terassa, Spain. M. Cavagna at Sesto St. Giovanni, and R. Di Luca at Tizzano, Italy.

(326) Tamara and SAO 56917, Oct 13: W. Palzer at Wiesbaden and A. Schott at Wi.-Freudenberg, West Germany. Belgian observers C. Baetens at Boechout, D. Baise and L. Zimmermann at Brussels, R. Boninsegna at Dourbes, M. Deconinck at Limal, N. Jonlet at Glons, D. Soumagne at Soumagne, and B. Thooris at Wervik. F. Boinck at Valkenswaard, Netherlands. French observers P. Rousselot at Besancon, H. Le Tallec at Toulouse, and J. Barthes at Castres.

(755) Quintilla and SAO 96897, Oct 15: W. Palzer at Mainz-Kastel and A. Schott at Wi.-Freudenberg, West Germany. J. Barthes at Castres, and Y. Thirionet at Nyons, France.

(1334) Lundmarka and SAO 111607, Oct 20: W. Palzer at Wiesbaden, West Germany. Belgian observers C. Baetens at Boechout, R. Boninsegna at Dourbes, D. Soumagne at Soumagne, Y. Thirionet at Charneux, B. Thooris at Werwik, and L. Zimmermann at Brussels. J. Barthes at Castres and H. Le Tallec at Toulouse, France. Spanish observers Joan Bullon and Jose Torres at Sacanet, M. Cruz at Sevilla, and Manuel Cortes at Lleida.

(1533) Saimaa and SAO 117433, Oct 21: A. Schott at Wi.-Freudenberg, West Germany.

(258) Tyche and SAO 115015, Oct 24: Belgian observers C. Baetens at Boechout, Y. Thirionet at Hevillers, and D. Baise and L. Zimmermann at Brussels. P. Mazelrey at Vernon, France.

(1099) Figneria and SAO 60505, Nov 30: The Pic du Midi Observatory at Bagneres and J. Barthes at Castres, France.

(214) Aschera and SAO 157963, Dec. 2: J. Barthes at Castres, France.

(115) Thyra and SAO 127949, Dec. 6: Tony Murray at Georgetown, GA. Ferrucio Ginelli at Fortaleza, Brazil.

(89) Julia and SAO 41024, Dec 9: Tony Freeman at Berkeley, CA. Mark Lang at West Raleigh, NC. Thomas Langhans at San Bruno, CA, obtained a 1-sec. photoelectric drop in signal.

(115) Thyra and SAO 128060, Dec 14: Greg Lyzenga at La Verne, CA.

(1639) Bower and SAO 118847, Dec 14: Thomas Langhans at San Bruno, CA. Greg Lyzenga at La Verne, CA.

(560) Delila and SAO 128767, Dec 29: Peter Manly from central Arizona.

(1567) Alikoski and SAO 420838, Dec 29, 1985: Peter Manly from central Arizona.

(510) Mabella and SAO 115666, Jan 15, 1986: The predicted path of this event crossed the central United States from coast to coast, giving a large number of observers a chance to record an occultation. In addition, the weather was generally cooperative. I have received 1 positive and 15 negative reports so far. Analysis of this event considers only those stations that were located between the center line and the 0".1 N track. Other observations will be included in the six-month summary.

David Dunham reported that last-minute astrometry was inconclusive, possibly shifting the path a little to the north. And that is, indeed, where Walter Russell recorded an occultation lasting from 04:39:20.5 to 04:39:22 (UTC) — at Boone, Colorado. Close-track negative observations were reported by Mark Lang at Cary, NC; G. Roger Harvey at Concord, NC; Bob Oldham at Burnsville, NC; Jim Stamm at London, KY; Joe Senne at Rolla, MO; and Glenn Erickson at Davis, CA.

Fig. 3 represents a plot of the six stations translated to Russell's cross-track line, with respect to Mabella's shadow. Russell's chord is shown as a line, and the circles define the asteroid's shadow (assuming a sphere), depending on whether Russell's chord is a southern or northern one. It appears that two or three other observers could have confirmed Russell's observation with occultations of their own, or shown that Russell could not have seen a primary occultation. Unfortunately, the only negative observer who began monitoring early enough was Harvey. Russell's event was 7 minutes early! Could Mabella have been that much ahead of the predicted time?

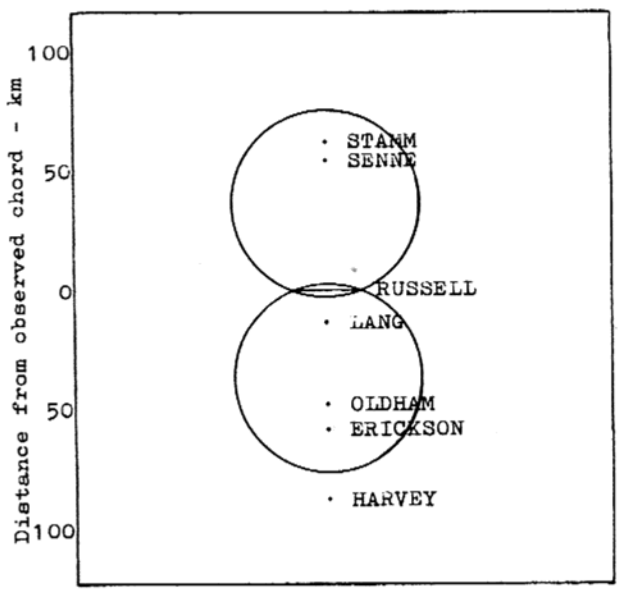


Fig. 3. Observers' stations relative to Mabella's shadow as determined from Russell's observation.

There are two reasons why I have included this report, whose conclusion is a question rather than an answer. I had nearly completed an extensive analysis which seemed to be leading to the conclusion that Mabella's diameter was some 20% less than the published value, when I looked at the observation times. I thought that I might extract something significant before throwing the whole thing away, and maybe that will come with a subsequent observation report. More importantly, I wanted to request that observers expand their observation windows somewhat. If the 5 negative observers had monitored just a few minutes earlier, we could have easily shown what Mabella's diameter was, or that Russell could not have seen a primary occultation. I have been suggesting that we observe the number of minutes equal to the number of seconds of maximum duration, with a minimum of 10 minutes, and a maximum of 40 minutes. It appears that we should extend the minimum to 15 or 20 minutes.

ANALYSIS OF TWO POSITIVE ASTEROIDAL OCCULTATION REPORTS

Roland Boninsegna

Two reports of asteroidal occultations that I have received in 1985 were not compatible with other information on the events. I have made calculations in order to try to determine whether the events reported were of primary occultations.

The positions of the reporting stations were projected onto the Besselian plane, and then shifted to a single line, which was perpendicular to the asteroid's motion. The results are shown in Figures 1 and 2.

In the case of (145) Adeona, Fig. 1 clearly shows that a primary occultation could not have occurred at La Paz, Bolivia (see *O.N. 3* (14), 297). A visual observer situated only ½ km south of the La Paz track recorded a miss. Also, a photoelectric survey and a visual observation at Jungfraujoch Observatory by M. Dumont, P. Louis, and me revealed no occultation.

A possible occultation was also reported from St. Andre, France, but two independent observers at St. Genest reported misses.

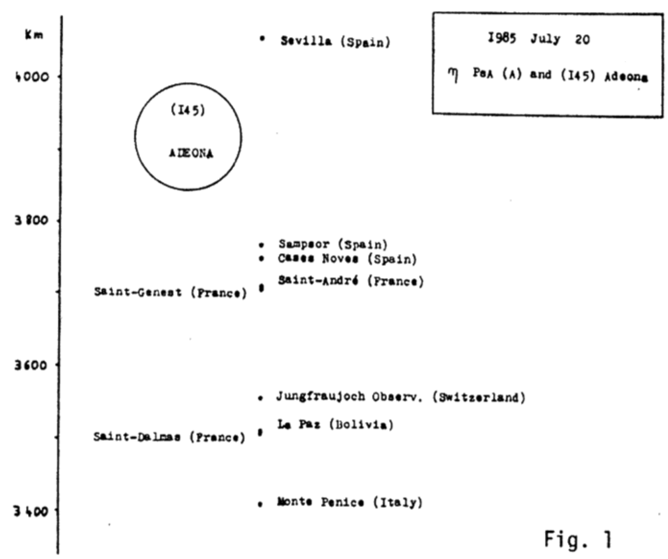


Fig. 1

For (2601) Bologna, not all of the stations reporting observations are represented in Fig. 2. However, it is plain that much more data could have been obtained if the diameter of the asteroid were considerably larger than its estimated 21 km.

The positive report came from Peter Serne at Amsterdam (see *O.N. 3* (14), 297). He recorded a 4.6-sec. occultation, which would require a minimum diameter

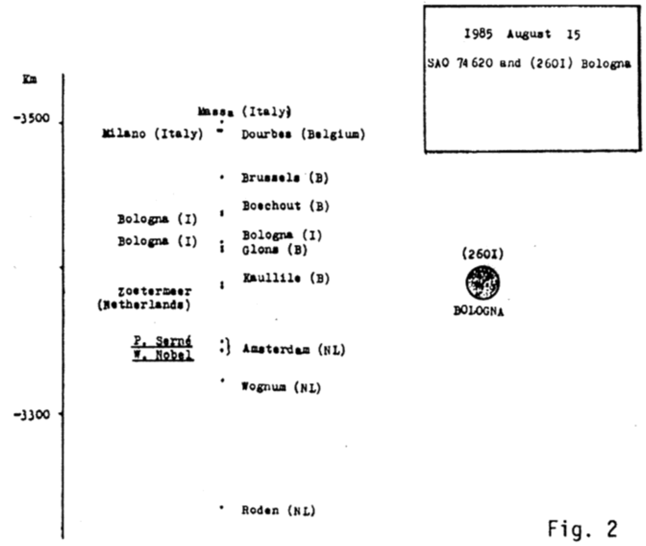


Fig. 2

of 24 km for Bologna. However, less than 7 km from Serne's track, William Nobel recorded a miss. No conclusion can be drawn from this case, except that it will be very difficult to obtain good shape and diameter definition for asteroids which have diameters less than about 50 km.

ASTROMETRIC UPDATES FOR ASTEROIDAL OCCULTATIONS

David W. Dunham

In previous issues, information about astrometric updates has virtually always been included with articles about asteroidal appulse and occultation observations. Since Jim Stamm assumed the responsibility of collecting the observations and writing summary articles about them for *O.N.*, and since I calculate most of the astrometric updates (some of which result in no observations), we have had to closely coordinate and merge our articles. In order to save some time, effort, and expense, we will try to publish our material separately for awhile, unless there are only one or two astrometric updates. Also, for cases where astrometric updates are obtained, I will describe some of the coordination of efforts to secure observations, and some of the unsuccessful attempts. For a few of the well-observed occultations, especially ones where I led the effort, I will write special articles giving some results. But for the large majority of cases, the results will be published by Jim Stamm, as they have been on p. 325 of this issue.

For some events, I have not been involved with the astrometric updates. I would appreciate it if others who perform such calculations would inform me of their results, and I will include them in articles such as this one, to make them more complete. Contributions should be sent to me at P.O. Box 7488; Silver Spring, MD 20907; U.S.A., or can be telephoned to 301,585-0989.

All of the astrometric updates that have not been reported in previous issues are listed in the table below. The date of the occultation is given under "Oc Date," the number of the minor planet is under "MP#," and the star number (SAO if six digits; B.D. or C.D. if degree-zone is given; or other special designation) is under "Star." The date that the plate(s) were taken is given under the next column headed "Date." Codes are given under LEOR to indi- the location (Q = Quonochontaug, RI, plates taken and measured by William Penhallow; H = Mt. Hamilton, or Lick Obs., CA, plates usually taken by Gene Harlan and measured by Arnold Klemola), number of Exposures, Object (A = asteroid only, S = star only, B = both), and Reference stars (A = AGK3; P = Perth 70; R = AGK3R; S = SAO; and blank = plate not independently reduced so that no following data are given), respectively. The cross-path correction (measured perpendicular to the asteroid's motion) to my nominal prediction, as shown on regional maps and/or Sôma's world maps with star position and orbital elements sources given in previous issues, is listed under "Shift"; the direction (N = north, etc.) follows the number. Finally, the along-track correction converted to time in minutes ("-" for earlier than the nominal prediction, "+" for later) is given under "Time Cor." Entries are given under "Oc Date," "MP#," and "Star" only for the first-obtained astrometry. If a year and fraction is given under "Date," the asteroid was not on the plate, which was measured only for stellar data. A "+" preceding the date indicates that the shift and time correction were computed using the correction for the asteroid listed with the "A" (asteroid) plate above plus the new star corrections. If, in these cases, "B" (both) is given under "O," it means that secondary reference stars were measured and used to re-reduce the "A" exposures listed above it to calculate the shift and time correction.

Oc Date	MP#	Star	Date	LEOR	Shift		Time Cor.	
85Dec30	18	114658	Dec22	Q3AS	0″.59N	±″.2	$-1^{m}.8$	$\pm 0^{m}.3$
			+1980.87	H3BR	0.07N	.07	−1.25	0.3
86Jan15	510	115666	Jan 2	Q3AR	0.00	.4?	−0.8	1
			+1977.13	H1SR	0.10N	.4?	−0.1	1
86Jan17	511	077911	Jan 9	Q4A				
			+1978.	H4BR	0.48S	.25	+0.7	0.6
86Feb 1	2	170643	1954	H1SP	0.6 E	.3	0	2
86Feb 8	444	137517	Jan26	H3BR	1.09S	.10	−1.6	0.4
			+Feb 4	H4BR	1.14S	.08	−1.5	0.3
86Feb18	90	080082	Feb 3	Q3AS	0.8 N	.5	−1	1
			Feb16	H3AR				
			+1975.93	H1SR	2.80S	.3	−4.6	1.0
86Feb24	494	076104	Feb 2	Q3AR	4.2 N	.8	0	3
86Mar 3	162	119391	Feb28	H4BR	2.62S	.08	−15.4	0.3

85 Dec 30: The updated path crossed central Newfoundland; Lake Winnipeg; and Calgary, Alberta, where the altitude was low. I telephoned observers in each of those areas. I monitored the appulse from Silver Spring, and estimated that Melpomene was about a magnitude brighter than the star, so that any occultation would have been very difficult to detect visually. Melpomene seemed to pass north of the star, as expected.

86 Jan 15: During the evening just before the occultation, I watched the television weather satellite photo, and called several potential observers in the path where it looked like clear skies would occur; a few of those I talked with said they were going to try anyway, before I called them. Jim Stamm discusses the results on p. 326.

86 Jan 17: The updated path crossed the eastern Aleutian Islands and the eastern Bering Sea. The star is Chi 2 Orionis, the brightest to be occulted by an asteroid during 1986. I sent an IOTA press release to several newspapers, some members of the American Astronomical Society, and two Astronomical League members in southern and western Alaska. A planned expedition was cancelled due to infrequent airline service and poor weather prospects in the area of the predicted path.

86 Feb 1: The update should have been considered much more uncertain than the quoted error due to the lack of astrometry for Pallas (in spite of its well-determined orbit) and proper motion error propagated from the early epoch of the Lick plate.

86 Feb 8: Using the first update, I mailed copies of a notice about the occultation to 84 observers in and near the predicted path, which crossed southern Texas and the Mexican border region with AZ and CA. Satellite images showed thick cloud cover from a Pacific storm over northwestern Mexico, AZ, and CA, so I concentrated last-minute telephone efforts on potential observers in southern Texas, where clear skies seemed to prevail. Paul Maley, Chuck Herold, and Gary Nealis flew from Houston to Harlingen, TX, and attempted observation from two separate sites. Two minutes before the occultation, adiabatic cooling caused the sky to become suddenly overcast, several hours earlier than predicted. At about the same time, the low clouds also hindered the pilot of American Airlines flight 844; it struck two landing light stanchions as it attempted to land at Harlingen. The flight was diverted to San Antonio. Damage to the Boeing 727 caused by hitting the stanchions was not discovered until after two other flights, making national news. Paul Maley entitled an article about their effort for the Johnson Space Center Astronomical Society newsletter, "Gyptis Gypped Us."

86 Feb 18: Penhallow said that his exposures the night of February 2-3 suffered from poor seeing and underexposed images of the faint asteroids. He recommended that discordant results be discarded. Since his three exposures of Antigone indicated shifts of 1″.46S, 0″.95N, and 0″.59N, I decided to discard the first one for the first-listed prediction. He got more consistent results on the 16th, when he overexposed SAO 8082 to obtain good images of Antigone. When reduced with secondary reference stars supplied by Klemola (who also supplied SAO 80082's accurate position from the same plate), the shift for Antigone amounted to 1″.58S, in close agreement with the first Feb. 3 exposure that I had discarded; the other two were bad! The star correction pushed the path even farther south, over southern Brazil, Bolivia, and northern Chile, but since the result became available only a few hours before the event, I couldn't get word to possible observers there. A satellite photo near the time of the occultation showed lots of clouds over Brazil, but clear in Bolivia and Chile.

86 Feb 21: For this occultation of SAO 97838 by (48) Doris, overcast skies persisted throughout the U.S.A. for most of the week preceding this event, preventing any astrometry in spite of planned efforts at three widely separated observatories. The bad weather continued through the night of the event, so it is doubtful that any observations would have been obtained, anyway.

86 Feb 24: See remark for Feb 18. The large north

shift pushed the path off the earth's surface far to the north, so no further astrometry was deemed necessary, especially with the other potentially better events in February demanding the attention of scarce astrometric resources.

86 Mar 3: This apparently accurately predicted path shifted far to the south, where it crossed Bogota, Colombia; southern Venezuela; northern Brazil; and Bulawayo, Zimbabwe. I sent telegrams to coordinators in the three South American countries, but don't know whether they were received in time, since the event occurred at the end of a weekend. I tried to telephone M. D. Overbeek in Edenvale, South Africa, but got no answer; he told me in a subsequent letter that he tried to observe a lunar graze some distance away the morning of March 2, and disconnected his phone to get some sleep before that journey. A few hours before the event, I did reach J. Barsby in nearby Hutten Heights; he told me it was raining. Overbeek noted that rain spoiled efforts in South Africa, and an observer in Bulawayo couldn't attempt it since his telescope was dismantled.

86 May 12: The next asteroidal occultation potentially visible from North America for which astrometry is planned involves SAO 143749 and (393) Lampetia. Logistics for the last-minute prediction update will be complicated by my being out of town from the afternoon of May 7 to the afternoon of May 11 for the IOTA meeting in Texas (see p. 317) but at least some information can be exchanged via my answering machine (I can retrieve messages from remote phones).

OBSERVING REAPPEARANCES

Dietmar Büttner

This article is addressed mainly to those observers who have little or no experience in observing lunar occultation reappearances. For two reasons, the number of reappearance observations is much lower than the number of disappearance observations, (ratio about 1:2.5):

1) Reappearances of stars at the dark limb mainly occur during the second half of the night, when generally the number of astronomical observations is lower than during the first half.

2) In case of a reappearance, the star is not visible before the event. This causes difficulties and uncertainties in locating the star at the moment of reappearance.

In order to provide a large number of occultation observations equally distributed around the moon's orbit, more reappearance observations than now are needed. This need is also expressed by the higher V-code allocated to reappearances in the USNO total occultation predictions (V = value of the event). Except for grazing and nearly grazing occultations, reappearances at the dark limb occur during waning phases of the moon. Especially, during the first days after full moon, reappearance observations are very difficult and only sensible for bright stars, whereas at lower illumination of the moon's disk, reappearances of fainter stars may be observed surely. A precise prediction of the occultation time is quite useful. In case of the USNO predictions computed for the observer's location, the necessary period of intense concentration is reduced to a few seconds. The main problem in observing reappearances is locating the correct point of reappearance at the moon's edge. At least one of the position angles given in USNO's predictions may be used as a sufficient help for orientation.

At crescent or smaller phase, the cusps are defined distinctly; thus the cusp angle (CA) may be used as the best (although if the earthlit features are clearly visible, the WA (Watts angle) can also be very useful). CA gives the angular distance of the occultation point from the nearest cusp. It is positive at dark limb and negative at bright limb. The nearest cusp is denoted by N for north and S for south. During the first days after full moon, the use of WA is advisable. For this purpose, one marks a scale from 0° to 360° at the periphery of a small chart of the moon, counterclockwise starting at the moon's north pole. With the argument WA from the prediction, the observer looks at the chart for a prominent object in the vicinity of the terminator and estimates the position of the reappearance point relative to this object. Practicing this method at the telescope several times during the last minutes before the reappearance improves the chance for a successful timing. As most moon charts are drawn for zero libration, the actual libration at the time of occultation (given as topocentric libration in USNO's predictions) should be considered, especially when near its maximum values. The application of actual librations in conjunction with the WA is described in detail by David Herald in *o.N. 1* (12), 127-128.

In my experience, the angles PA (position angle) and VA (vertex angle) are not as convenient in finding the reappearance point. These angles are referred to the lunar limb point nearest to the celestial pole, and to the zenith, respectively. As these two points are only defined mathematically, but not indicated prominently like the cusps or features at the limb, they are more difficult to use, especially if the telescope has a rotatable tube or a star diagonal.

Generally, the orientation is facilitated if the dark limb of the moon is visible in earthshine. In such cases, the observer has a favorable guide to imagine the lunar disk to be a full circle, and he can see the actual limb. For visual observations with small instruments, one uses such a magnification as to show the lunar disk about as large as the view field of the telescope. A higher magnification may be used for very bright stars.

A diaphragm covering half of the view field turned out to be quite useful at my telescope. It permits covering the illuminated portion of the lunar disk partly or totally in such a way that the eye experiences much less glare from moonlight. This allows for possibility of observations of fainter stars and for more convenient observation. The reduction of the visible illuminated portion of the disk by using such a half diaphragm turned out to be more practicable than the use of a smaller field due to higher magnification. A half diaphragm may be produced easily by substituting the cross of a crosswire insert of an ocular with a semicircular piece of cardboard or razor blade.

Of course, the observer must consider that he must focus his telescope at other (preferably faint) stars ***before*** the event.

Especially, nights with several favorable reappearances are interesting to the observer. Practicing the particular method for finding the occultation point several times within a few hours enhances the certainty in looking to the correct location. Besides, staying up for observing several reappearances in the second half of the night is more rewarding than for only one event.

For his first observations of reappearances, an observer with little experience should select such events as occur under favorable circumstances, especially bright stars and low phase of moon's illumination (say about 60% and lower).

Following these advices and overcoming his reluctance to interrupt his sleep, an observer will see that reappearances are not too difficult, and that successful observations of them are mainly a question of training.

THOSE UNNAMED LINES

Homer F. DaBoll

What do you call those horizontal lines on a predicted profile, some of which you transfer to a tracing of a topographic map of the area where you plan to mount your graze expedition? Of course, the most important of these lines are the sea-level limit and the elevation-corrected limit, or the central line of a solar eclipse, but what about those other parallel lines drawn to indicate various depths in the shadow of the moon, such as one second south, or 1.5 kilometers north?

Every discipline has its jargon. Even the term 'graze', in the sense in which we use it, has no meaning to the vast majority of the English-speaking population, but is familiar to us, and convenient to use. I would like to suggest a word to call those lines mentioned above. The word is 'isoskiatic' (eye"so·skee·at'ik) [from Gr. ισοσ, equal, and σκια, shade or shadow], n. and a. (Analogous to isoclinal and isogonic, the word can be used as either noun or adjective; 'isoskiatic' is the exact equivalent of 'isoskiatic line'.) connecting, or a line connecting, points on the earth's surface which are equally deep in the shadow of a solar system object as cast by an extraterrestrial luminous body, or the representation on a map of such a line.

SOLAR SYSTEM OCCULTATIONS DURING 1986

David W. Dunham

Notes about individual asteroidal and planetary occultations during the remainder of 1986 are given below, as a continuation of the article with the same title which began on p. 301 of the last issue.

Apr. 29, (16) Psyche: The star is Z.C. 905 in Orion.

Apr. 30: The star is Z.C. 3275 = 45 Aquarii.

May 4: Mars will be about 90% sunlit, so its defect of illumination (or defect, the maximum width of the dark crescent separating the terminator and the edge of the dark limb) will be 1".2.

May 11: (216) Kleopatra's lightcurve indicates that it is very elongated, possibly a contact binary asteroid. A brief secondary extinction was seen from two sites during an occultation in October 1980, described in *o.N.* 2 (11), 140-141.

May 12, (336) Lacadiera: The star is Z.C. 2518 = A.D.S. 10561. The components are nearly equal at mag. 8.6 and 8.8. The separation is about 0".29 in p.a. 88°. The paths of the occultation of the two components are then separated by 0".17 (about twice the diameter of Lacadiera) with an along-track difference of 0".24, amounting to a 39-second time difference.

June 10: The star's light will be focused by Venus' atmosphere to produce a brief ring of light around Venus' dark limb probably much brighter than the star itself. Such a central flash is potentially visible along the central lines of all of this year's occultations, except perhaps the ones late in the year, when Venus' angular size is so large that the light of the star refracted in Venus' atmosphere will be blocked by the Cytherean clouds.

June 22: The star is Z.C. 202.

June 28: (171) Ophelia has an unusual light curve that some investigators claim may be caused by a large satellite.

July 1: The star is Z.C. 1515.

July 18: The star is Z.C. 2978.

Aug. 5, Jupiter: The star is Z.C. 3472. For practical purposes, Jupiter will be fully sunlit, with no significant defect, making observation difficult; the star's color differs by only one spectral type from that of the sun. Gordon Taylor predicts an occultation of the star by Ganymede around 8^h of August 6, probably visible from Central and northern South America.

Aug. 5, (19) Fortuna: The star is a distant "secondary" of 6.1-mag. SAO 93284, which has the same B.D. number and lies 2' to the south.

Aug. 10: The star is Z.C. 2995. The star is a close double, with 6.8 and 7.2-mag. components separated by about 0".1 in a p.a. of about 14°.

Aug. 14: Venus will be 55% sunlit.

Aug. 18: Venus will be 53% sunlit.

Aug. 26: The star is Z.C. 1887. Venus will be 49% sunlit.

Sep. 6: Mars will be 89% sunlit with a 1".8 defect.

Sep. 7: The components are mag. 7.3 and 9.8, separated by 0".8 in p.a. 206°, according to the last observations made in 1938, provided by Wayne Warren from the I.D.S.

Sep. 11: Venus will be 40% sunlit.

Sep. 28: Venus will be 28% sunlit.

Oct. 1: Venus will be 26% sunlit.

Oct. 9: Mars will be 86% sunlit with a 1".8 defect.

Oct. 29: The star is Z.C. 1459.

Nov. 13: (9) Metis may have a large satellite; see *O.N.* 2 (7), 76.

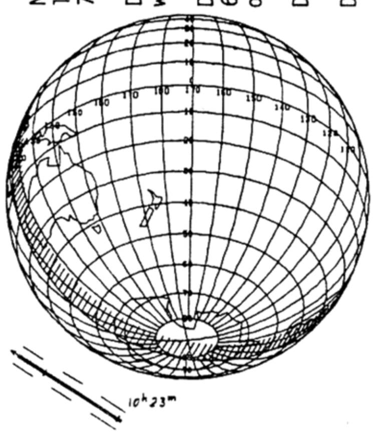
Dec. 1: Mars will be 86% sunlit with a 1".2 defect.

Dec. 22: The star is Z.C. 650 = 63 Tauri in the Hyades, and is a one-line spectroscopic binary.

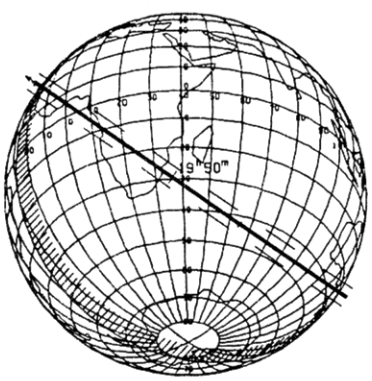
Dec. 26: The star is Z.C. 2162.

Dec. 28: The star is Z.C. 917.

Finder charts for North American and European events not included in E. Goffin's supplements, Sôma's world maps, and some regional maps for events during the next few months that were not included in the last issue, are given in the remaining pages of this issue.

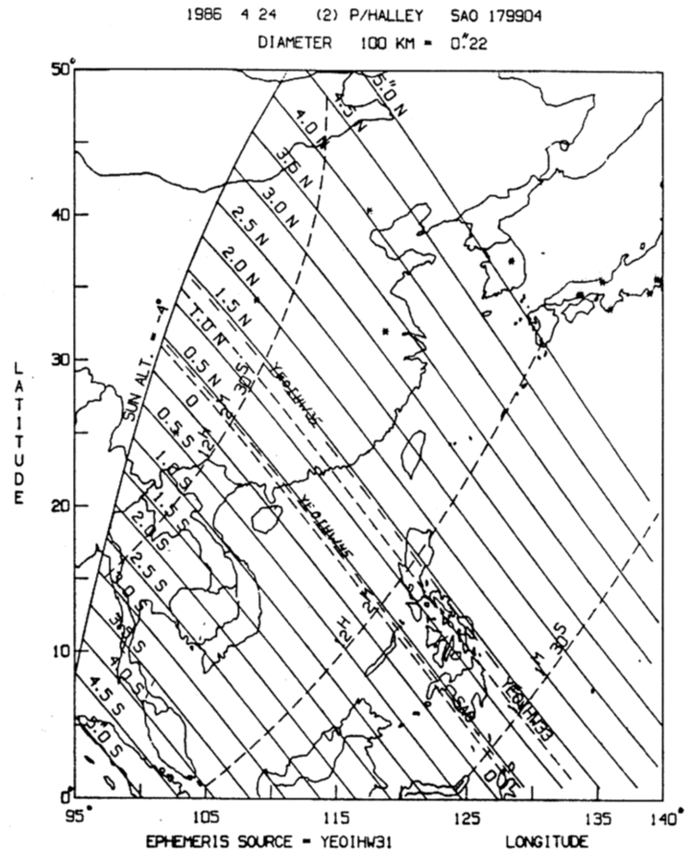


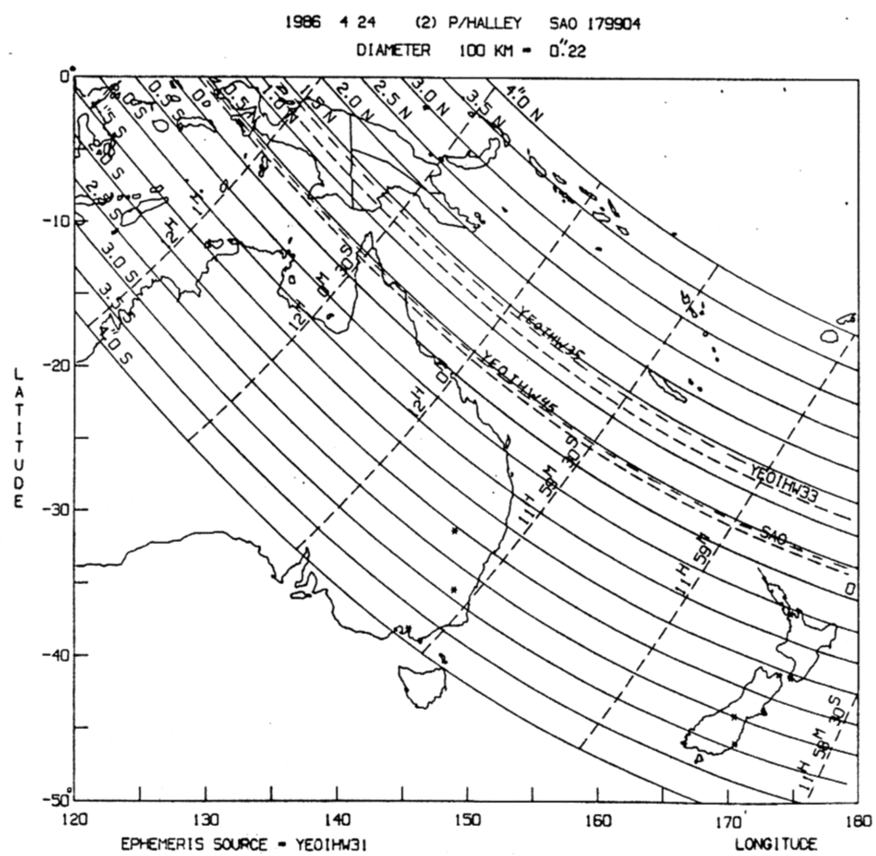
SAO 203688 by P/Halley 1986 Apr 17

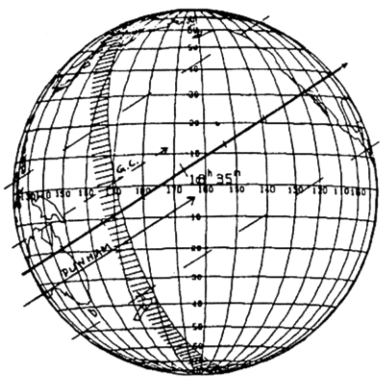


SAO 203363 by P/Halley 1986 Apr 18

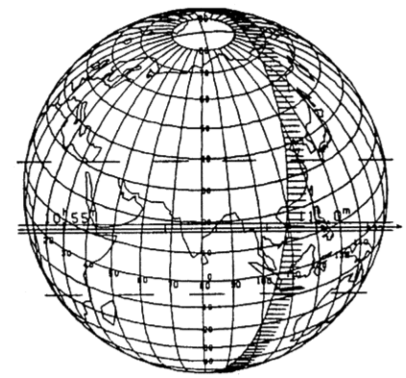
SAO 179904 by P/Halley 1986 Apr 24



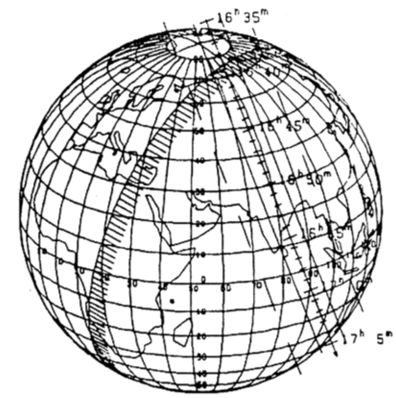




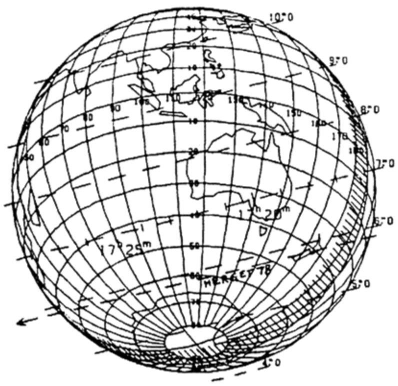
SA0145581 by Scheherezade 86 Apr 21



SAO 78559 by Patientia 1986 Apr 25

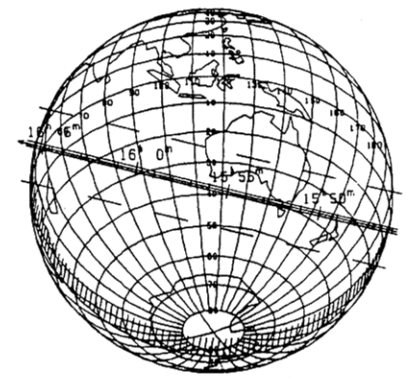


SAO 81466 by Ceres 1986 Apr 26

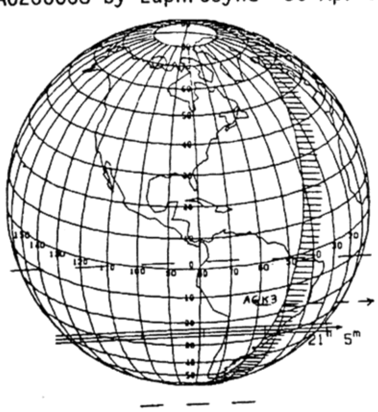


SA0206608 by Euphrosyne '86 Apr 26

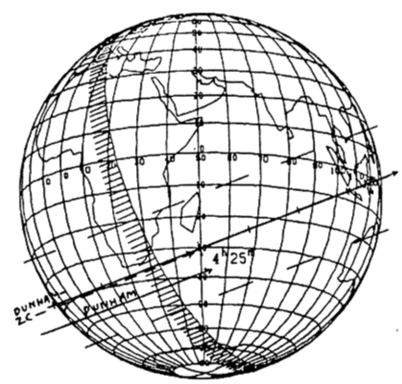
+01°1752 by Pallas 1986 Apr 28



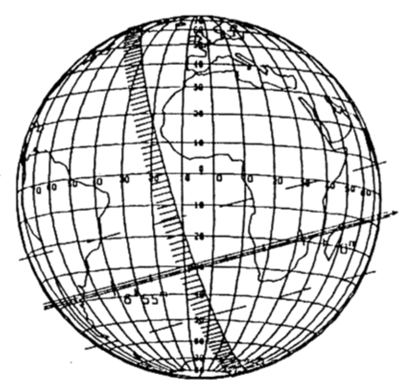
SAO 205232 by Aegle 1986 Apr 29



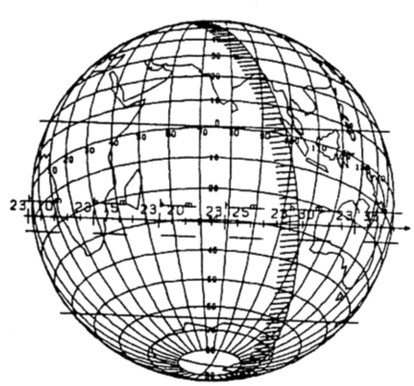
SAO 77813 by Psyche 1986 Apr 29



SAO 164996 by Velleda 1986 Apr 30



SAO 145289 by Ino 1986 May 2



SAO 187831 by Mars 1986 May 4

SAO 190235 by Pandora 1986 May 7

SAO 146166 by Comacina 1986 May 8

1986 5 8 (489) COMACINA SAO 146166

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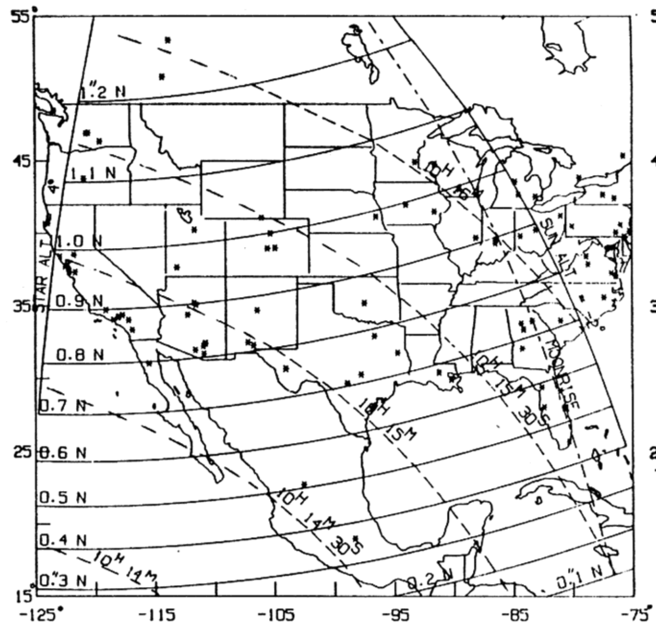

LONGITUDE

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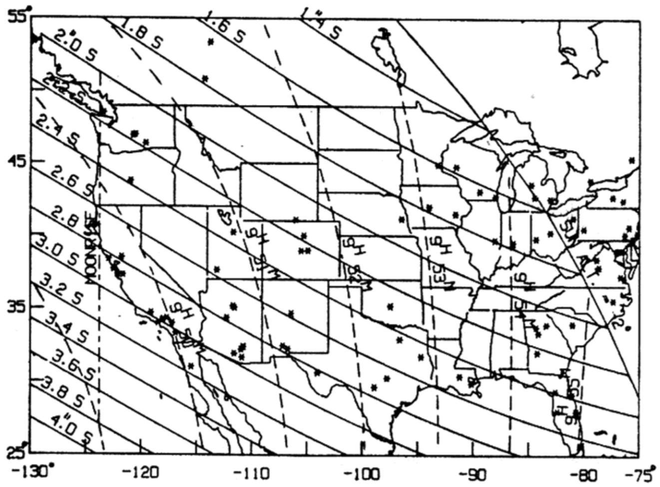
1986 6 1 (42) ISIS SAO 190252

DIAMETER 104 KM = 0."11

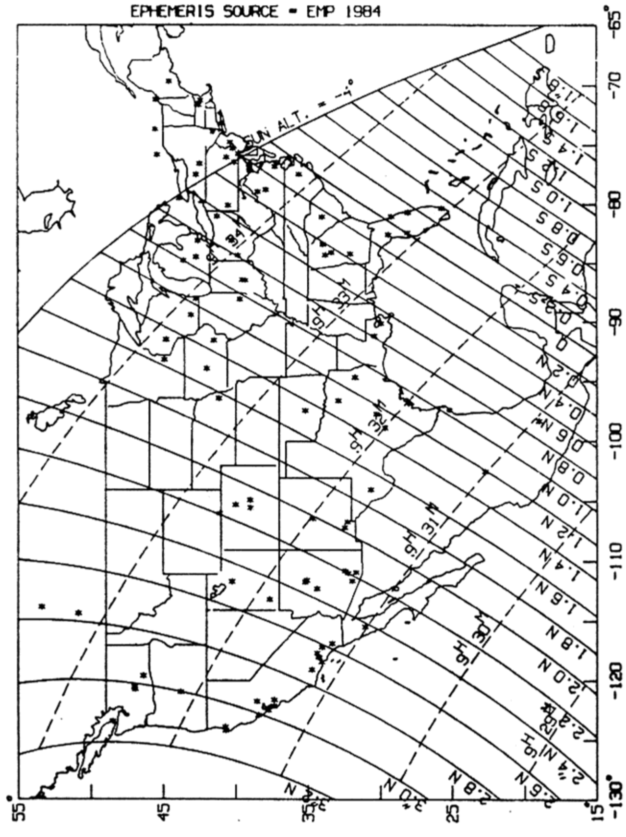


LONGITUDE

EPHEMERIS SOURCE = HERGET77

1986 5 12 (393) LAMPETIA SAO 143749

DIAMETER 117 KM = 0."12



LATITUDE

LONGITUDE

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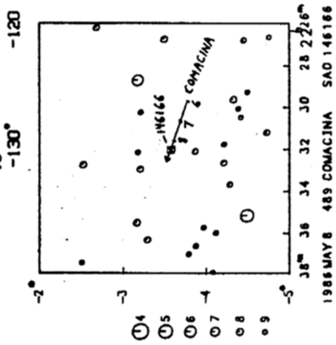
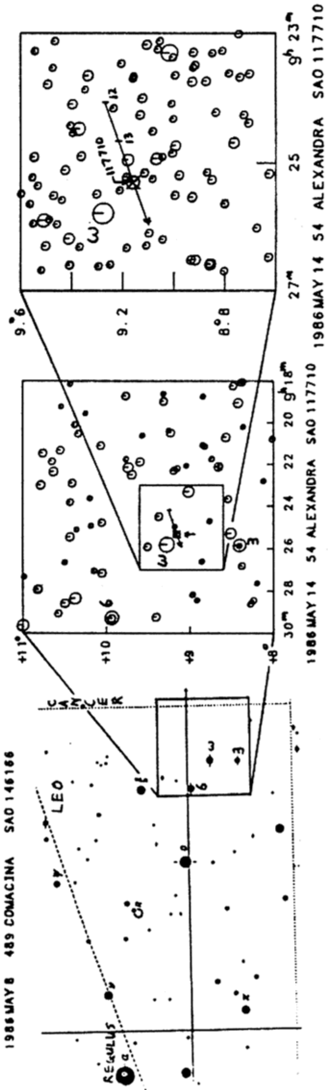
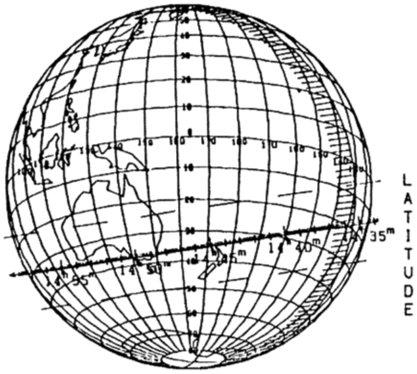
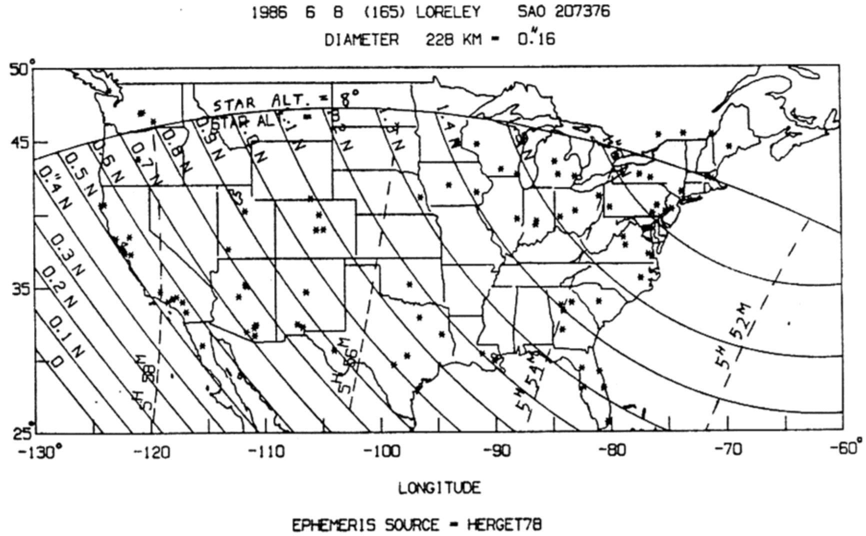
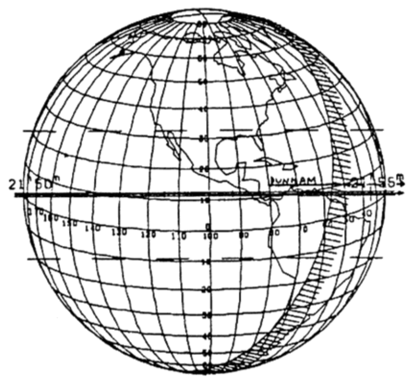




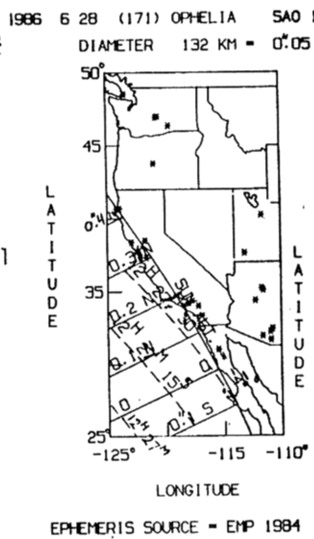


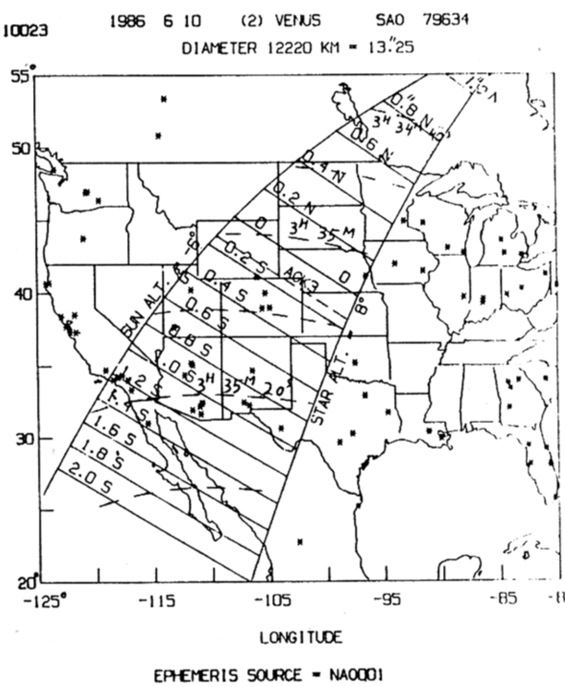
SAO 160139 by Aletheia 1986 May 10

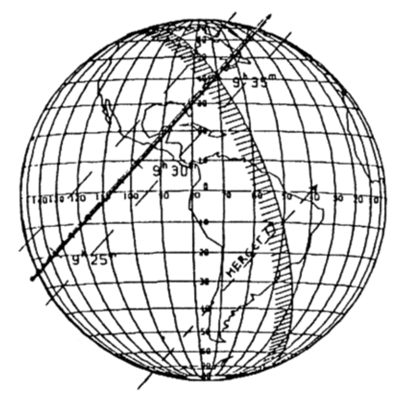




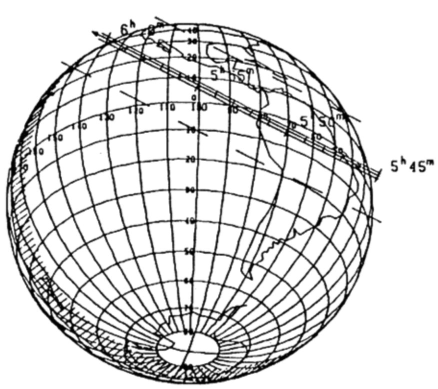
SAO 95631 by Kleopatra 1986 May 11



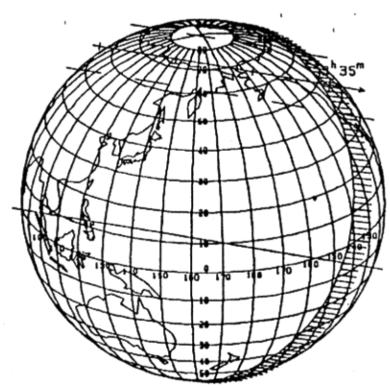




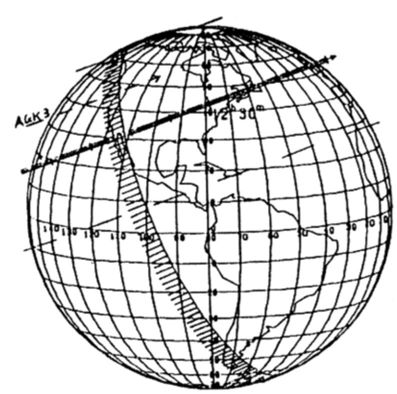
SAO 143749 by Lampetia 1986 May 12



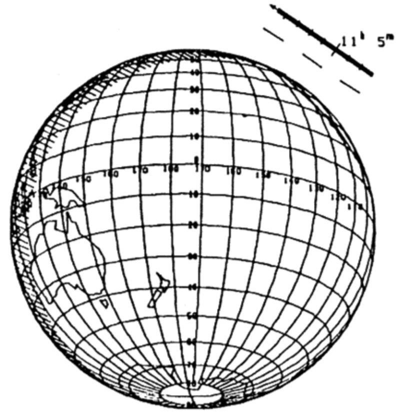
SAO 207376 by Loreley 1986 Jun 8



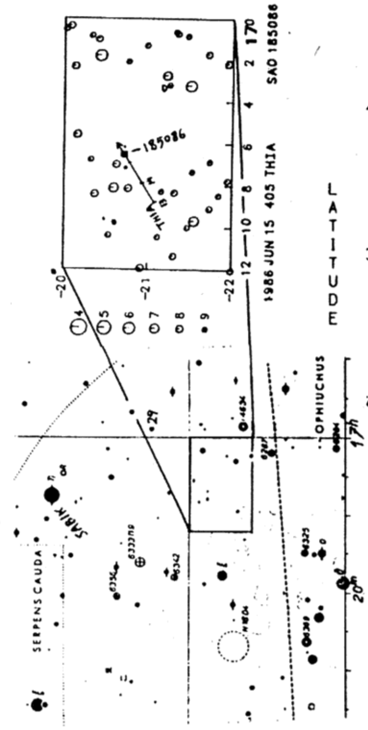
SAO 79634 by Venus 1986 Jun 10

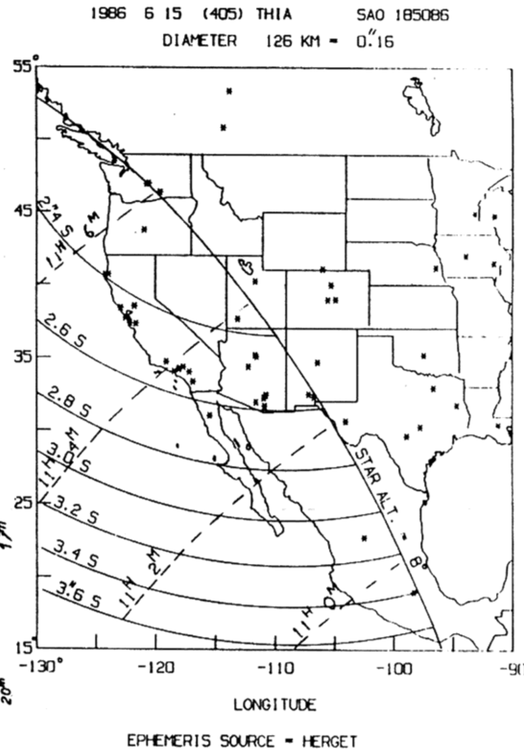


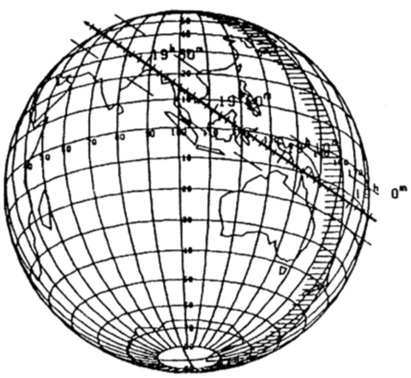
SAO 110023 by Ophelia 1986 Jun 28



SAO 185086 by Thia 1986 Jun 15

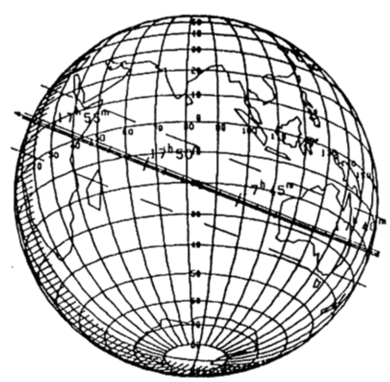




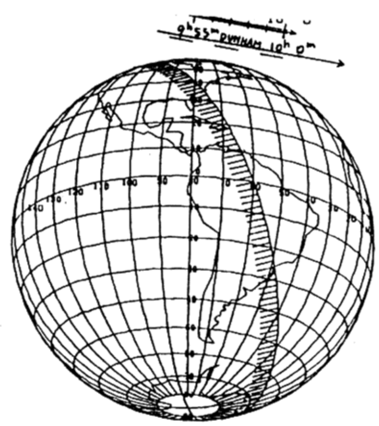


SAO 185428 by Lacadiera '86 May 12

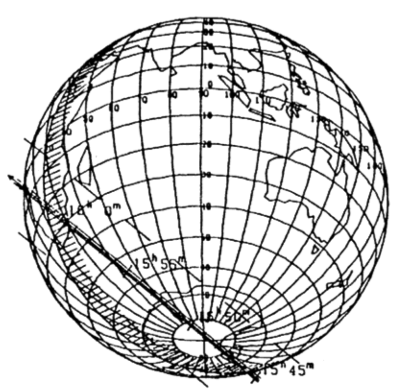
SAO 117710 by Alexandra '86 May 14



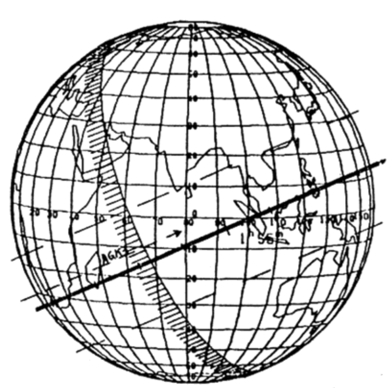
SAO 183016 by Ate 1986 May 16



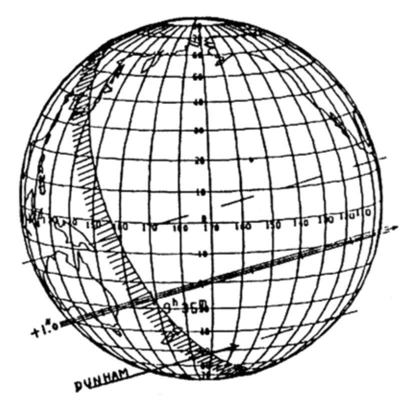
SAO 190252 by Isis 1986 Jun 1



SAO 204909 by Aegle 1986 May 19

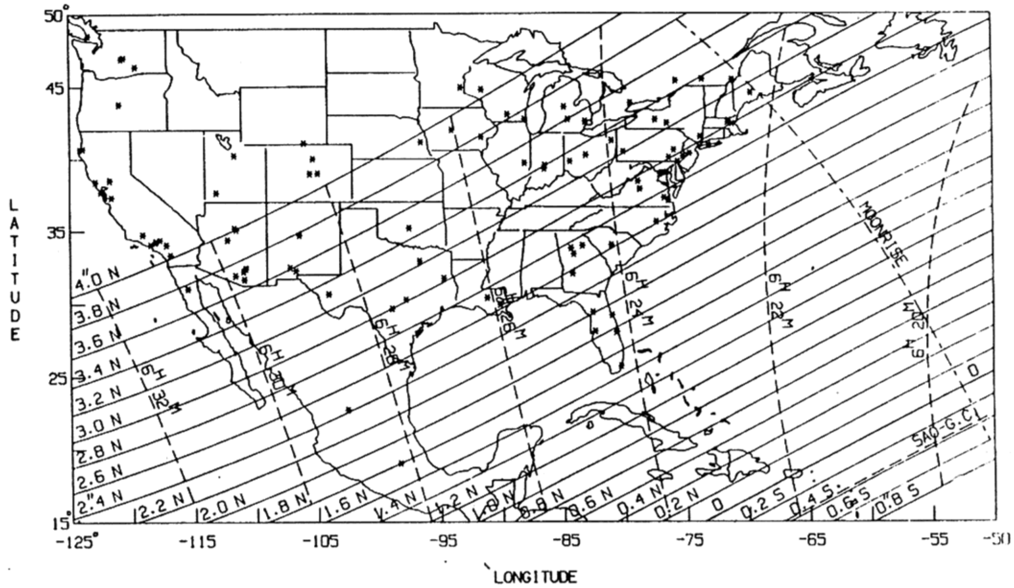


SAO 109835 by Havnia 1986 Jun 22



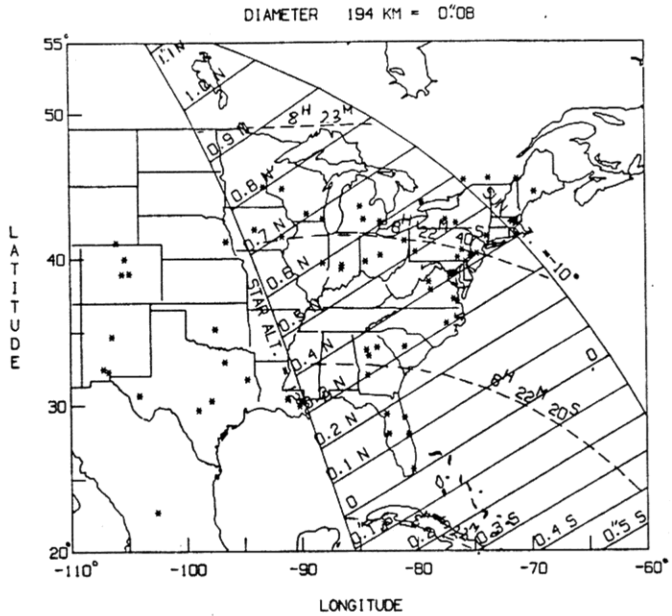
SAO 110625 by Irene 1986 Jun 29

1986 7 4 (306) UNITAS SAO 161893
DIAMETER 53 KM = 0".07



EPHEMERIS SOURCE = EMP 1985

1986 7 14 (409) ASPASIA HPN 2257
DIAMETER 194 KM = 0".08



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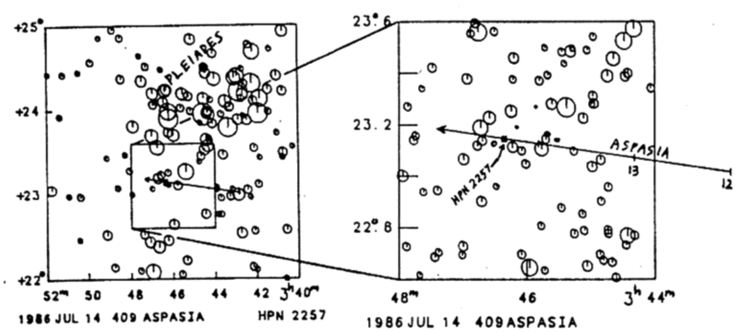
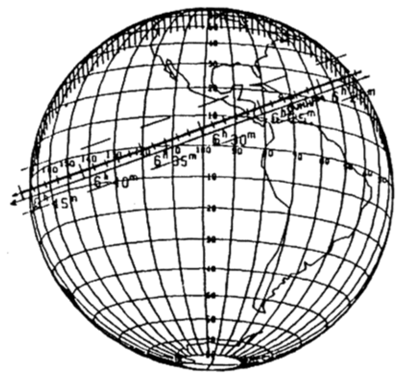
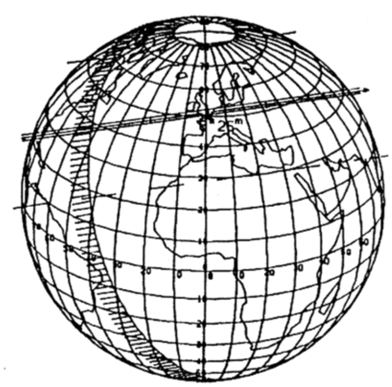
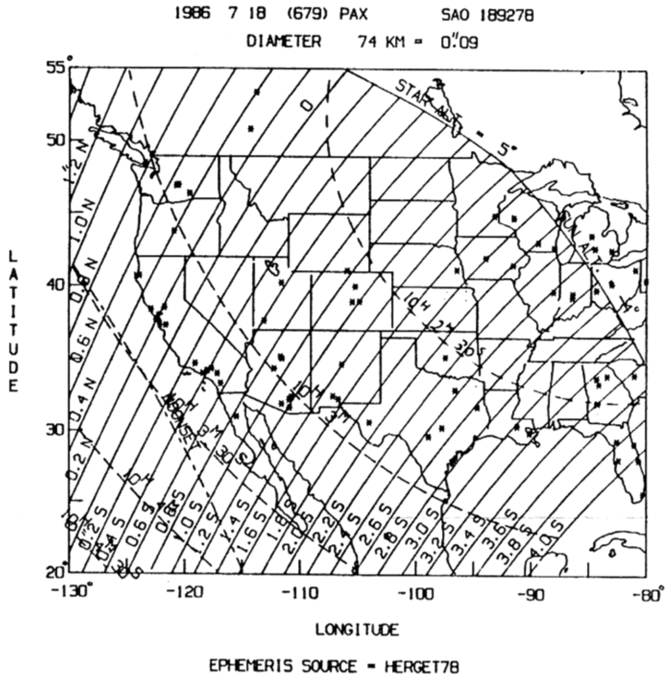


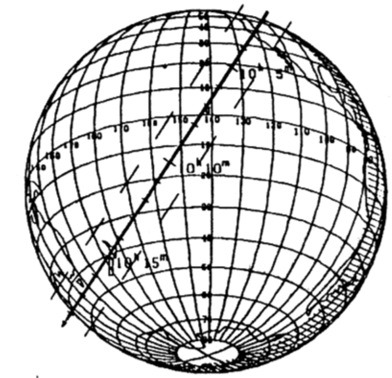


SAO 161893 by Unitas 1986 Jul 4

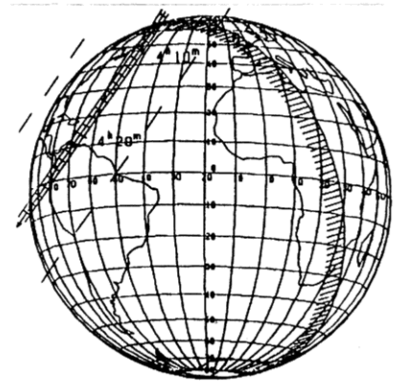


HPN 2257 by Aspasia 1986 Jul 14

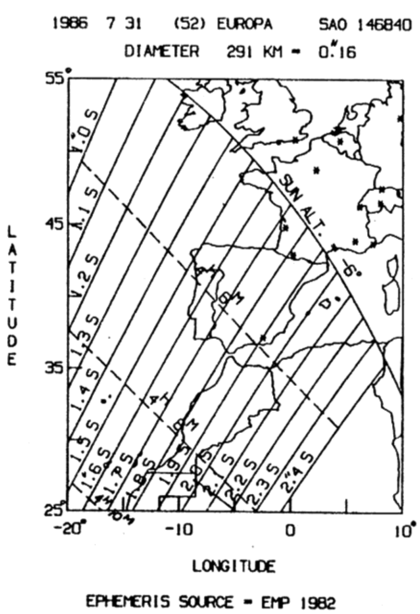


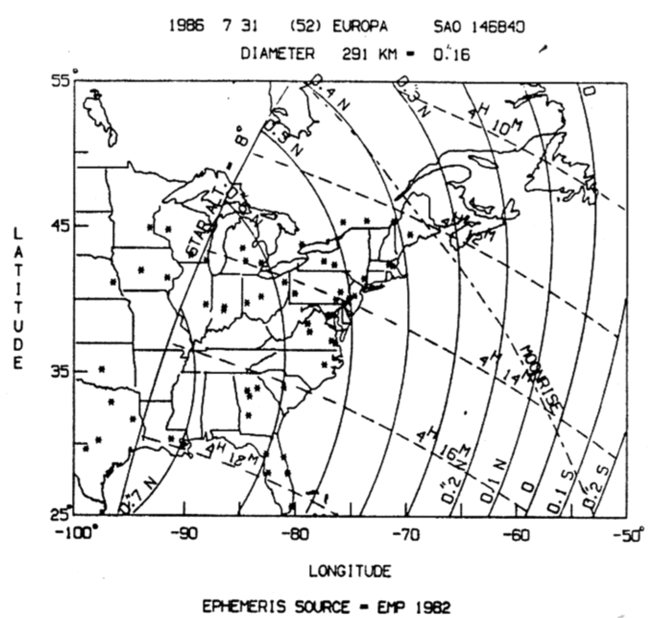


SAO 189278 by Pax 1986 Jul 18



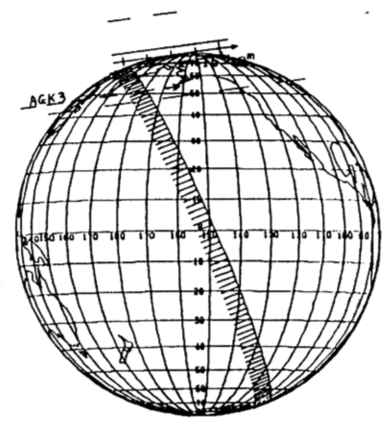
SAO 146840 by Europa 1986 Jul 31



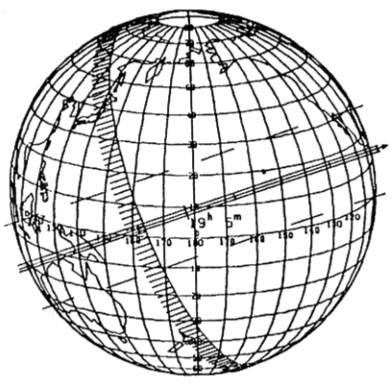


SAO 99081 by Themis 1986 Jul 1

LS 162 by Melete 1986 Jul 2

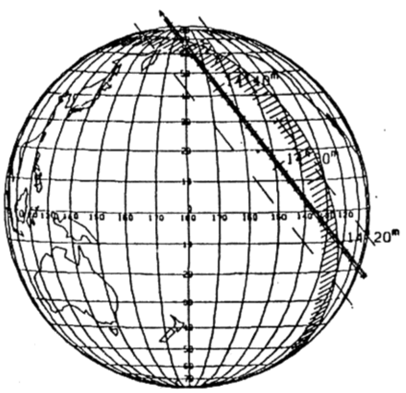


-02°0143 by Vesta 1986 Jul 11

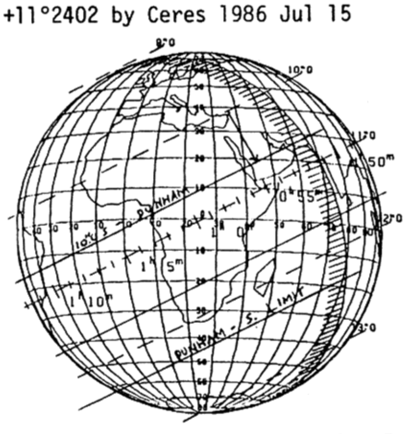


+14°0401 by Fortuna 1986 Jul 12

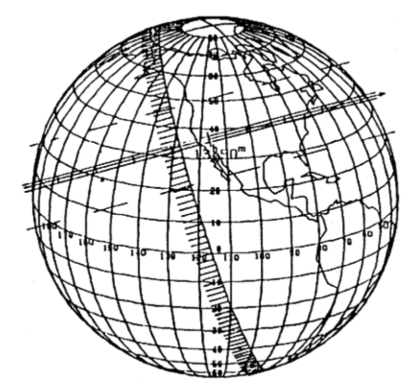
+11°2402 by Ceres 1986 Jul 15



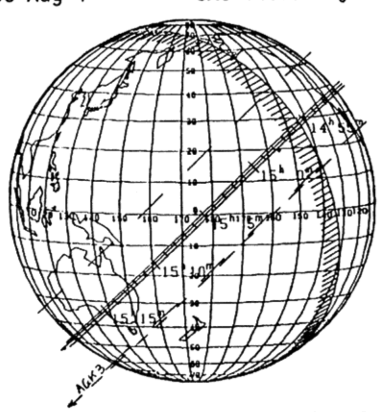
+01°4719 by Lumen 1986 Aug 4



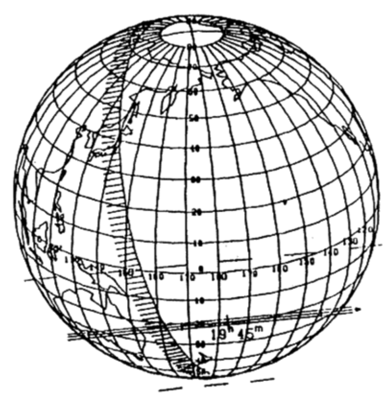
SAO 146774 by Jupiter 1986 Aug 5



+17°0493 by Fortuna 1986 Aug 5



SAO 128307 by Daphne 1986 Aug 6



+23°0685 by Aspasia 1986 Aug 7