Occultation Newsletter

Volume III, Number 14 December, 1985

Occultation Newsletter is published by the International Occultation Timing Association. Editor and compositor: H. F. DaBoll; 6 N 106 White Oak Lane; St. Charles, IL 60174; U.S.A. Please send editorial matters, new and renewal memberships and subscriptions, back issue requests, address changes, graze prediction requests, reimbursement requests, special requests, and other IOTA business, but not observation reports, to the above.

FROM THE PUBLISHER

This is the fourth issue of 1985.

If you have ordered any back issues of *O.N.* which you have not received, please advise us, at the above address. Please specify which issues.

When renewing, please give your name and address exactly as they appear on your mailing label, so that we can locate your file; if the label should be revised, tell us how it should be changed.

If you wish, you may use your VISA or MasterCard for payments to IOTA; include the account number, the expiration date, and your signature. Card users must pay the full prices, which are shown below, FOLLOWED BY THE DISCOUNT PRICES IN BRACKETS FOR THE USE OF THOSE PAYING BY CASH, CHECK, OR MONEY ORDER.

Effective as of the date of publication of this issue, the price of *O.N.* for North American (U.S.A., Canada, Mexico) subscribers is $1.82[1.75]/issue, or $7.28[7.00]/year (4 issues) including any supplements (for North American observers) associated with those issues. The supplements now include comprehensive asteroidal occultation predictions computed by Edwin Goffin for your region, but we may distribute some other information via similar supplements in the future. For all other areas, when served by surface mail, the price is $1.78[1.71]/issue, or $7.12[6.84]/year, not including any supplements; when served by air (AO) mail, add these amounts to the surface prices: for Central America, St. Pierre and Miquelon, Caribbean islands, Bahamas, Bermuda, Colombia, and Venezuela, 45¢[43¢]/issue, or $1.79 [1.72]/year (for these areas, any supplements for North American observers will be available @ $1.23 [$1.18]/year by surface mail, or $1.56[1.50]/year by AO mail); for the rest of South America, Mediterranean Africa, Europe (except Estonia, Latvia, Lithuania, and U.S.S.R.), 80¢[77¢]/issue, or $3.20[3.08] per year; for all others, $1.16[1.11]/issue, or $4.63[4.44]/year. 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

(Continued overleaf)

IOTA NEWS

David W. Dunham

The third annual meeting of IOTA was held at the Armand Bayou Nature Center in Clear Lake City, Texas, on 1985 November 16. The official minutes of the meeting will be reported in the next issue. Main business highlights were the financial report and the consequent decision to raise the *O.N.* subscription price (but not IOTA membership rates; see "From the Publisher" at the beginning of this issue); decision to combine the offices of the Treasurer and Corresponding Secretary to facilitate processing of requests and finances; and fulfilling requirements for the support test required by the I.R.S. to maintain our tax-exempt status.

The combined office of Treasurer and Corresponding Secretary will be called the Secretary-Treasurer. H. F. DaBoll will fulfill this position during 1986. Being the main point of contact for IOTA, his address follows my name in the articles I publish in the 1986 January issue of *Sky and Telescope*. In practice, a few requests may initially be handled by Mark Allman, since the Columbus, Ohio, address was published in the 1986 R.A.S.C. *Observers' Handbook*, whose deadline predated the IOTA meeting.

We have ninety days from the end of 1985 to submit materials to the Internal Revenue Service for the support test to continue our tax-exempt status. Much of this involves financial questions that are being answered by DaBoll, Paul Maley, and me. However, it also involves proving that we are a public organization. Publication of IOTA's name by news media in connection with occultation and eclipse observations and research are valuable for this. If you have any local publications mentioning IOTA, such as in newspapers or local astronomical society newsletters, please send a copy to: Paul Maley; 15807 Brookvilla; Houston, TX 77059; phone 713,483-5378. Remember this in the future. When organizing a local occultation expedition, call it an IOTA expedition, or joint IOTA/local astronomical society expedition, not just a local expedition. Although mention of IOTA in foreign publications helps (we appreciate being sent such references), the I.R.S. will be more interested in American publications.

The scientific agenda of the meeting will be included in the next issue. One major item was discussion of the observations of the grazes of Zubenelgenubi at both limits of last May 4th's occultation in Africa during the total lunar eclipse. This culminat-

(FROM THE PUBLISHER, continued)
available at $1.23[1.18]/year by surface, or $2.04 [1.96]/year by AO mail, from Jim Stamm (Rt. 13, Box 109; London, KY 40741; U.S.A.).

The prices of back issues by surface mail remain as follows: $1.04[1.00]/issue through *Vol. 2*, No. 13; later issues, through *Vol. 3*, No. 13, $1.46[1.40] per issue. Air mail shipment of back issues, if desired, remains at 47¢[45¢]/issue extra, outside the U.S.A., Canada, and Mexico.

IOTA membership, subscription and supplement included, remains at $11.46[11.00]/year for residents of North America (including Mexico) and $16.67[16.00] for others, to cover costs of overseas air mail. For IOTA members, the following items are available without extra charge; non-members pay $1.04[1.00] for local circumstance (asteroidal occultation) predictions, and $1.56[1.50] per graze limit prediction.

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.

(IOTA NEWS, continued)
ed in a small workshop where we discussed techniques for preparing reduction profiles from graze observations and computer data generated with Van Flandern's OCC program at U.S.N.O. Since then, Paul Maley has prepared preliminary reduction profiles for each of the May 4th expeditions, some information about which is given in the graze article on p. 300.

We decided to hold the next (fourth) annual meeting in conjunction with the Texas Star Party to encourage more participation. The IOTA meeting will be held during Saturday, May 10th, the last day of the Texas Star Party. If you are interested in attending, contact the organizer for the 1986 Texas Star Party: Carol Rodgers; 128 N. Commerce; Burleson, TX 76028; phone 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; phone 301,585-0989. The 1986 meeting is an election meeting for officers for the three-year terms 1987-1989. Contact me or one of the other IOTA executive committee members if you want to nominate someone for an office. Ballots and more information will be distributed with the next issue.

There also will be an IOTA session held in conjunction with the Astronomical League's annual meeting in Baltimore, MD, early in August. Contact me for presentations or agenda items.

On December 13 and 14, a meeting was held at the Space Telescope Science Institute (STScI) in Baltimore to discuss possible amateur-professional cooperation in use of the Hubble Space Telescope. The presidents of the major American amateur astronomical organizations attended (the first time that they all had gathered in one place), including George Ellis (Astronomical League), Janet Mattei (A.A.V.S.O.), John Westfall (Association of Lunar and Planetary Observers), Jesse Eichenlaub (Independent Space Research Group), Stephen Edberg (Western Amateur Astronomers), Gerald Persha (I.A.P.P.P.), and me. Members of the staff of the STScI gave interesting presentations of the capabilities of the Hubble Space Telescope.

Berton Stevens sent me a listing of the IOTA records in October. I was surprised to see that there was no station information (primarily longitude, latitude, and graze travel radii) for a large fraction of fully paid IOTA members. If you are in this category, you are not receiving the predictions to which you are entitled, and which we want to provide. Those with small travel radii rarely get graze predictions, but everyone with station data receives planetary/asteroidal appulse local-circumstances calculations from Joseph Carroll each year. He now is computing and distributing these predictions for 1986. If you are an IOTA member and do not receive Carroll's predictions within two weeks of receipt of this issue, chances are very good that we do not have station data for you in our computer records, and you should transmit the information on the observer information form to H. F. DaBoll to rectify the situation. We apologize if you had previously sent us an observer information form, which may not have reached Berton Stevens through the somewhat complex channels in place during the last two years. We prefer coordinates specified to full accuracy (one arc second or better), but less accuracy is sufficient for predictions. For graze predictions, your coordinates should be accurate to at least 1' (one arc minute), while for Carroll's predictions, 10' is often all right. Coordinates to these accuracies can be found in some of the large encyclopedic atlases; other IOTA members also can help with coordinate determination.

We have decided on the content for an IOTA membership card, and Tony Murray in Georgetown, GA, is preparing a detailed design. These should be ready for distribution with the next issue of *O.N.* We are also working on an illustrated one-page handout briefly describing lunar grazes and asteroidal occultations, their uses, and IOTA, intended primarily for our contacts with the public during expeditions and advance-planning field work.

Last October, Joan and I made some more updates to the occultation manual, improving it considerably over the April version. A few copies of this version were made and distributed at the IOTA meeting. There are still some missing or unfinished sections, which we hope to largely complete during the next two months. The project has top priority, so there is a good chance that it will be distributed before, or along with, the next issue of *O.N.* We plan to distribute that issue in March, when post-perihelion observations will permit a good update of the orbit of Halley's Comet and refinement of predictions of occultations by Halley.

ASTEROIDAL APPULSE AND OCCULTATION OBSERVATIONS

Jim Stamm

Beginning with this issue, summaries of asteroidal occultations and appulses will be published in tabular form. Some groups are so well coordinated that we are beginning to get more reports than can be published comfortably in the old format. We still will retain all of the data that are included in the report form, and they will be available to anyone who requests them. It is still important to report all of the information on the report form to us. For events that are well covered, or show interesting results, I will write up a separate paragraph or article.

In the tabular format, a line represents a negative visual observation. A "p" follows the line for a photoelectric observation, and a "v" follows the line for a video observation. The beginning and ending times of observation are above and below the line, respectively. A number within a circle refers the reader to the notes given below. The name following the continent name is the coordinator who has supplied most of the reports. When an event description is preceded by an asterisk, it means that the event also is listed under one or more of the other continents.

Notes:

① Maksymowicz reported 1-second occultations beginning at 04:37:19 and 04:40:30. He considered at least the last event doubtful because of a bright sky and poor stability. The observed north shift (*O.N. 3* (13), 280) placed the primary path over Scandinavia.

② From the center of Amsterdam, under a very clear sky, Serne recorded an occultation from 00:06:11.5 to 00:06:16.1.

③ A total of 22 stations reported data to Roland Boninsegna for this event — the best-observed event since Feb 16 Iris (another European accomplishment!). Boninsegna will reduce the data, and I will report his results (including Serne's observation) in a future issue of *O.N.*

④ Yamaguchi, along with Edgar Espinosa and Federico Aripe of the Astronomy Association of Bolivia, recorded a 14-second occultation beginning at 02:58:00. The occurrence was 7½ minutes later than predicted, the duration 3 seconds longer, and the path south-shifted 1400 km.

⑤ *O.N. 3* (13), 280.

⑥ *O.N. 3* (13), 281.

⑦ *O.N. 3* (1), 15.

Europe — Roland Boninsegna

Observer	Location	③ 85 Aug 15 2601 Bologna SAO 74620	85 Aug 17 270 Anahita ?	85 Aug 17 28 Bellona SAO 162924	85 Aug 31 205 Martha ?	85 Sep 1 230 Athamantis SAO 108346	85 Sep 5 606 Brangane SAO 128195	85 Sep 7 230 Athamantis SAO 108226	85 Sep 9 1206 Numeronia ?
J. Aloy	Sampsor, Spain	—							
C. Baetens	Boechout, Belgium	—							
D. Baise	Hevillers, Belgium	—							
L. Baldinelli	Tignano, Italy	—p		—p			2000 / 2040 p		
S. Baroni	Milan, Italy	—							
J. Barthes	Toulouse, France			—	—		—	—	
P. Barufetti	Massa, Italy	—					—	—	
A. Bertoglio	La Balma, Italy	—	—						
S. Bruno	La Balma, Italy	—	—						
H. Bulder	Zoetmeer, Netherlands	—							
R. Casas	Sabadell, Spain							—	
Catania Obs.	Catania, Italy				—p				
E. Cifuentes	Renteria, Spain							—	
F. Clette	Bagneres, France		—	—					
R. Di Luca	Tizzano, Italy							—	
C. Gallart	Cases Noves, Spain		—						
M. Genovese	La Balma, Italy	—	—	—					
V. Ghisolfi	Savona, Italy							—	
C. Gualdoni	Maggio, Italy	—							
V. Hainaut	Dourbes, Belgium	—							
R. Heidmann	Vernon, France							—	
N. Jonlet	Glons, Belgium	—							
M. Kopp	Velbert, West Germany								
J. Lecacheux	Jonville, France	—							
H. Le Tallec	Toulouse, France			—					
P. Lipski	Dresden, West Germany	—							—
P. Louis	Dourbes, Belgium	—							
S. Maksymowicz	Chapet, France					①		—	
A. Manna	Minusio, Switzerland						—	—	
M. March	Mataro, Spain	—	—						
W. Marinello	Bassano, Italy			—			—		
J. Marti	Mataro, Spain	—	—						
Marseille Obs.	Marseille, France						—		
P. Mazalrey	Vernon, France	—							
Meudon Obs.	Meudon, France						—v		
F. Muzzi	Bologna, Italy	—							
W. Nobel	Amsterdam, Netherlands	—							
R. Norelli	Tignano, Italy					—			
L. Orsi	Bologna, Italy	—							
G. Passerini	Bologna, Italy	—							
Pic du Midi Obs	Bagneres, France				—v				
P. Poitevin	Kaulille, Belgium	—							
U. Quadri	Bassano, Italy			—			—		
C. Raffo	Massa, Italy	—					—	—	
G. Raspadori	Bologna, Italy	—					—		
G. Riccabone	La Balma, Italy	—	—	—					
J./C. Royer	Saint-Etienne, Fr.		—		—				
A. Scholten	Eerbeek, Netherlands	—							
P. Serne	Amsterdam, Netherlands	②							
J. Soldevilla	Sampsor, Spain	—							
P. Soler	Vilanova, Spain	—	—				—		
P. Tanga	La Balma, Italy	—	—						
B. Thooris	Wervik, Belgium			—					
T. Tobal	Vilanova, Spain	—	—				—		
S. Trentini	Bologna, Italy	—					2000 / 2040 p	2125 / 2140 p	
F. Tulipani	Bologna, Italy	—		—			—		
P. Vaissiere	Ambert, France		—				—	—	
L. Zimmermann	Hevillers, Belgium	—					—		
		(*O.N. 3* (13) p. 280)		(*O.N. 3* (13), 280)		(*O.N. 3* (13), 280)		(*O.N. 3* (13), 281)	

"?" means star numbers were not reported (events predicted by Goffin for which neither Stamm nor Dunham have predictions).

Notes about individual events not tabulated.

(7) Iris and SAO 94467, Feb 16, 1985: (*O.N. 3* (13), 279). Matthias Kopp monitored the star from 21:00 to

21:30, and recorded an estimated 0.8-0.9-magnitude drop for 7 seconds, beginning at 21:04:31.

(746) Marlu and SAO 138569, May 1: (*O.N. 3* (13), 280). Andrea Manna's observation was at Munisio, Switzerland.

Pluto and 12.8-mag. star, Aug 19: N. Brosch and H. Mendelson recorded a photoelectric dimming lasting 80 seconds from Wise Observatory (Mitzpe Ramon, Israel). The mid-time of the event was 17:59:21, ±2 seconds. The starlight disappeared completely for only about 14 seconds, indicating that this was an almost-grazing occultation. This may be the first detection of an atmosphere around Pluto.

(2) Pallas and SAO 171571, Oct 24: The occultation of this 6.4-mag. star was timed from three stations in the Brisbane, Queensland, area, making it the sixth observed occultation of a star by this asteroid, many more than for any other minor planet. The timings, all visual, are listed below:

Peter Anderson	152°55'54".0 E.	D $16^h23^m29^s.9$ ±0^s.2
The Gap	27°27'48".0 S.	R $16^h23^m58^s.4$ ±0^s.1
	height 176 m	duration 28^s.5
Charlie Smith	153°05'43".6 E.	D $16^h23^m31^s.4$ ±0^s.2
Woodbridge	27°38'18".7 S.	R $16^h23^m59^s.4$ ±0^s.2
	height 40 m	duration 28^s.0
Steve Hutcheon	153°13'20".0 E.	D $16^h23^m31^s.2$ ±0^s.2
Sheldon	27°30'21".0 S.	R $16^h23^m58^s.4$ ±0^s.2
	height 32 m	duration 27^s.2

Anderson noted in his report that "The asteroid appeared blue-green as a contrast effect compared with the K2 star. . . The observers were spaced (west to east) at 0, 12, and 27.5 km relative to the almost north-south motion of the asteroid. From these observations the actual path of the central track (some 31 seconds duration) passed some 100 km or more to the west of Brisbane, which is a displacement of around 1".8 from the predicted (nominal) track, which was just east of New Zealand." Graham Blow notes that Sydney also must have been in the path, but observers there were clouded out, as were all in New Zealand. David Dunham notes that the large shift can not be due to the star, which has a good position (especially in right ascension) from the photoelectric Perth 70 catalog. The orbit used for the nominal prediction was published by Sitarski in 1982, using observations from 1960 to 1979, a relatively short data arc for determining an accurate asteroid orbit. In 1983, it agreed with astrometric observations of Pallas better than any other available orbit, and served very well for the well-observed occultation of 1 Vulpeculae on May 29th of that year. In 1984, Landgraf determined a new orbit for Pallas. Remembering the 1983 astrometry, Dunham figured that Sitarski's orbit was good enough, and decided not to replace it with Landgraf's data for the 1985 predictions. Experience has shown that the stationary points of an asteroid's orbit are especially sensitive to astrometric errors. After learning of the above observations, Dunham computed an ephemeris using Landgraf's orbital elements, and computed a path for the occultation in essentially exact agreement with the Brisbane observations. Landgraf used data for over a century up through 1983, and his orbit is also in good agreement with

South America — Ignacio Ferrin		85 May 30 145 Adeona SAO 190841	85 Jul 18 192 Nausikaa SAO 128570	85 Jul 20 145 Adeona SAO 190822	85 Aug 9 21 Lutetia SAO 93083
J. Balseiro	Mercedes, Uruguay	—		—	
J. de Campos	Rio de Janeiro, Braz	—			
N. Cerruti	Dolores, Uruguay	—			
W. Malony	Caracas, Venezuela	—			
D. Marchioro	Puerto Ordaz, Venez				
E. Netto	Rio de Janeiro, Brazil	—	0605		
L. da Silva	Porto Alegre, Brazil		0626		
C. Torres	Merida, Venezuela	—			
W. Yamaguchi	La Paz, Bolivia			(4)	

North America		85 Aug 22 1036 Ganymede SAO 38952	85 Oct 31 159 Aemilia SAO 96895	85 Nov 5 70 Panopaea SAO 76770	85 Nov 10 521 Brixia SAO 80435
T. Freeman	Berkeley, California		0844 0854	0315	
R. Harper	La Porte, Texas		0840	0340	1152
J. Stamm	Tucson, Arizona		0857		1213
S. Shaw	Athens, Georgia	–p			
		(5)		(6)	

Asia	I. S. Balinskaya	83 Oct 9 36 Atalante SAO 41289	83 Dec 28 776 Berbericia AGK3 +33°0763
M. Fedyanin	Tomsk, w. Siberia	1507	1943 2001
M. Pishnenko	Khabarovsk, e.Sib.	1528	(7)

the older orbit in *Astron. Papers Prepared for use of the Amer. Ephem. and Naut. Almanac 20*, which also was determined from a very long series of observations. Dunham further remarks that the Brisbane observations show that Sitarski's orbit already is deviating from the true path, which now is represented best by Landgraf's orbit. Dunham apologizes to the Australian observers, who would have mobilized to secure more chords if the nominal path had been calculated with Landgraf's orbit (some even preliminary astrometry on Pallas also could have spotted the error in Sitarski's orbit). The observers monitored the star for at least ten minutes around the time of the occultation, and no secondary extinctions were seen.

(89) Julia and SAO 41024, Dec 9: Three Lick Observatory exposures of both objects on the same plate on Nov. 26 gave a path shift of 1".68 north ±0".10, with a time correction of 6.6 ±0.2 minutes early, according to calculations by David Dunham. This placed the path across Canada at about latitude 60° north, well north of any known occultation observers in North America.

(89) Julia and SAO 40525, Dec 20: Dunham gives the following account of the astrometry and one successful observation of this occultation: "I combined the substantial Lick corrections to Julia's ephemeris from the Nov. 6 plate [mentioned above] with an improved star position from a 1977 Lick plate to derive a prediction of 1".38 N. ±0".3. Since this path crossed the U.S.A., another Lick plate with four exposures was taken on December 11th. The path shifts derived from each of the four exposures were 1".72, 1".44, 1".55, and 1".49, all north. The first exposure disagreed with the last three, the average of which gave 1".49 N. A straight (or "overall") average of

all four exposures gave $1''.55$ N. Previous experience has shown that it is usually just as well to use the overall average. I decided to include the first exposure, but not with full weight, to derive a shift of $1''.53 \pm 0''.5$ north and a time correction of 4.9 ±0.2 minutes early. The central line for this improved path passed near Castle Rock, Washington; The Dalles, Oregon; the southwest corner of Idaho; and near Wendover and Salinas, Utah. I told Richard Linkletter about this shift, so that he might notify potential observers in Washington and Oregon, and he also notified three observers in Utah.

"On the night of the event, a high pressure area settled over the region after a storm had left much snow and moisture. With the onset of the high, Temperatures plummeted to well below freezing. Low-level winds died, while high-level winds brought warm air from the south. The result was a strong, persistent temperature inversion which kept cold, moist air in the valleys. Thirteen of fifteen observers in the northwestern U.S.A. notified by Linkletter, failed to observe the appulse, mainly due to fog and smog. Linkletter notes the strength of the inversion by the temperature of 52° F. at the University of Oregon's Pine Mountain Observatory at a height of 6280 feet, while at the same time at nearby Bend, at about 2000 feet, the temperature was only 15° F. At Pine Mountain (at a shift value of about $1''.43$ north), Lynn Carroll and Dan Kraus visually timed a 4.22-second occultation starting at $14^h 13^m 17^s$, in excellent accord with the time I predicted from the Lick data. Nick Liepin, at Salem, Oregon, saw a miss, showing that Pine Mountain was near the southern limit. The path center must have been close to $1''.49$ north, in virtually exact agreement with the average of the last three Lick exposures of December 11. This path crossed Portland, Oregon, where, unfortunately, the fog was especially thick.

"Brent Sorenson observed a miss during the critical minute of closest approach at Cedar City, Utah, using a fourteen-inch Schmidt-Cass. Four minutes later, at about $14^h 17^m$ U.T., he saw the star disappear for a couple of seconds, but observation by then was very difficult, due to the brightening dawn.

"A few IOTA members, including me, thought of traveling into the path to observe with portable equipment, but none did, primarily due to the extreme pressure of year-end work that had to be completed before many took Christmas vacations. Also, by the time we had the December 11 Lick results, tickets for the few remaining seats on scheduled flights were priced at two to three times as much as the normally available discount tickets, due to the holiday crunch. If one of us had made the trip, chances are good that we would have obtained a second chord and an estimate of Julia's diameter."

(18) Melpomene and SAO 114658, Dec 30: Dunham reports that William Penhallow obtained three exposures on December 22. Using positions for SAO 114658 and SAO stars near Melpomene measured by Klemola from a 1980 Lick plate, Dunham calculated a path shift of $0''.07$ north $\pm 0''.20$ and time correction of 1.2 minutes early ±0.3 minutes.

REPORT ON E. S. O. P. IV

Eberhard Bredner

The Fourth European Symposium on Occultation Predictions was arranged by Josef Van Camp and Edwin Goffin and was held on August 24-25, 1985, in Urania, the Public Observatory of Antwerp, in Belgium. More than 25 participants from Czechoslovakia, German Federal Republic, the Netherlands, Belgium, and Denmark joined the meeting.

We were welcomed very obligingly the evening before the symposium and had a first evening with long-lasting talks on astronomy in a smaller group.

The symposium was opened by the director of the Urania, Marc Gyssens, and by Hans-Joachim Bode of IOTA/ES. The lectures started with a review by Bohumil Malecek on E.S.O.P. III in Czechoslovakia. Very impressive slides showed the possibilities of the meeting. Henk Bril gave a report, "Some Investigations Concerning Reaction Time" depending on more than 2400 measurements. With more than 95% probability, $0^s.15 <$ reaction time $< 0^s.45$ is valid; for a skilled observer you can estimate $0^s.21 \pm 0^s.06$. The 'grand old man' of occultation, N. P. Wieth-Knudsen, showed us "Experiments on the Precision of the Minnaert Method" for the timing of solar eclipse contacts to reduce the first contact. Hans-Joachim Bode explained the "Occultation Work Concerning the IHW." He emphasized the necessity of a network of observers with photoelectric equipment.

The lunch break was prepared in the Urania Observatory. Refreshed, we had a guided visit to the Public Observatory by director Marc Gyssens.

The afternoon session started with a topic by Norbert Kordts, "Contrast Effects in Astronomical Observations, or Can you see the Star or Can't you?" He gave a lot of helpful advice to reduce light scattering. Some slides of "The Solar Eclipse of November 22, 1984, in New Guinea" (H.-J. Bode) showed the troublesome travel in a wobbly dugout to mount a camera with a telephoto lens in a swamp. Roland Boninsegna showed us "The Organization and Activities of GEOS (Groupe Europeen D'Observation Stellaire." More than 150 members have joined the departments of Variable Stars, Photoelectric Photometry, and Asteroidal Occultations. Josef Van Camp and Pierre Vingerhoets presented the increasing French-Belgian-Dutch collaboration in observing minor planets. They showed "An Electronic Occultation Timing and Registration Device" that stores 64 timings with the accuracy of an atomic clock. The device will be in stock by the end of 1985 for about 120 dollars. The first day ended with a visit to the Town Hall and some astronomical sites of interest in the little neighboring town, Lier. There we had a splendid dinner in a typical comfortable restaurant.

Edwin Goffin started the next morning after a refreshing night — the accommodation had been chosen very cautiously — with "Predictions of Occultations by Minor Planets." Gordon Taylor finished his minor-planet prediction work, which Landgraf and Goffin will continue. "Video Observations of Mutual Occultations by Jovian Satellites" were shown by Jean Bourgeois; they were recorded by an RCA Ultricon camera with the 100-cm mirror at the Observatoire Pic du Midi, France. The measured timings were in good agreement with the predictions. Roland Boninsegna discussed "Minor Planet Occultations:

Precautions to Take" during visual observations (equipment for timekeeping, recording) and the best geographical position for different groups: "Do not try to observe too faint stars!" Edwin Goffin, referring to the topic "An Occultation Premiere," listed the occultations of pairs of minor planets, but most of the events are very hard to observe (see *Sky and Telescope 70* (5), 464 (Nov. 1985)). Bohumil Malecek explained the "Occultation Activities in the C.S.S.R.," where in 20 years more than 6500 observations at 58 stations by 447 observers have been recorded and sent to Tokyo.

Hans-Joachim Bode closed the symposium with a survey of the present situation of IOTA/ES. The problems with the data on magnetic tapes from David Dunham are very time wasting because the computer systems are so different. There are high costs for copies, and the time lag by spreading information over Europe is too great. But there is hardly anybody who can help to do the work.

ESOP V is scheduled for Poland (1986), and ESOP VI for Denmark (1987).

The symposium was closed with a marvelous lunch in the great assembly room at Urania Observatory. H.-J. Bode thanked the organizers for their careful preparations, and the Urania for providing their observatory for the symposium.

Fifteen participants who stayed in Antwerp for another day had a guided visit to the Royal Observatory Brussels (Koninklijke Sterrenwacht van Belgie) by four heads of departments — Time Service and Geodetic; Occultation Work With Video Camera; Spectroscopy; and Sunspot Index Data Center — and afterwards a lunch, with a subsequent walk through the old part of the centre of Brussels.

What a lovely time it was!

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.

Observers using profiles of the Cassini region (identified by limb points coded "3" or "4") should be aware of possible spurious features. They arise from the process of combining data from several different grazes. If a discontinuity of about one arc second or more is found on one of these profiles, there is a chance that the feature so formed may be false. During the graze of ZC 1067 on 1983 Nov 3, Don Oliver and I discovered that the large feature at Watts angle 182°, longitude libration -6°3, and latitude libration -6°1, either does not exist, or is much smaller than indicated. For an excellent article on Dr. Watts and how the limb corrections were measured, see the "Astronomical Scrapbook" in the February, 1964, issue of *Sky and Telescope*.

I would like to emphasize again that the shift of the moon's shadow is the most important result of a graze expedition. Please delay the report in order to measure it, if that's what it takes; there is no benefit connected with rushing the report in without the shift! Plotting the observations after the graze is the best way to make sure everything correlates; the shift is then easily read from the left-hand side of the profile. Progress is being made on keypunching the graze tables, so this is becoming much more important. When all the graze tables are in machine-readable form, the list will be sorted by star number. Before an upcoming graze, this list can be examined to see if the star ever has been observed in a graze before. If a shift were reported, the update would be instantly available. If no shift were reported, a rough one would have to be computed (perhaps with only part of the data), and even this would take some effort. Thus, reporting the observed shift ultimately will benefit the person filing the report and other expedition leaders.

ZC 1093 is a close double. The combined magnitude is 6.4 and the primary's magnitude is 7.2. Since Dombrowski saw a graze for only the primary star on October 7, I put 7.2 in the "Mag" column. Observers of the graze of ZC 3052 on November 18 timed a few events involving the 8.5-mag. secondary star.

The "Place Name" at the top of the graze report form is the town or village nearest the point of observation. For grazes, it usually will differ from the city in the address. Its purpose is to associate the observation with a geographical location which is nor readily apparent from the geodetic coordinates alone.

When totaling timings for an expedition, count certainty 1 events as one, certainty 2 events

Mo	Dy	Star Number	Mag	% Snl	CA	Location	# Sta	# Tm	S S	Ap cm	Organizer	St	WA	b
1981														
8	23	093938	7.1	44-	9N	Delfgauw, Nether.	1	7	1	20	Henk Bulder		350	61
1985														
4	23	0599	4.5	7+	5N	Morton Grove, IL	1	4	2	15	Berton Stevens		1	-14
5	4V	2118	2.9	0E	82U	HagAbdullah,Sudan	4	18	1	5	David Dunham	0	22	-2
5	4	2118	2.9	0E	35U	Naboomspruit, RSA	7	28	1	0	R. Wallace	1S	201	-7
5	4	2118	2.9	0E	35U	Naboomspruit,RSA	10	52	1	6	B. Fraser	1S	201	-7
5	4	2118	2.9	3E	40U	Dullstroom, RSA	3	28	1	4	R. Wallace	2S	201	-7
5	4	2118	2.9	4E	42U	Badplaas, RSA	10	55	1	11	A. C. Voorvelt	1S	201	-7
5	4	2118	2.9	11E	49U	Sodwana Bay, RSA	6	34	1	4	A. Hilton	3S	201	-7
9	12	1408	7.4	7-	14N	Burns, TN	2	21	2	6	Michael Crist	0	354	-64
10	7	1093	7.2	48-	9N	East Hartland, CT	1	4	1	15	Philip Dombrowski			
10	9	1363	5.2	27-	7N	Summit, MS	2	10	1	33	Benny Roberts	2N	356	-67
11	3	1067	7.2	73-	5S	Ennis, TX	2	4	1	20	Don Stockbauer	C5S	182	-61
11	4	1162	8.6	67-	4S	Zoetmeer, Nether.	1	2	1	30	Henk Bulder	C	182	-61
11	4	1206	5.9	63-	9S	Barstow, CA	1	3	1	20	David Werner	C	187	-66
11	17	188639	7.6	25+	15S	St. Augustine, FL	1	2	1	15	Harold Povenmire			
11	18	3052	6.4	36+	16S	Titusville, FL	2	14	1	15	Harold Povenmire			
12	8	Mars	1.4	18-	-6N	Barto, PA	1	4			David Blackmore		9	-11

as ½, and certainty 3 events as zero; round up any fractions. This might explain why the total in the graze table is sometimes lower than the one you reported. If you see a gradual disappearance or reappearance, and time both the beginning and end of the fade, you may count these as two separate timings only if the fade's duration was 0^{s}5 or greater. Also, the more information you can provide at the bottom of the form, the more complete the graze table will be.

While the report forms should be filled out in pencil to facilitate corrections, please be sure the print is dark enough to photocopy well. I had to trace over a few that I received recently.

Please keep the reports coming in; every one is appreciated.

USNO NEWS

David W. Dunham

David Herald suggested that accurate stellar apparent places be given for "graze nearby" cases in the U. S. Naval Observatory's detailed total lunar occultation predictions generated mainly by Marie Lukac with the EVANS program. Then people like him, who have microcomputer programs for computing grazes, could generate their own reasonably accurate path data with the help of lunar data from the Astronomical Almanac. Marie and I updated EVANS to print out the seconds of R.A. and DEC. to 0^{s}001 and 0$''$01 precision, respectively. The full R.A. and Dec. are already printed to 0^{s}1 and 1" accuracy for each occulted star. Also, the latitude and coefficient in the graze-nearby formula were changed to 0°001 precision. This increased precision should be accurate to ±0°005 for most graze-nearby messages.

Although MVT now has to be specially installed, it still is working, and we still can make 78A OCC runs; see p. 277 of the last issue. We will increase efforts to fix the CMS 80G version of OCC early in 1986, since the CalComp disk drives needed to support MVT most likely will be removed in October. One of the CalComp drives sometimes gave select locks when started during recent uses of MVT, but we always got it to work after one or two additional attempts.

SOLAR SYSTEM OCCULTATIONS DURING 1986

David W. Dunham

Predictions of occultations of stars by major and minor planets, and by comets, during 1986 are given in two tables below, which are presented in nearly the same format as those for last year's events. The only difference from last year is that columns in Table 2 relating to the diameter of the occulted star have been eliminated. In practice, these data are almost never used, and their elimination saves me some work in the current cumbersome procedures that I need to undertake to produce the tables. The tables are given on alternating pages, so that all data for a given event are available on facing pages. Explanations of the data given in the tables, and of 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, were given in the article about 1983 events in *O.N. 3* (1), 9. Joseph E. Carroll, 4261 Queen's Way, Minnetonka, MN 55345, computes the appulse predictions. Specific information about some of the events is given in my article on planetary occultations in the 1986 January issue of *Sky and Telescope*, for others at the end of this article, and for many during the last half of the year, will be given in future issues. Some important new events or astrometric updates sometimes can be published in the monthly *Sky and Telescope* before the quarterly *O.N.* Sections on reporting observations, prediction sources, and prediction updates were given in *O.N. 3* (10), 208 and 209. I understand that Robert Millis, Lowell Observatory, P.O. Box 1269; Flagstaff, AZ 86002, is now the chairman of the I.A.U.'s Commission 20 Working Group on Predictions of Occultations by Satellites and Minor Planets. Under prediction updates, we now can add the Astronomy Bulletin Board System (ASTBBS) mentioned on p. 272 of the last issue.

This issue of *O.N.* was delayed much longer than I like, due mainly to the length of time needed to prepare the computer database used to generate all my detailed solar system occultation predictions and charts. I had a fairly efficient system of computer programs for generating the stellar data from different star catalog tapes last spring, but this system depended on the data being punched on cards, which then were shuffled and merged with the different ephemeris datasets. This system ended when the card punch at USNO was removed. An equivalent shuffling of the stellar data with disk datasets is very cumbersome, and often I find it easier just to key in all the data for a star directly from the printed catalogs. But this is time-consuming. A solution is to use the software that I use to automatically find occultations of Astrographic Catalog stars and produce appropriate occultation datasets, but before I can do this in general, I need to reformat my star catalog tapes and merge them into a master catalog. I had plans to do that in 1985, but never had time to execute them. After Halley's Comet dies down at the end of April, I will make time to create the merged master star catalog, which will allow me to use my automatic search software for 1987 events and eliminate the current time-consuming procedure.

Asteroidal Occultations. The main source is Wasserman, Bowell, and Millis' article, "Occultations of Stars by Solar System Objects. VI. Occultations of Catalog Stars by Asteroids in 1986 and 1987" in *Astron. J. 90* (10), 2124 (1985 Oct.). G. Taylor first found five occultations by large asteroids, those on Mar. 21, Apr. 26 (Ceres), Apr. 28, July 11, and July 15, as listed in *Astron. J. 86* (6), 903. I found that two of the events in Wasserman *et al*'s list will not occur: (216) Kleopatra on Feb 11 (both Herget's orbital elements, and the new elements given in EMP 1986, show a miss by about 9") and (602) Marianna on Dec. 29.60, AGK3 N21° 39 (the same star was occulted on the same date at the same time in 1985, and the event somehow made it into the Lowell 1986 list; Marianna never comes close to the star during 1986). Several of Edwin Goffin's better events, involving larger asteroids or bright stars, are included in my dataset, even though his comprehensive predictions have been distributed in separate supplements. This is so that at least the better events can be included in the local circumstances appulse predictions. Also, I find that my paths of-
(Text continues on pg. 303)

1986 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	OCCULTATION Possible Area	El SUN	MOON El	MOON %Snl	MOON Up	Ephem. Source
Jan 2	19h43m	P/Halley	11.8	1.19	145945	9.1	K5	22h10.7m	-2°59'	2.7	5s	10	17	southwestern Africa? 2"n (low)	52°	152°	61-	none	YEOIHW31
Jan 3	1 49-60	Chloris	12.9	2.36		10.5	K2	7 01.7	24 30	2.5	9	18	24	South Africa?n; Brazil, Peru	177	78	58-	w 35°W	EMP 1984
Jan 8	20 28	Brunhild	14.5	3.33	183171	7.1	F2	15 03.3	-23 08	7.4	2	11	99	s. e. Siberia, n. Japan	58	35	4-	none	EMP 1986
Jan 11	9 51	P/Giac-Zin	12.6	1.22	196652	9.8	F8	6 15.3	-33 22	2.9	4	18	71	(e. Australia, New Guinea)? 2"n	122	115	1+	all	YEOIHW33
Jan 13	0 24	Myrrha	13.5	2.53	99159	9.0	K0	10 27.1	14 56	4.5	17	36	24	(Mongolia, central Siberia)?s	139	172	8+	none	HERGET
Jan 15	4 36-48	Mabella	14.2	2.15	115666	6.6	A0	7 32.7	7 41	7.6	5	19	45	n.w. Africa, Canaries, U.S.A.	166	118	25+	w105 W	HERGET78
Jan 15	12 48-61	Carlova	11.8	1.63	96478	9.2	K0	7 02.9	15 06	2.7	12	22	17	Hawaii?s; Siberia	168	107	28+	w130 E	EMP 1984
Jan 16	13 40	Melpomene	9.0	1.23	95935	8.9	A0	6 35.8	10 39	0.8	16	23	12	Alaska?s	159	88	37+	none	EMP 1980
Jan 16	17 45-59	Doris	11.2	2.00		9.5		8 51.8	9 16	1.9	18	25	14	southern Australia?n; se Africa	161	119	39+	w 75 E	HERGET77
Jan 17	10 50-65	Davida	10.0	1.71	77911	4.7	B2P	6 00.9	20 08	5.3	33	25	7	w. North America?n; w. Alaska	153	69	46+	w155 W	EMP 1982
Jan 19	17 53-67	Brixia	12.0	1.42	80380	9.5	K5	8 40.5	28 30	2.6	9	21	20	sw Australia?n; central Africa	168	77	67+	w100 E	EMP 1982
Jan 20	17 20-34	Arachne	12.4	1.66		9.8		7 35.9	21 27	2.7	9	21	23	Australia; se Africa?n	172	52	75+	w120 E	EMP 1982
Jan 28	7 38-51	Eugenia	11.3	1.84		9.5		7 40.2	16 31	2.0	20	22	11	Tierra del Fuego(low),s Pacific	166	42	94-	e170 W	HERGET77
Feb 1	0 11-20	Pallas	7.9	1.53	170643	8.4	F2	5 37.2	-25 32	0.5	36	17	4	S.America,Puerto Rico, ME, Que.	115	112	63-	none	LANDGRAF
Feb 2	4 00-08	Polyxo	12.2	1.91	97085	9.2	F0	7 34.3	15 51	3.1	12	24	20	Patagonia, southeast Pacific	159	109	50-	w 80 W	EMP 1981
Feb 4	10 32-48	Davida	10.3	1.85		9.2	K0	5 53.0	22 08	1.4	53	43	8	Hawaii, Alaska, nw Canada	134	166	25-	none	EMP 1982
Feb 6	2 49-50	Sylvia	12.9	3.53	110095	8.6	K0	1 41.4	4 45	4.3	10	14	19	central and nw South America	69	106	11-	none	HERGET78
Feb 8	4 53-65	Gyptis	12.5	2.27	137517	7.4	G5	10 19.5	-0 28	5.2	12	22	20	nw Africa, U.S.A., sw Canada	159	147	1-	none	HERGET
Feb 9	14 38-50	Scheila	13.2	2.02	61871	8.6	F8	10 04.1	33 50	4.6	10	21	22	N.Z.,n Austrl,Indonesia;India?n	159	163	1+	none	LANDGRAF
Feb 15	14 04-17	Hispania	12.5	2.31	60650	8.4	A0	8 10.1	34 45	4.1	14	23	19	HI?s; Sakhalin, n&wChina, India	148	75	38+	w150 E	EMP 1985
Feb 18	0 34-49	Antiope	13.7	2.76	80082	8.5	A3	8 15.5	22 23	5.2	11	26	29	northern Africa, se U.S.A.	152	50	61+	w 10 E	EMP 1984
Feb 18	20 05-18	Sophrosyne	12.1	1.61	118942	7.9	G5	11 33.7	3 35	4.3	10	24	22	Japan, central Asia, s Europe	157	91	69+	w110 E	EMP 1984
Feb 21	7 55-65	Doris	11.4	2.05	97838	7.6	K2	8 25.3	11 52	3.8	20	28	15	Newfoundland, ne Canada (low)	153	18	88+	all	HERGET77
Feb 22	3 07-35	Devosa	12.2	1.51		12.0		13 05.0	-8 09	0.8	25	56	21	Lapland,Scotland,North Carolina	135	76	93+	all	EMP 1981
Feb 22	6 00	Ursula	13.0	3.19	208557	9.4		17 10.5	-38 14	3.7	8	13	22	(Palmer Pe., Patagonia)? 1".5n	73	136	93+	all	EMP 1981
Feb 24	0 08-11	Virtus	14.6	3.12	76104	8.3	A5	3 40.7	24 13	6.3	5	19	47	southeast Canada; Iberia (low)	84	88	99+	all	EMP 1984
Feb 26	10 08	Ceres	6.9	1.59		9.8	G0	11 08.2	23 51	0.1	88	23	2	N.Z.?s; e Australia (low)	163	25	96-	all	APAENAXX
Mar 3	1 54-77	Laurentia	12.2	1.56	119391	7.5	K0	12 23.4	4 29	4.7	14	31	21	northern Africa, se U.S.A.	157	63	55-	e 30 W	HERGET
Mar 3	11 23	P/Giac-Zin	14.0	1.89	151324	8.5	K2	6 15.6	-16 44	5.5	3	14	110	New Zealand? 2"n	107	131	51-	all	YEOIHW33
Mar 5	18 54-69	Faina	13.0	1.99	100323	7.1	K0	12 51.3	19 20	5.9	9	22	26	W.Australia;sAsia?n; Yemen,Sudan	150	101	25-	e105 E	EMP 1982
Mar 21	8 00-04	Pallas	8.4	1.83	132993	8.6	K0	6 11.3	-8 39	0.6	21	10	5	New Caledonia, Hawaii	93	45	75+	all	LANDGRAF
Mar 25	10 32-82	Siwa	12.4	1.84	159625	5.5	F8	15 57.5	-16 23	6.9	31	79	25	s Pacific, n Chile (sunrise)	123	65	99+	w 85 W	HERGET77
Mar 28	14 55	P/Halley	10.8	0.60	210769	8.9	B9	18 54.9	-34 20	2.1	3	4	9	(New Zealand, Tasmania)?n	86	61	92-	all	YEOIHW31
Mar 29	5 26-40	Laurentia	12.1	1.54		10.3	K0	12 02.7	5 50	2.0	11	25	21	Argentina, Chile, se Pacific	169	52	87-	e145 W	HERGET
Mar 29	7 52	P/Halley	10.7	0.58	210652	8.2	K5	18 48.9	-35 13	2.6	3	4	8	(South Pole and McMurdo)? 5"n	88	50	86-	all	YEOIHW31
Apr 1	13 47-54	Mars	0.1	1.03	186404	8.7	F5	18 07.5	-23 35	0.0	442	13	1	sw Pacific, N.Z., e Australia	99	8	53-	all	NA0001
Apr 4	14 58	P/Halley	10.1	0.47	228046	7.5	F5	17 26.9	-43 43	2.7	2	3	7	Antarctica? 7"n	109	56	21-	all	YEOIHW31
Apr 6	7 25	P/Halley	10.0	0.44	227471	9.6		16 53.0	-45 40	1.0	2	2	6	Antarctica 0° to 150°W	116	83	9-	e 80 W	YEOIHW31
Apr 7	7 49-50	P/Halley	9.9	0.43	226884	8.5	B9	16 29.9	-46 34	1.7	2	2	6	Barbados,Venez.,Panama;Mexico?n	120	99	4-	e 45 W	YEOIHW31
Apr 7	10 44	Eunomia	10.3	2.85	76447	9.0	G5	4 03.0	25 39	1.6	6	8	16	Norweg.& Barents seas,nw Siberia	47	68	3-	none	BRANHAM
Apr 11	5 35-48	Melete	11.7	1.57		11.7		12 46.9	-4 26	0.8	12	21	16	Patagonia; Marquesas Is?s; Hi?n	172	150	4+	w155 W	EMP 1980
Apr 12	3 27	P/Halley	9.6	0.42	224955	9.0	F5	14 25.8	-46 06	1.1	2	2	6	McMurdo Sound? 3"n	140	152	8+	n 63 S	YEOIHW31
Apr 13	5 56	P/Halley	9.6	0.42	224622	9.5	A3	13 58.8	-44 48	0.8	2	2	6	Patagonia, Marquesas Is.	143	146	14+	w140 W	YEOIHW31
Apr 14	17 28	P/Halley	9.6	0.44	224173	9.6	A2	13 26.0	-42 32	0.8	2	2	6	McMurdo Sound; Cape Town?n	147	129	25+	n 50 S	YEOIHW31
Apr 16	14 17	P/Halley	9.8	0.46	203912	9.2	G0	12 51.0	-39 11	1.1	2	3	7	Marshall Is., Japan, Vladivostok	149	103	42+	w150 E	YEOIHW31
Apr 16	15 03	P/Halley	9.8	0.46	203904	6.8	K2	12 50.5	-39 07	3.0	2	3	7	Japan? 2"s	149	103	42+	w155 E	YEOIHW31
Apr 16	16 51	P/Halley	9.8	0.46	203882	9.1	G5	12 49.2	-38 58	1.1	2	3	7	Papua,Indonesia,India, Pakistan	149	102	43+	w100 E	YEOIHW31
Apr 17	10 23	P/Halley	9.8	0.47	203688	7.5	A2	12 37.6	-37 35	2.4	2	3	14	Antarctica?6"n; w Australia?8"n	149	91	50+	n 70 S	YEOIHW31
Apr 18	19 50	P/Halley	10.0	0.50	203363	9.2	G5	12 18.0	-34 57	1.2	2	3	14	se Australia, s & nw Africa	149	72	64+	w 65 E	YEOIHW31
Apr 21	18 30	Scheherezade	16.1	3.93	145581	7.8	K5	21 37.9	-2 45	8.3	2	14	82	southern Australia	65	149	90+	w135 E	EMP 1984
Apr 24	11 59-63	P/Halley	10.7	0.62	179904	6.8	K0	11 25.1	-25 35	3.9	3	4	18	N.Z., Queensland, P.I., se China	140	39	10E	all	YEOIHW31

ten differ from Goffin's by a few to several tenths of an arc second, so that producing Sôma's world maps for all listed events does not always duplicate Goffin's maps, and also gives the better events worldwide, rather than just regional, distribution. I am now producing fewer finder charts, because Goffin's charts usually are adequate. My finder charts are mainly for faint stars (where the A.C. plots are helpful), for several events (mainly due to star catalogs not used by Goffin) found by Lowell but not Goffin, and for some bright stars where not enough faint stars to be seen in a telescopic field are included on Goffin's charts.

I computed ephemeris differences for several asteroids. Only those with path shifts greater than 0".25 or time differences greater than 1.5 minutes are included in Table 3 below, similar to the one for 1985 in *O.N. 3* (10), 209:

Table 3.

Ephemeris Differences for 1986

Date	MP#	Shift	Δt	Ephem. Source
Feb 15	804	3".50S	-3m.1	Herget
Apr 11	56	2.35N	+11.4	Herget77
Apr 26	31	5.84N	-10.0	Herget78
May 12	393	5.54S	-8.5	Herget77
Jul 2	56	0.06N	-8.4	Herget77
Aug 29	145	0.59S	-8.1	Herget78
Sep 18	702	2.02S	-12.1	Herget78
Oct 27	93	0.75S	-2.6	Herget78
Dec 17	145	4.17N	+9.5	Herget78

Table 1, Part A, is on preceding page. Table 2, Part A, is below. Text continues on page 305.

1986 DATE	PLANET No.	OR COMET Name	km-diam.	-"	RSOI	Type	MOTION °/Day	PA	STAR SAO No	DM No.	D	S	COMPARISON DATA AGK3 No.	Shift	Time	APPARENT R.A.	Dec.
Jan 2		P/Halley	100	0.12	126		0.614	248°	145945	-03°5403		HS		-0".37	-0m.5	22h12m.6	-2°48'
Jan 3	410	Chloris	142	0.08	729	C	0.231	286		+24 1520		XA	N24 773			7 04.0	24 27
Jan 8	123	Brunhild	49	0.02	130	S	0.315	110	183171	-22 3901		X				15 05.4	-23 16
Jan 11		P/Giac-Zin	50	0.06	88		0.338	328	196652	-33 2858		S				6 16.6	-33 23
Jan 13	381	Myrrha	150	0.08	789	C	0.113	325	99159	+15 2208	C	XA	N14 1121	-0.44	1.2	10 29.0	14 45
Jan 15	510	Mabella	69	0.04	227	C	0.233	280	115666	+07 1773		AG	N 7 1039	-2.14	4.0	7 34.7	7 37
Jan 15	360	Carlova	138	0.12	542	C	0.231	298	96478	+15 1458		AS	N15 737	0.14	-1.6	7 05.0	15 03
Jan 16	18	Melpomene	148	0.17	505	S	0.257	300	95935	+10 1205		AS	N10 788	0.48	-0.0	6 37.8	10 37
Jan 16	48	Doris	200	0.14	1074	C	0.188	287		LJ 4839		H				8 53.7	9 08
Jan 17	511	Davida	335	0.27	2072	C	0.196	307	77911	+20 1233	V	ZA	N20 615	-0.53	0.2	6 03.1	20 08
Jan 19	521	Brixia	104	0.10	327	C	0.260	301	80380	+28 1639		AS	N28 935	-0.65	0.1	8 42.7	28 22
Jan 20	407	Arachne	104	0.09	361	C	0.241	268		LJ 3455		H				7 38.0	21 22
Jan 28	45	Eugenia	250	0.19	1426	U	0.224	290		LJ 3604		H				7 42.3	16 26
Feb 1	2	Pallas	533	0.48	3406	U	0.319	359	170643	-25 2577		S				5 38.7	-25 31
Feb 2	308	Polyxo	139	0.10	603	DU	0.199	286	97085	+16 1526		XA	N15 819	0.27	0.3	7 36.4	15 46
Feb 4	511	Davida	335	0.25	2079	C	0.112	337		+22 1104		XA	N22 610	0.01	0.0	5 55.2	22 08
Feb 6	87	Sylvia	275	0.11	1940	P	0.257	59	110095	+04 305		XA	N04 203	-0.11	0.5	1 43.2	4 56
Feb 8	444	Gyptis	167	0.10	894	C	0.200	294	137517	-00 2328		PG	S00 1489	0.38	2.0	10 21.4	-0 41
Feb 9	596	Scheila	134	0.09	593	U	0.220	300	61871	+34 2083		AS	N33 993	-0.29	0.4	10 06.2	33 39
Feb 15	804	Hispania	175	0.10	950	C	0.183	254	60650	+35 1777		AS	N34 896	0.58	-0.9	8 12.5	34 39
Feb 18	90	Antiope	138	0.07	765	C	0.153	282	80082	+22 1900		XA	N22 988	-0.05	-1.0	8 17.6	22 16
Feb 18	134	Sophrosyne	107	0.09	364	C	0.216	273	118942	+04 2501		AS	N03 1521	-0.46	-1.0	11 35.5	3 23
Feb 21	48	Doris	200	0.13	1080	C	0.161	299	97838	+12 1844		AS	N11 985	-0.77	1.2	8 27.3	11 45
Feb 22	337	Devosa	107	0.10	330	C	0.094	249		LS 1110		H				13 06.9	-8 21
Feb 22	375	Ursula	214	0.09	1234	C	0.278	109	208557	-3811663	A	YG		3.30	-1.6	17 12.9	-38 17
Feb 24	494	Virtus	97	0.04	392	C	0.191	78	76104	+23 495		XA	N24 322	-0.91	-0.6	3 42.9	24 20
Feb 26	1	Ceres	946	0.82	9563	C	0.224	299		+24 2323		A	N23 1144			11 10.2	23 39
Mar 3	162	Laurentia	109	0.10	368	C	0.169	288	119391	+04 2614		XA	N04 1614	-0.04	-0.6	12 25.2	4 16
Mar 3		P/Giac-Zin	50	0.04	108		0.334	30	151324	-16 1427		S				6 17.2	-16 45
Mar 5	751	Faïna	113	0.08	448	C	0.207	306	100323	+19 2614		AG	N19 1247			12 53.1	19 08
Mar 21	2	Pallas	533	0.40	3368	U	0.460	45	132993	-08 1355		PS		0.50	-0.5	6 13.0	-8 40
Mar 25	140	Siwa	105	0.08	351	C	0.061	86	159625	-16 4196	V	F				15 59.6	-16 30
Mar 28		P/Halley	100	0.23	145		2.083	234	210769	-3413269		S				18 57.3	-34 17
Mar 29	162	Laurentia	109	0.10	371	C	0.207	281		+06 2544		XA	N05 1687	0.01	-0.0	12 04.6	5 37
Mar 29		P/Halley	100	0.24	146		2.203	235	210652	-3512981		S				18 51.3	-35 10
Apr 1		Mars	6782	9.12	*****		0.495	92	186404	-2314016		X				18 09.7	-23 34
Apr 4		P/Halley	100	0.30	159		3.554	249	228046	-4311763		G				17 29.5	-43 45
Apr 6		P/Halley	100	0.31	162		3.935	255	227471	-45 8209		S				16 55.7	-45 43
Apr 7		P/Halley	100	0.32	164		4.139	260	226884	-46 8059		S				16 32.6	-46 39
Apr 7	15	Eunomia	261	0.13	1245	S	0.471	86	76447	+25 674		XA	N25 401	-0.47	-0.4	4 05.1	25 45
Apr 11	56	Melete	142	0.12	560	C	0.253	305		LS 211		H				12 48.8	-4 37
Apr 12		P/Halley	100	0.33	174		4.493	283	224955	-45 6861		S				14 28.2	-46 16
Apr 13		P/Halley	100	0.32	176		4.391	288	224622	-44 6616		S				14 01.1	-44 58
Apr 14		P/Halley	100	0.32	179		4.163	294	224173	-42 6280		S				13 28.2	-42 43
Apr 16		P/Halley	100	0.30	183		3.769	300	203912	-38 8069		S				12 53.0	-39 23
Apr 16		P/Halley	100	0.30	183		3.762	300	203904	-38 8062	A	YG		-0.37	-0.0	12 52.5	-39 19
Apr 16		P/Halley	100	0.30	183		3.745	300	203882	-38 8043		S				12 51.2	-39 10
Apr 17		P/Halley	100	0.29	184		3.573	302	203688	-37 8042		G				12 39.5	-37 47
Apr 18		P/Halley	100	0.28	187		3.235	305	203363	-34 8087		S				12 19.9	-35 10
Apr 21	643	Scheherezade	69	0.02	269	C	0.237	58	145581	-03 5272		PG		0.35	-0.3	21 39.8	-2 35
Apr 24		P/Halley	100	0.22	198		2.028	313	179904	-25 8682		YG		0.36	0.1	11 26.9	-25 47

1986 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	OCCULTATION Possible Area	El SUN	MOON El	MOON %Snl	MOON Up	Ephem. Source
Apr 25	11h00m	Patientia	12.4	3.21	78559	8.7	B3	6h34m.5	29°31'	3.7	9s	12	17	Philippine Is.	63°	130°	99-	e121°E	HERGET78
Apr 26	16 40-53	Ceres	7.9	1.96	81466	9.1	F5	10 38.0	23 38	0.3	142	41	3	central U.S.S.R., India	116	94	93-	s 48 N	APAENAXX
Apr 26	17 24	Euphrosyne	12.1	2.66	206608	7.4	F0	15 21.9	-31 59	4.7	16	19	14	Antarctica? 5"n	156	14	93-	all	EMP 1980
Apr 28	21 24-26	Pallas	8.7	2.19		9.1	A0	7 13.6	1 32	0.6	16	9	6	Brazil, Ascension Is.	73	152	74-	none	LANDGRAF
Apr 29	15 49-65	Aegle	11.6	1.82	205232	10.2	F5	14 05.9	-38 47	1.7	17	24	14	N.Z.?s; Bass Strait, Seychelles	155	66	66-	e 90 E	EMP 1984
Apr 29	21 04-05	Psyche	11.6	3.39	77813	6.7	A0	5 56.7	21 36	4.9	7	10	20	southeastern Brazil	50	156	64-	none	HERGET79
Apr 30	4 24	Velleda	13.7	2.41	164996	6.1	K0	22 16.3	-13 33	7.6	1	10	85	South Africa?n	68	34	61-	all	EMP 1985
May 2	6 54	Ino	12.6	2.47	145289	8.1	G0	21 16.3	-7 32	4.5	7	13	21	Chile, Argentina	82	14	38-	all	HERGET78
May 4	23 00-30	Mars	-0.7	0.74	187831	9.0	F2	19 10.1	-23 48	0.0	884	22	1	cen and s Africa, Indian Ocean	118	74	14-	e 60 E	NA0001
May 7	4 51-55	Pandora	12.4	2.42	190235	9.5	K5	21 16.7	-23 56	3.0	6	17	31	northern Brazil, Angola	92	73	3-	e 0	HERGET78
May 8	10 15	Comacina	14.3	3.49	146166	7.8	F2	22 32.0	-3 34	6.5	5	14	39	Central America	69	63	0-	none	EMP 1984
May 10	14 36-57	Aletheia	11.8	1.84	160139	9.3	M0	16 49.8	-16 04	2.6	12	31	26	Austral Is., N.Z., se Australia	155	169	3+	none	HERGET81
May 11	21 55	Kleopatra	12.2	3.09	95631	7.9	G5	6 21.7	13 03	4.3	3	9	33	Brazil?s; Cape Verde Is.?n	46	19	8+	w 25 W	EMP 1986
May 12	9 30-34	Lampetia	11.3	1.31	143749	9.1	A0	19 42.2	-2 45	2.4	8	16	16	southern Mexico, Florida	113	144	11+	none	EMP 1986
May 12	19 02-36	Lacadiera	12.1	1.11	185428	8.1	F8	17 25.3	-20 55	4.0	14	44	23	Papua,sThailand,India,s.cenUSSR	149	166	13+	w 55 E	EMP 1982
May 14	0 47-51	Alexandra	13.1	2.90	117710	9.1	A2	9 25.3	9 10	4.0	12	24	24	central South America	88	34	22+	w 55 W	HERGET78
May 16	17 38-56	Ate	11.6	1.70	183016	8.7	F5	14 53.6	-24 29	3.0	13	22	16	Australia, Seychelles, n Africa	170	87	47+	w 85 E	EMP 1979
May 19	15 46-60	Aegle	11.7	1.87	204909	7.5	K0	13 48.5	-37 09	4.2	19	28	15	South Pole, southeast Africa	150	46	77+	e100 E	EMP 1984
Jun 1	9 54	Isis	10.4	1.29	190252	7.1	F2	21 18.2	-21 02	3.3	10	21	18	northern Canada?s	114	47	31-	all	HERGET77
Jun 8	5 46-59	Loreley	11.7	1.98	207376	10.0	A	16 05.7	-34 39	1.9	19	24	13	Amazon, Ecuador; w Mexico?n	163	160	1+	none	HERGET78
Jun 10	3 35	Venus	-4.0	1.27	79634	8.6	K0	7 40.0	23 24	0.0	269	5	1	central Canada, western U.S.A.	34	7	6+	all	NA0001
Jun 15	11 05	Thia	10.6	1.12	185086	8.6	A3	17 06.5	-20 43	2.2	14	24	13	western U.S.A.? 1".5s	174	84	50+	none	HERGET
Jun 22	1 51	Havnia	13.9	2.68	109835	7.0	G5	1 20.1	4 29	6.9	3	12	40	South Africa, Mauritius	70	111	100+	all	EMP 1985
Jun 28	12 26	Ophelia	15.0	3.64	110023	8.8	A5	1 35.7	7 23	6.2	5	15	40	(Hawaii, California)?n	71	25	55-	all	EMP 1984
Jun 29	19 34-36	Irene	12.1	3.37	110625	6.2	K0	2 32.4	7 15	5.9	5	12	32	south of New Zealand	59	23	42-	all	HERGET77
Jul 1	7 21-22	Themis	12.8	3.21	99081	7.9	F8	10 19.2	10 57	4.9	6	10	20	central Pacific; Hawaii?	54	118	28-	none	HERGET78
Jul 2	9 40	Melete	12.7	2.11		10.7		12 45.5	-0 58	2.1	9	19	22	Hawaii	91	143	20-	none	EMP 1980
Jul 4	6 17-44	Unitas	10.7	1.02	161893	6.5	K2	18 47.7	-13 38	4.2	7	27	28	Azores?n;PR,CostaRica,c.Pacific	171	145	8-	e 50 W	EMP 1985
Jul 11	15 54	Vesta	7.5	2.02		8.7	F8	0 58.4	-1 51	0.3	39	20	5	(Japan, northeastern Asia)?s	96	147	19+	none	APAENAXX
Jul 12	19 02	Fortuna	11.3	2.17		10.0	K5	2 24.2	14 51	1.6	8	10	14	Timor Sea, New Guinea	71	136	29+	none	EMP 1981
Jul 14	8 22	Aspasia	12.9	3.26		12.8		3 46.3	23 09	0.8	6	10	24	Florida, Bermuda	52	135	45+	none	HERGET78
Jul 15	14 25	Ceres	8.8	2.93		10.3	F8	11 47.4	10 47	0.2	29	10	4	Maldives, Cocos Is.	61	40	58+	all	APAENAXX
Jul 18	10 02-17	Pax	11.5	1.19	189278	8.3	A3	20 23.3	-25 07	3.3	6	16	23	western U.S.A., New Zealand	171	49	87+	w125 W	HERGET78
Jul 31	4 08-23	Europa	11.4	2.47	146840	9.2	G5	23 38.0	-7 51	2.4	47	51	12	Newfoundland,Virgin Is.,Panama	135	73	27-	n 30 N	EMP 1982
Aug 4	14 22-44	Lumen	11.6	1.31		9.6	K0	23 20.9	1 43	2.1	20	39	16	Hawaii, Aleutians	139	126	2-	none	
Aug 5	0 53-73	Jupiter	-2.8	4.16	146774	7.0	F5	23 30.9	-4 41	0.0	4h24	44	2	Europe, Africa, South America	140	132	1-	none	NA0001
Aug 5	13 46	Fortuna	11.1	1.91		10.6		3 04.6	17 43	1.0	10s	12	12	Marshall Is., Hawaii	84	81	0-	none	EMP 1981
Aug 6	14 57	Daphne	12.1	2.13	128307	9.4	F5	23 37.1	3 53	2.8	25	36	15	Hawaii, eastern Australia	137	146	1+	none	HERGET78
Aug 7	19 42	Aspasia	12.8	2.99		11.0		4 21.0	24 07	2.0	7	13	22	Australia	67	91	5+	none	HERGET78
Aug 10	13 54-64	Russia	13.8	1.62	163645	6.2	G0	20 28.3	-15 14	7.6	5	23	43	Samoa, Fiji, se Australia	168	110	24+	none	EMP 1985
Aug 14	8 43	Venus	-4.3	0.79	138759	9.4	G5	12 21.9	-3 13	0.0	495	7	1	Queensland, Papua, Micronesia	46	61	64+	all	NA0001
Aug 18	3 51	Venus	-4.3	0.76	138883	9.2	K0	12 35.7	-5 05	0.0	524	7	1	Pitcairn Is.	46	112	96+	all	NA0001
Aug 21	22 02-07	Lilea	12.7	1.79	185266	8.9	G5	17 16.3	-20 11	3.9	12	29	25	nw Africa; sw Europe?n	112	96	94-	all	EMP 1981
Aug 26	22 02-04	Venus	-4.3	0.69	139183	6.4	K0	13 06.6	-9 16	0.0	608	8	1	eastern South America	46	141	54-	none	NA0001
Aug 28	18 41	Papagena	11.0	2.38	94719	8.7	MA	5 35.5	17 14	2.4	5	11	24	China, Korea, Japan	71	11	37-	all	EMP 1980
Aug 29	2 21	Adeona	12.9	2.26	111430	7.0	G5	3 45.8	9 30	5.9	11	23	24	Antarctica?n; South Africa? 2"n	98	31	34-	e 30 E	EMP 1984
Sep 6	18 52-60	Mars	-1.5	0.56	187784	8.9	K5	19 08.0	-27 08	0.0	1269	28	1	Antarctica	122	91	7+	none	NA0001
Sep 7	8 06-33	Sabauda	15.0	2.91	211769	7.0	A2	20 00.2	-36 44	8.0	7	54	96	Chile, New Zealand, e Australia	129	92	11+	w175 W	EMP 1986
Sep 7	21 09	Bertha	13.0	3.40	182536	7.7	K0	14 22.9	-21 12	5.3	6	11	25	south Atlantic	56	12	15+	w 5 E	LANDGRAF
Sep 11	16 05	Venus	-4.5	0.56	158288	8.8	K5	13 58.1	-16 05	0.0	867	10	1	Madagascar,Mauritius,eAntarctica	45	50	54+	all	NA0001
Sep 18	21 26	Alauda	13.1	3.35		10.5	F8	6 40.5	33 08	2.7	10	17	22	Norwegian Sea	77	96	99-	all	LANDGRAF

Virtually all of these cases involve orbits computed by Herget about 8 years ago, for which more recent and generally better orbits have been published in the Ephemerides of Minor Planets (EMP).

Major Planets. The predictions for major planets include some of the better events from scans for Mercury through Saturn sent to me by Larry Wasserman at Lowell Observatory. I will be interested to learn how observable these events are, and what value observations of them may have. Predictions have not been distributed for as many of these occultations in a previous year, and I wonder if more or less effort should be devoted to them in the future.

Venus: Most of the events occur at relatively large elongations, when Venus is crescent or near quarter phase, but not highly gibbous. Hence, like the moon, the Δm column (always 0.0) is meaningless, since relatively faint stars can be seen disappearing (or fading) on the dark side. It may be possible to see a central flash near the central line of the occultation path, but if Venus is too close to the earth, the atmospheric depth where refraction occurs will be below the cloud tops so that it will not occur. It would be useful if somebody would compute the minimum distance where a central flash could occur, with the light path grazing the cloud tops around the planet.

Table 1, Part B, is on preceding page. Table 2, Part B, is below. Text continues overleaf.

1986	PLANET		OR COMET				MOTION		STAR				COMPARISON DATA				APPARENT	
DATE	No.	Name	km-diam.	-"	RSOI	Type	°/Day	PA	SAO No	DM No.	D	S	AGK3	No.	Shift	Time	R.A.	Dec.
Apr 25	451	Patientia	281	0.12	1762	C	0.306	90°	78559	+29°1289		XA	N29	749	0".11	-0m.2	6h36m.8	29°29'
Apr 26	1	Ceres	946	0.67	9603	C	0.113	159	81466	+24 2257		AS	N23	1108	0.10	0.9	10 40.0	23 27
Apr 26	31	Euphrosyne	270	0.14	2057	C	0.209	257	206608	-3111937		S					15 24.2	-32 07
Apr 28	2	Pallas	533	0.34	3378	U	0.500	67		+01 1752		A	N01	867			7 15.4	1 28
Apr 29	96	Aegle	183	0.14	883	U	0.200	284	205232	-38 9099		S					14 08.2	-38 58
Apr 29	16	Psyche	249	0.10	1446	M	0.352	88	77813	+21 1072		ZA	N21	605	0.37	-0.1	5 58.8	21 36
Apr 30	126	Velleda	41	0.02	77	S	0.423	70	164996	-14 6255		PZ			0.43	-0.4	22 18.3	-13 23
May 2	173	Ino	169	0.09	717	C	0.308	75	145289	-07 5537		S					21 18.3	-7 23
May 4		Mars	6782	12.69*****			0.344	91	187831	-2315161		X					19 12.3	-23 44
May 7	55	Pandora	113	0.06	410	CMEU	0.243	81	190235	-2416578		S					21 18.8	-23 46
May 8	489	Comacina	130	0.05	623	C	0.249	71	146166	-04 5705		X					22 33.9	-3 23
May 10	259	Aletheia	103	0.08	376	CMEU	0.158	263	160139	-15 4403		X					16 51.9	-16 07
May 11	216	Kleopatra	137	0.06	516	M	0.431	90	95631	+13 1229		AS	N13	583	0.19	-0.9	6 23.7	13 01
May 12	393	Lampetia	117	0.12	316	C	0.359	42	143749	-02 5099		S					19 44.1	-2 40
May 12	336	Lacadiera	69	0.09	152	C	0.142	305	185428	-20 4775	O	Z					17 27.5	-20 57
May 14	54	Alexandra	177	0.08	922	C	0.163	110	117710	+09 2187		XA	N09	1209	-0.23	0.7	9 27.2	9 00
May 16	111	Ate	156	0.13	677	C	0.226	291	183016	-2411760		S					14 55.7	-24 38
May 19	96	Aegle	183	0.13	891	U	0.173	308	204909	-36 8898		S					13 50.6	-37 20
Jun 1	42	Isis	104	0.11	266	S	0.272	98	190252	-21 5992		PG			-0.03	0.4	21 20.3	-20 53
Jun 8	165	Loreley	228	0.16	1314	C	0.196	296	207376	-3410795		S					16 08.1	-34 45
Jun 10		Venus	12220	13.25*****			1.183	99	79634	+23 1795		XA	N23	861	-0.14	0.3	7 42.2	23 19
Jun 15	405	Thia	126	0.16	388	C	0.262	304	185086	-20 4653		X					17 08.7	-20 46
Jun 22	362	Havnia	97	0.05	311	C	0.344	66	109835	+03 190		ZA	N04	169	0.25	0.2	1 22.0	4 40
Jun 28	171	Ophelia	132	0.05	673	U	0.222	71	110023	+06 250		XA	N07	185	0.56	-1.9	1 37.6	7 34
Jun 29	14	Irene	155	0.06	741	S	0.299	74	110625	+06 392		AG	N07	278	-0.68	-0.1	2 34.3	7 25
Jul 1	24	Themis	228	0.10	1214	C	0.368	112	99081	+11 2212		ZA	N10	1315	0.51	1.3	10 21.1	10 46
Jul 2	56	Melete	142	0.09	515	C	0.238	108		LS 162		H					12 47.3	-1 12
Jul 4	306	Unitas	53	0.07	100	S	0.241	249	161893	-13 5119		PG			-0.37	0.9	18 49.8	-13 35
Jul 11	4	Vesta	555	0.38	3967	U	0.232	82		-02 143		XA	S01	88	-0.77	0.2	1 00.3	-1 39
Jul 12	19	Fortuna	226	0.14	908	C	0.451	72		+14 401		XA	N14	219	-0.00	0.0	2 26.1	15 01
Jul 14	409	Aspasia	194	0.08	958	C	0.348	81		HPN 2257		H					3 48.5	23 16
Jul 15	1	Ceres	946	0.44	9725	C	0.372	121		+11 2402		A	N10	1472			11 49.3	10 35
Jul 18	679	Pax	74	0.09	179	U	0.372	214	189278	-2514768		Z					20 25.5	-25 00
Jul 31	52	Europa	291	0.16	2089	C	0.082	214	146840	-08 6165		X					23 39.8	-7 39
Aug 4	141	Lumen	117	0.12	356	C	0.145	323		+01 4719		XA	N01	2821	0.04	0.0	23 22.7	1 55
Aug 5		Jupiter	140900	46.68*****			0.073	243	146774	-05 6011		PZ			-0.03	-1.2	23 32.8	-4 28
Aug 5	19	Fortuna	226	0.16	903	C	0.394	75		+17 493	N	A	N17	275			3 06.7	17 52
Aug 6	41	Daphne	204	0.13	1108	C	0.125	227	128307	+03 4887		XA	N03	3032	-1.04	-1.6	23 39.0	4 06
Aug 7	409	Aspasia	194	0.09	959	C	0.301	85		+23 685		XA	N24	406	0.01	-0.0	4 23.2	24 13
Aug 10	232	Russia	54	0.05	136	C	0.224	245	163645	-15 5696	C	PZ			0.28	0.1	20 30.3	-15 06
Aug 14		Venus	12220	21.45*****			1.039	118	138759	-02 3512		X					12 23.8	-3 25
Aug 18		Venus	12220	22.31*****			1.021	119	138883	-04 3317		X					12 37.6	-5 17
Aug 21	213	Lilea	105	0.08	327	F	0.166	116	185266	-20 4722		X					17 18.5	-20 14
Aug 26		Venus	12220	24.58*****			0.970	119	139183	-08 3495		Z					13 08.5	-9 28
Aug 28	471	Papagena	145	0.08	507	S	0.390	81	94719	+17 967		XA	N17	508	-0.81	-0.4	5 37.6	17 16
Aug 29	145	Adeona	137	0.08	539	C	0.189	81	111430	+09 494		AG	N09	349	-0.43	-0.3	3 47.8	9 36
Sep 6		Mars	6782	16.79*****			0.318	75	187784	-2713645		X					19 10.3	-27 05
Sep 7	1115	Sabauda	44	0.02	136		0.071	289	211769	-3613856	A	G					20 02.7	-36 38
Sep 7	154	Bertha	201	0.08	1087		0.325	116	182536	-20 4023		PX			0.30	1.2	14 25.0	-21 22
Sep 11		Venus	12220	29.97*****			0.830	118	158288	-15 3785		P					14 00.1	-16 16
Sep 18	702	Alauda	217	0.09	1345	C	0.206	96		+33 1391		A	N33	689			6 42.9	33 05

1986	UNIVERSAL	PLANET			STAR					OCCULTATION					El	MOON			Ephem.
DATE	TIME	NAME	m_v	Δ,AU	SAO No	m_v	Sp	R.A.(1950)	Dec.	Δm	Dur	df	P	Possible Area	SUN	El	%Snl	Up	Source
Sep 28	9^h21^m-29^m	Venus	-4.6	0.44	182838	8.8	K2	$14^h42.^m0$	-21°38'	0.0	1677^s	18	1	Japan,Micr'nsia,Papua,Queensland	41°	106°	29-	none	NA0001
Sep 29	10 46-62	Gallia	10.6	1.38	167259	9.5	F8	1 41.5	-23 51	1.4	8	19	22	s cen U.S.A., Mexico, McMurdo	147	117	20-	n 5°S	EMP 1981
Sep 29	18 54	Parthenope	11.6	2.43		10.1		6 44.8	19 27	1.8	9	17	23	se Asia, Philippines, Marianas	85	37	17-	e115 E	HERGET77
Oct 1	00 58-88	Octavia	12.0	1.17	166016	6.5	G5	0 00.6	-24 25	5.5	12	34	22	cen Africa, cen South America	152	155	9-	e 40 E	EMP 1986
Oct 1	21 16	Venus	-4.6	0.41	182934	9.2	K5	14 48.8	-22 29	0.0	2097	22	1	ne Brazil, Tristan da Cunha	39	63	4-	none	NA0001
Oct 4	10 14-24	Leda	12.3	1.68	75363	9.1	G0	2 23.2	25 31	3.2	17	37	21	U.S.A.	147	155	1+	none	EMP 1986
Oct 9	11 09-16	Mars	-0.8	0.74	189038	9.0	K2	20 10.4	-23 16	0.0	552	14	1	Japan,se Asia,Philippines,Papua	104	29	38+	none	NA0001
Oct 27	19 18-34	Minerva	11.6	1.84		9.6	G0	0 04.5	2 42	2.2	22	34	15	s U.S.S.R., s Europe	149	142	32-	e 70 E	EMP 1981
Oct 29	16 23	Lutetia	12.9	2.96	98854	7.5	G5	9 53.9	14 58	5.4	5	14	38	New Zealand? 1".3n	70	23	16-	all	EMP 1984
Nov 4	7 54-63	Aurora	12.7	2.58	79994	9.0	K5	8 07.4	29 37	3.7	20	33	20	Baja, cen U.S.A., se Canada	103	132	6+	none	EMP 1981
Nov 6	0 50	Isis	10.8	1.53	190724	9.4	K0	21 51.6	-24 32	1.6	6	14	21	s Peru, n Bolivia, Amazon	99	47	19+	w 50 W	HERGET77
Nov 10	11 24	Dembowska	10.9	2.48	190516	9.4	F8	21 36.0	-21 44	1.8	8	18	25	Sumatra, Philippines; Japan?n	92	18	67+	all	EMP 1983
Nov 13	3 13-26	Metis	8.8	1.14		10.1	G0	4 31.3	20 24	0.3	26	29	9	n Europe, Greenland, Alaska	161	57	89+	w 15 E	BRANHAM
Nov 14	20 52-57	Prymno	12.3	1.39		9.8	B8	4 43.5	18 57	2.6	9	26	24	(Mauritius, South Africa)?n	160	39	97+	all	EMP 1985
Nov 15	5 45-67	Havnia	12.4	1.56		11.4	G0	1 25.8	10 55	1.4	12	31	23	Brazil,n Bolivia,Peru; Tahiti?s	152	14	98+	all	EMP 1985
Nov 16	3 52-70	Euterpe	9.4	1.06		10.2	K0	2 26.2	12 04	0.4	16	28	13	Gibraltar, Florida, n Mexico	165	12	100+	all	HERGET77
Nov 19	5 58	Eunomia	10.7	2.77		10.2	K2	10 37.0	3 15	1.0	12	15	15	Nova Scotia, Azores, nw Africa	77	74	93-	all	BRANHAM
Nov 28	13 44-61	Klymene	11.9	1.71	76849	9.0	F0	4 53.2	24 46	3.0	13	25	19	nw Mexico, Sakhalin Is., China	170	128	13-	e155 W	EMP 1983
Dec 1	19 26	Mars	0.2	1.11	165064	9.1	G0	22 22.9	-11 26	0.0	297	9	1	Azores, Ireland, Scotland, Norway	85	83	0+	none	NA0001
Dec 4	10 08	Parthenope	10.6	1.73	96444	9.1	A5	7 01.5	18 55	1.7	18	31	16	s Pacific; New Zealand?n (low)	147	170	11+	w180	HERGET77
Dec 12	6 24-44	Campania	12.3	1.57	93534	8.8	K0	3 36.5	13 08	3.6	12	30	22	n Brazil, n Peru; Tahiti?n	155	21	86+	w 55 W	EMP 1981
Dec 13	22 38-45	Venus	-4.6	0.43	158670	8.7	A3	14 33.9	-12 17	0.0	1604	17	1	w&n China, Mongolia, Lake Baikal	41	164	95+	w100 E	NA0001
Dec 17	12 34	Adeona	11.8	1.60	93262	9.1	K0	3 02.2	11 31	2.8	18	32	17	Australia? 2"n	141	53	98-	all	EMP 1984
Dec 22	7 37-65	Walkure	13.4	1.24	93900	5.7	A2	4 20.5	16 40	7.7	7	33	41	nw South America; Hawaii?	156	90	70-	e140 W	EMP 1986
Dec 26	13 05	Hypatia	13.9	3.75	159042	7.6	G5	15 05.4	-11 52	6.3	4	10	35	Marquesas Is.; Mexico? 1".3n	47	18	27-	all	EMP 1983
Dec 28	6 01-13	Sylvia	12.0	2.56	77917	8.4	K2	6 01.1	28 18	3.7	18	21	14	nw Africa, n Canada, Alaska	173	145	12-	e 25 W	HERGET78
Dec 30	10 34-58	Poesia	14.4	1.80	80322	8.7	K0	8 36.5	20 14	5.8	6	34	54	Colombia; (Mexico,CA,Japan)?n	152	142	1-	none	EMP 1984

Mars: Mars is always highly gibbous, and I have doubts about any of the listed events being observable. I have eliminated potential events close to opposition, where the defect of illumination (or "defect") is near zero. A lucky observer might see a brief occultation by Phobos or Deimos. But any occultation by Mars has dubious value considering the relative abundance of in situ observations. The percent of Mars sunlit ranges from 86 to 90 for all events listed, and the defect of illumination ranges from 1".1 to 1".8 (on Sept. 6 and Oct.9).

Jupiter: I have not worked out the geometry to see whether the Jovian rings might dim the star's light.

Outer Planets: Wasserman found no occultations by Saturn. D. J. Mink and A. Klemola have published "Predicted Occultations by Uranus, Neptune, and Pluto: 1985-1990" in *Astron. J. 90* (9), 1894. Their Uranus and Neptune events involve stars of mag. 12.2 or fainter, which will be overwhelmed in the telescopes used by most *O.N.* readers. The brightest star occulted by Pluto in 1986 is mag. 14.9, again out of most observers' range. Mink updated his published predictions for Pluto using recent astrometric data. Of his 5 listed events, only the ones on April 30 (central Pacific) and June 22 (northern South America, Cape Verde Is.) will probably actually occur.

Comets: Predictions of occultations by comets, especially P/Halley, were given and discussed starting on p. 281 of the last issue. I obtained IHW orbit #31 for P/Halley early in November. It showed substantial deviations from IHW #28 used last time, so I have included revised predictions for all of the 1986 P/Halley predictions here. I also have included some wider misses than I considered before, when selecting events from the Lowell list in *IHW Newsletter #7*, to take into account possible future deviations. For those interested in knowing where the P/Halley paths in 1985 went, IHW31 was 1".5 north of IHW28 during essentially all of November and December, 1985.

A new orbit, IHW #33, recently became available, using observations through 1985 Dec. 16. Fortunately, the changes from IHW #31 are under 0".3, considerably less than the over 1" mean residual of the observational fit. Hence, I have not bothered to show the IHW #33 updates, except in a couple of the regional maps, where the correction from my slightly inaccurate earth orbit to the better one used by Yeomans is also included. I made a mistake on the chart for April 24; the YEOIHW33 path should be at 0".38 N. (virtually identical to the SAO – G.C. path), not 1".3 N. as shown, so the path still should cross the northernmost part of Australia.

P/Giacobini-Zinner's orbit changed substantially near perihelion, and P/Halley's orbit may do likewise. But we won't know about it until the comet is recovered in late February, after which rather large changes to my predictions could occur. I will maintain Halley ephemeris updates on the recorded telephone message at 301,585-0989.

Neil Divine at J.P.L. recently sent me the results of opacity calculations using his dust models for P/Halley. These indicate that visual observers probably will be able to detect an event if the miss distance is under 5 km, while photoelectric observers might be able to detect dimming out to about 50 km. But Divine states that "the uncertainty in these results is considerable," and ends his letter saying: "Should confirmed detection of any of these potential occultations be obtained, I would appreciate prompt notification, as comparison with the predictions might be useful to improve the environmental models for the spacecraft flybys in March 1986." Unfortunately, few P/Halley events occur before the spacecraft encounters. Most of them, including the three best occultations (and perhaps the only ones involving bright-enough stars to separate from the light of the inner coma), occur in April. Hence, it is much more probable that the occultation strategies will benefit from the spacecraft results than the other way around. And the spacecraft data may be so good that any occultation results would have little or no value.

Table 1, Part C, is on page 306. Table 2, Part C, is below.

1986 DATE	PLANET OR COMET No.	Name	km-diam.	-"	RSOI	Type	MOTION °/Day	PA	STAR SAO No	DM No.	D	S	COMPARISON DATA AGK3 No.		Shift	Time	APPARENT R.A.	Dec.
Sep 28		Venus	12220	38.41	*****		0.550	118°	182838	-21°3956		X					14h44m.1	-21°47'
Sep 29	148	Gallia	92	0.09	260	S	0.287	204	167259	-24 732		S					1 43.3	-23 40
Sep 29	11	Parthenope	155	0.09	634	S	0.245	96		LJ 1691		H					6 47.0	19 25
Oct 1	598	Octavia	78	0.09	185	C	0.177	260	166016	-2417960		YG			-0".23	4m.4	0 02.5	-24 13
Oct 1		Venus	12220	40.63	*****		0.465	119	182934	-2210699		X					14 50.9	-22 38
Oct 4	38	Leda	118	0.10	425	C	0.136	268	75363	+25 397		A	N25	220	1.01	3.7	2 25.3	25 41
Oct 9		Mars	6782	12.63	*****		0.549	73	189038	-2316069		X					20 12.6	-23 10
Oct 27	93	Minerva	173	0.13	801	C	0.140	263		+02 4754		XA	N02	8	0.01	-0.1	0 06.4	2 55
Oct 29	21	Lutetia	114	0.05	436	M	0.279	107	98854	+15 2136		ZA	N14	1065	-0.09	0.9	9 55.9	14 47
Nov 4	94	Aurora	191	0.10	1009	C	0.124	82	79994	+29 1701		AS	N29	943	0.43	3.9	8 09.7	29 30
Nov 6	42	Isis	104	0.09	266	S	0.375	59	190724	-2416895		S					21 53.7	-24 22
Nov 10	349	Dembowska	145	0.08	608	R	0.228	56	190516	-2215498		S					21 38.1	-21 34
Nov 13	9	Metis	190	0.23	709	S	0.212	277		+20 775	P	XA	N20	417	0.01	-0.1	4 33.5	20 29
Nov 14	261	Prymno	84	0.08	232	C	0.215	266		+18 721		XA	N18	380	-0.00	0.0	4 45.7	19 01
Nov 15	362	Havnia	97	0.09	306	C	0.170	265				A	N10	154			1 27.7	11 07
Nov 16	27	Euterpe	116	0.15	327	S	0.230	256		+11 344		XA	N12	266	0.01	0.0	2 28.2	12 14
Nov 19	15	Eunomia	261	0.13	1477	S	0.267	126		+03 2400		XA	N03	1419	0.02	-0.0	10 38.9	3 04
Nov 28	104	Klymene	134	0.11	537	C	0.203	269	76849	+24 708		XA	N24	437	0.02	-0.3	4 55.5	24 50
Dec 1		Mars	6782	8.43	*****		0.682	66	165064	-11 5829		X					22 24.9	-11 15
Dec 4	11	Parthenope	155	0.12	648	S	0.161	279	96444	+19 1597		XA	N18	684	0.32	1.5	7 03.7	18 52
Dec 12	377	Campania	103	0.09	336	CMEU	0.174	251	93534	+12 497		XA	N13	287	-0.30	0.3	3 38.6	13 15
Dec 13		Venus	12220	39.21	*****		0.587	98	158670	-11 3766		P					14 35.9	-12 26
Dec 17	145	Adeona	137	0.12	505	C	0.160	298	93262	+11 429		XA	N11	301	0.04	-1.1	3 04.2	11 40
Dec 22	877	Walkure	44	0.05	81	CMEU	0.179	278	93900	+16 586	J	ZA	N16	364	0.53	-1.1	4 22.7	16 45
Dec 26	238	Hypatia	155	0.06	787	C	0.321	99	159042	-11 3881		PZ			0.60	-2.3	15 07.4	-12 00
Dec 28	87	Sylvia	275	0.15	2080	P	0.193	280	77917	+28 997		ZA	N28	601	0.31	-0.1	6 03.5	28 18
Dec 30	946	Poesia	48	0.04	117	C	0.143	289	80322	+20 2145		XA	N20	1000	0.21	-0.4	8 38.6	20 06

Notes about Individual Events. Some of the visual double star data, and some of the Yale and AGK3 data, were supplied by Wayne Warren, Astronomical Data Center, Goddard Space Flight Center, Greenbelt, MD. Some of the notes published in my article on planetary occultations in the January issue of *Sky and Telescope* will not be repeated here. Notes for events after April will be given in the next issue.

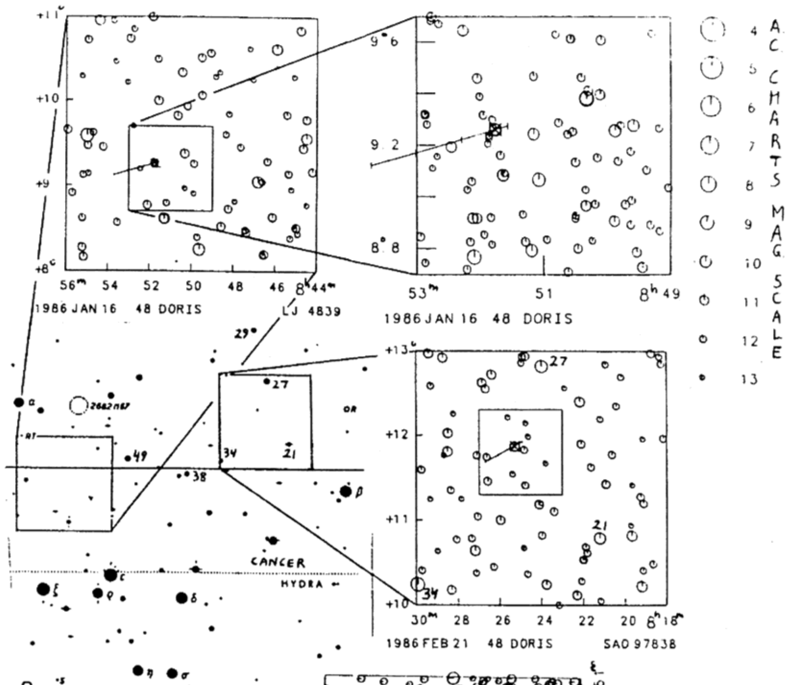
Jan. 2: The star position used was supplied by W. Landgraf, who received it from the European Space Operations Center. It was one of several reference stars "observed on La Palma (Canary Is.) with the Carlsberg Automatic Meridian Circle for targeting the ESA space probe GIOTTO onto Halley's Comet for close encounter in March 1986." Unfortunately, in the list of a few hundred stars along Halley's path up to the time of the Giotto encounter, this star was the only one in my list that may be occulted, but even it probably won't be; also, all or most readers will receive this after the event.

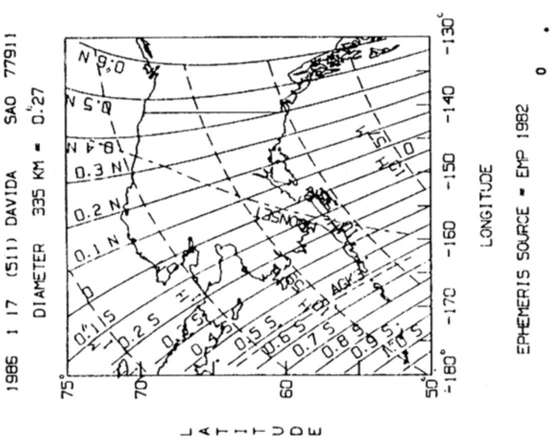
Jan 13: The star has an 11th-mag. companion 15" away in p.a. 330° that may be occulted along a path about 1".3 south of the primary star's path.

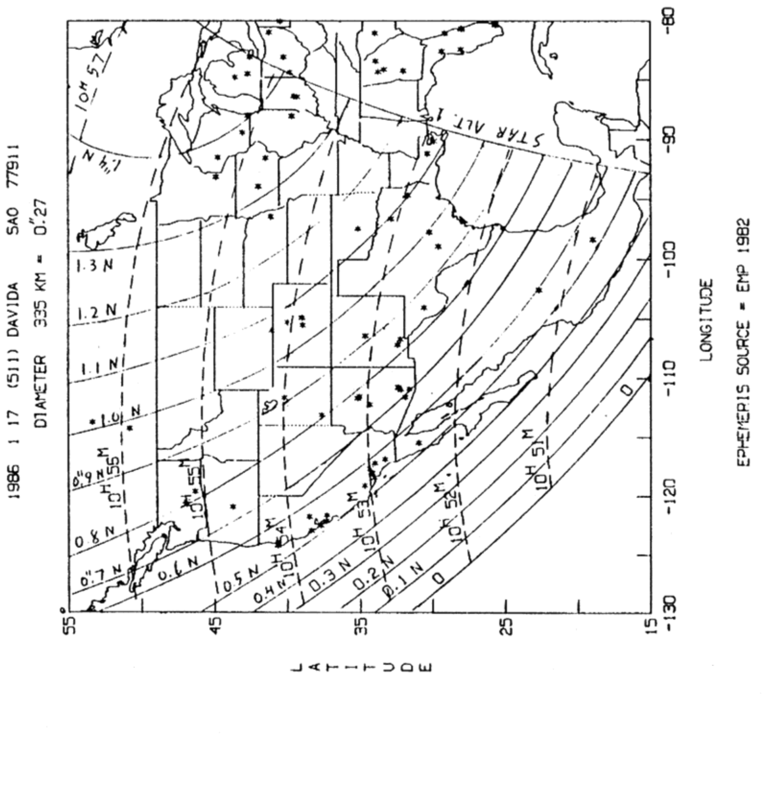
Jan. 17: The star is Z.C. 915 = Chi 2 Orionis, whose close duplicity is suspected from 1975 graze observations. This is the brightest star to be occulted by any asteroid during 1986, and a large asteroid at that. Preliminary astrometry is in progress to see if the path might shift to California, but in any case, observers throughout western North America should monitor the appulse, at least for possible secondary occultations. If the path stays where it is, it might be reached by boat (observation could be with binoculars), or it might be seen from southern Alaska, where recent weather has been comparatively warm (but chances of clear sky remain low). I am giving some thought to the possibilities; let me know if you also might be interested in making an unusual observation.

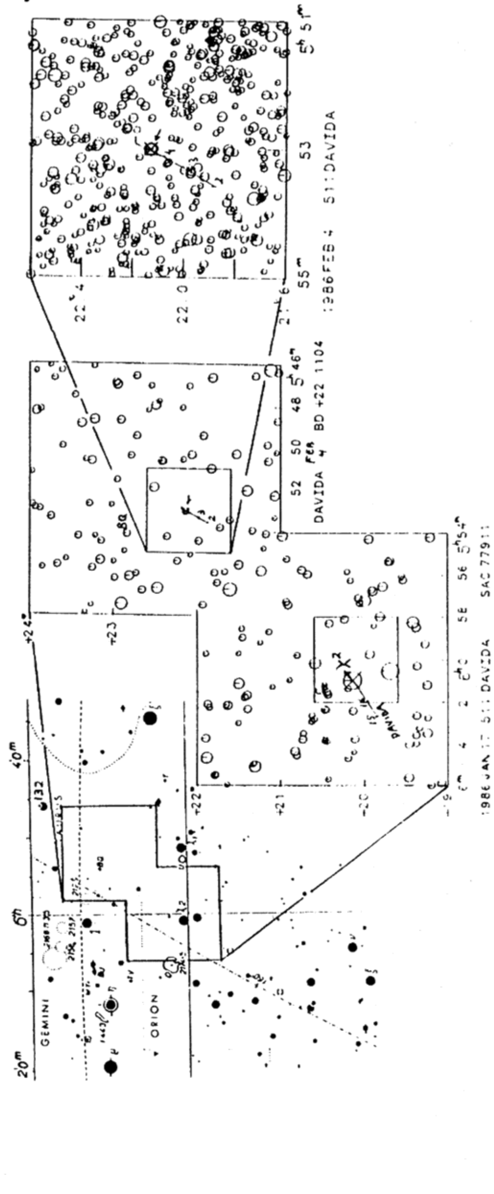
Mar. 25: The star is Z.C. 2291 = 49 Librae, a spectroscopic binary.

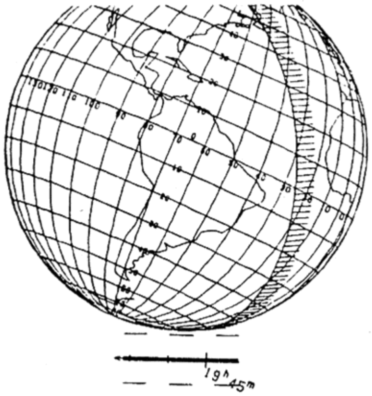
Apr. 24: This is the best occultation by P/Halley during the current apparition, and it occurs during the deep partial phases just before a total lunar eclipse. I'm planning to travel to Australia to try to observe this occultation and the comet; let me know if you also would be interested in making a largely tax-deductible trip to also attempt this once-in-a-lifetime event. It should be possible to get in a little regular comet viewing after moonset a few days before the 24th. If the path predicted from post-perihelion observations shows that the path goes entirely north of Australia, I will lose interest fast. If it shifts south, it may be possible to mobilize large numbers of Australian observers. I will check into the possibilities of getting Schmidt plates at one of the southern observatories to obtain a last-minute path update. See also the end of the second paragraph of *Comets* above.



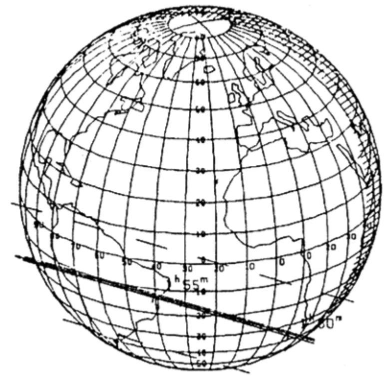




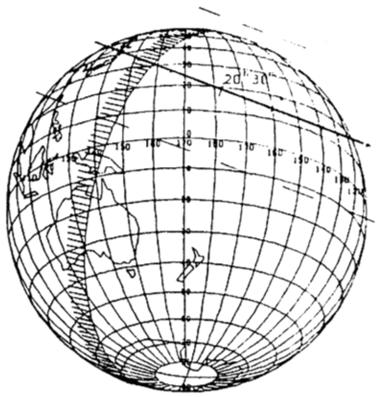




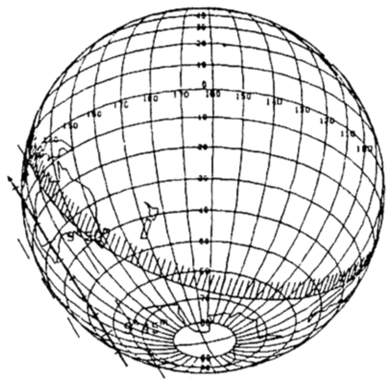
SAO 145945 by P/Halley 1986 Jan 2



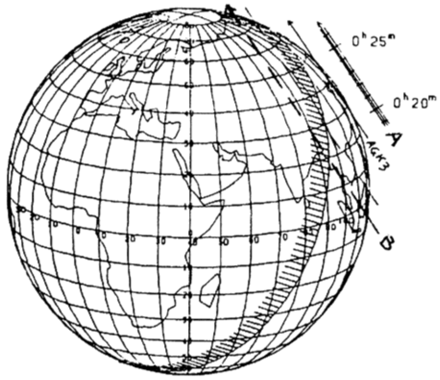
+24°1520 by Chloris 1986 Jan 3



SAO 183171 by Brunhild 1986 Jan 8

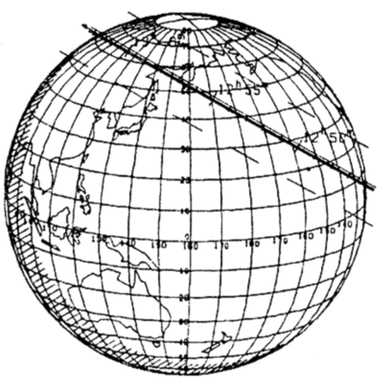


SAO 196652 by P/G-Z 1986 Jan 11

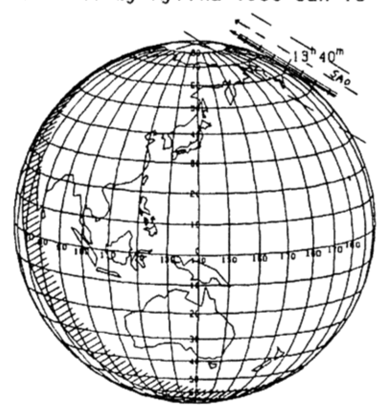


SAO 99159 by Myrrha 1986 Jan 13

SAO 115666 by Mabella 1986 Jan 15

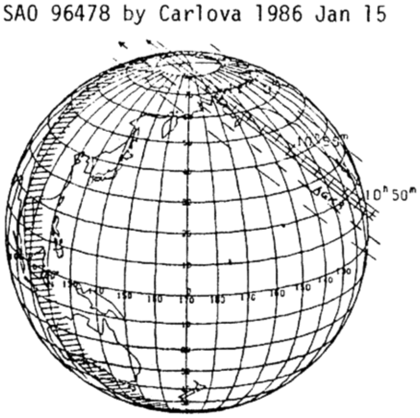


SAO 96478 by Carlova 1986 Jan 15

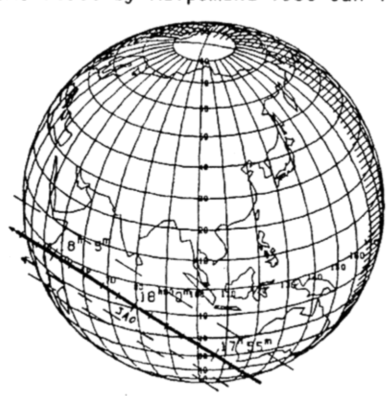


SAO 95935 by Melpomene 1986 Jan 16

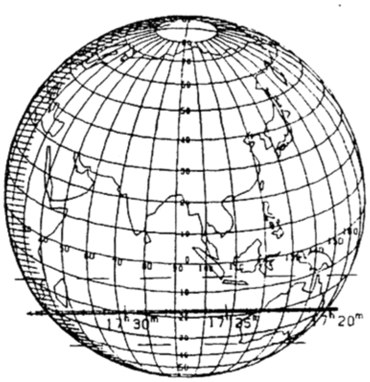
LJ 4839 by Doris 1986 Jan 16



SAO 77911 by Davida 1986 Jan 16

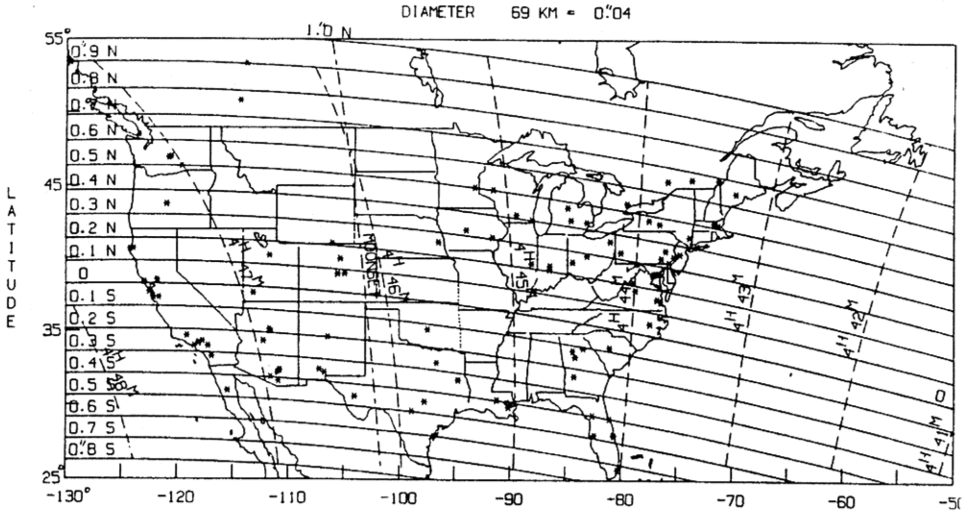


SAO 80380 by Brixia 1986 Jan 19



LJ 3455 by Arachne 1986 Jan 20

1986 1 15 (510) MABELLA SAO 115666
DIAMETER 69 KM = 0".04



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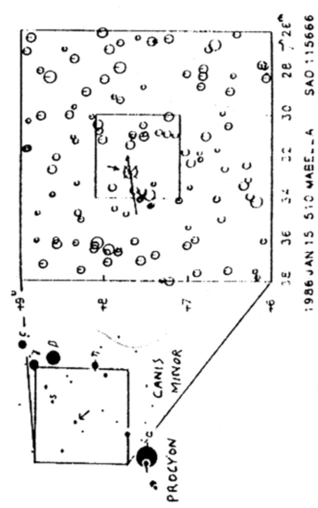
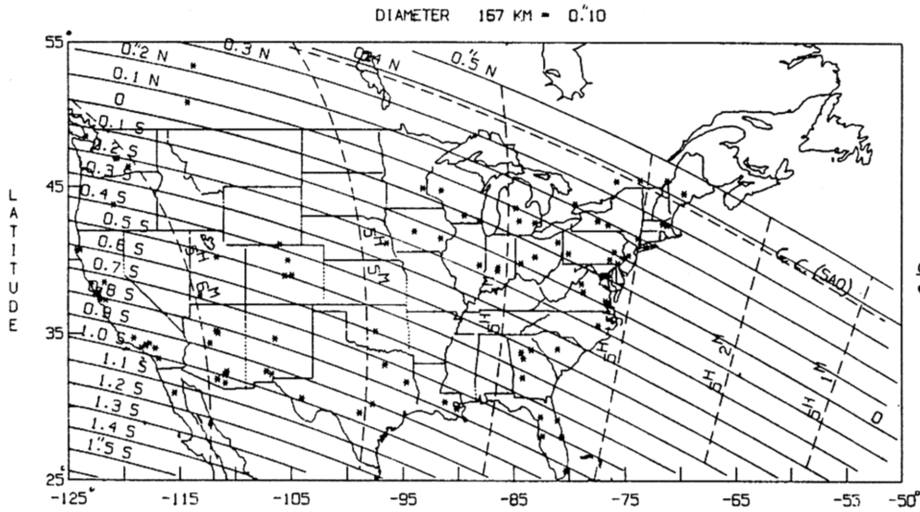
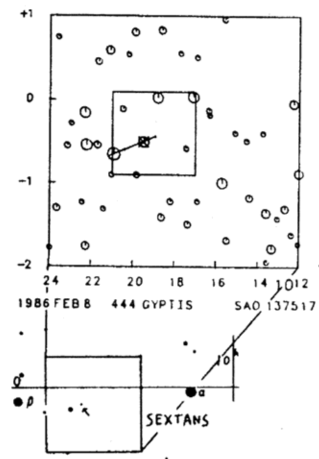
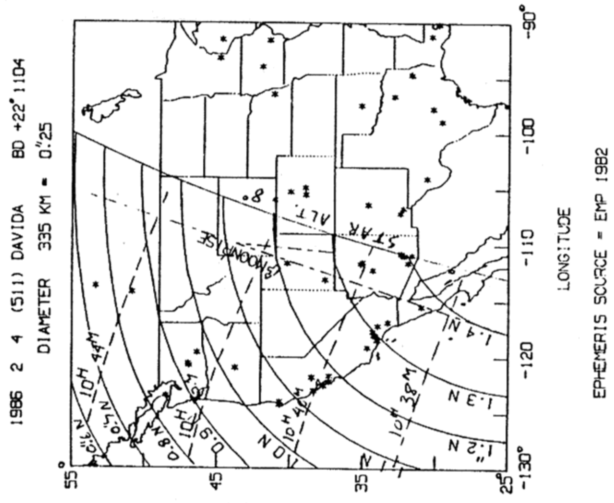


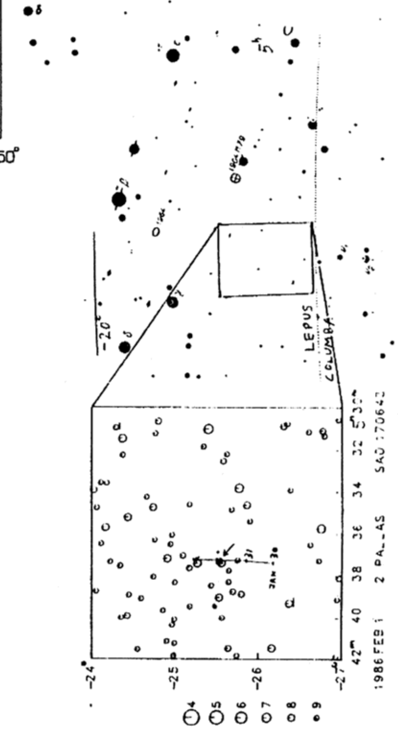
1986 2 8 (444) GYPTIS SAO 137517
DIAMETER 167 KM = 0".10

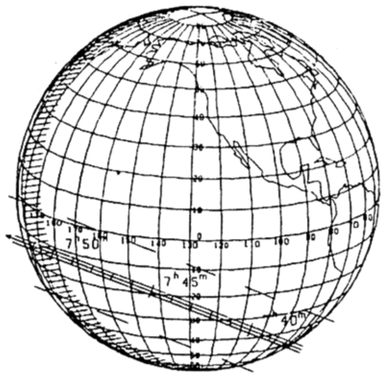


EPHEMERIS SOURCE = HERGET

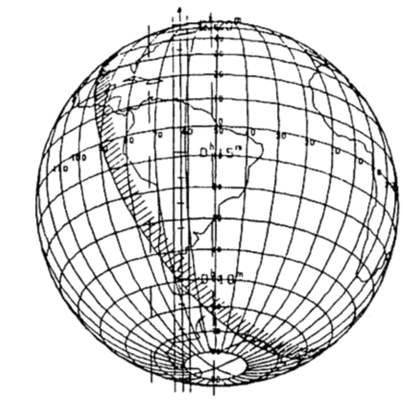




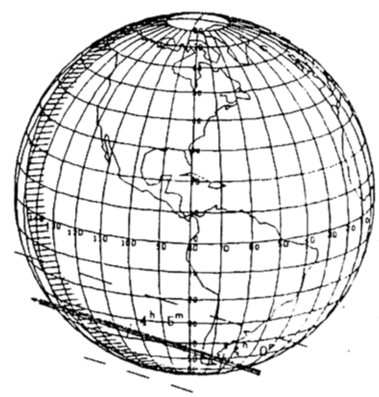




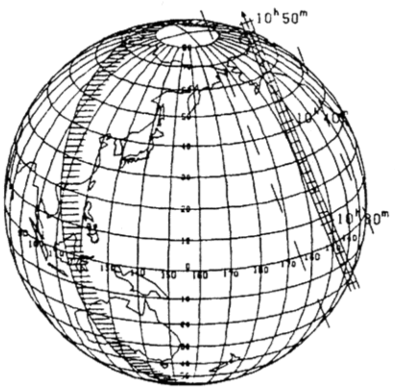
LJ 3604 by Eugenia 1986 Jan 28



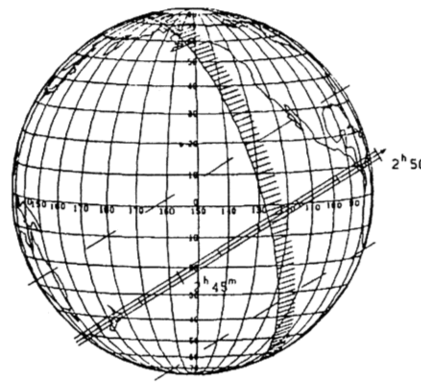
SAO 170643 by Pallas 1986 Feb 1



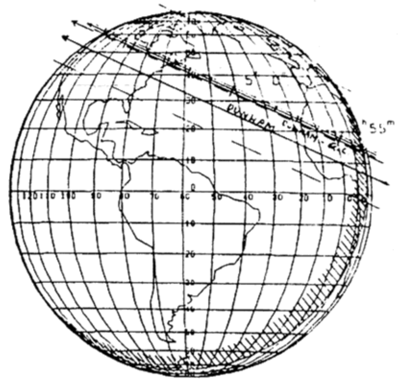
SAO 97085 by Polyxo 1986 Feb 2



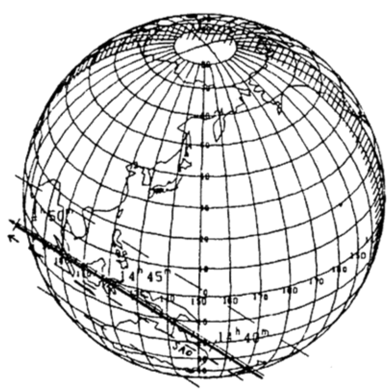
+22°1104 by Davida 1986 Feb 4



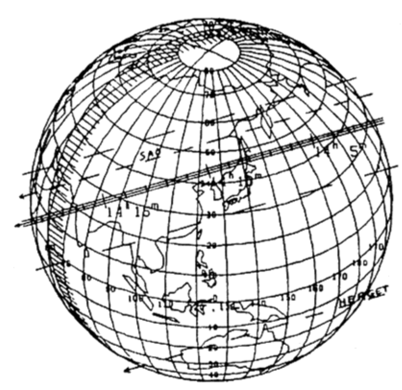
SAO 110095 by Sylvia 1986 Feb 6



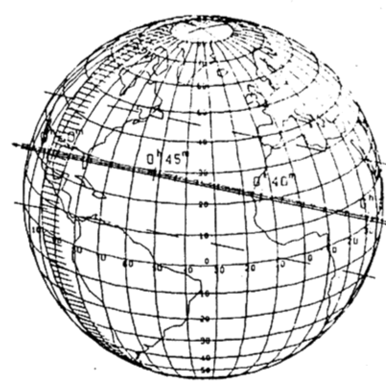
SAO 137517 by Gyptis 1986 Feb 8



SAO 61871 by Scheila 1986 Feb 9

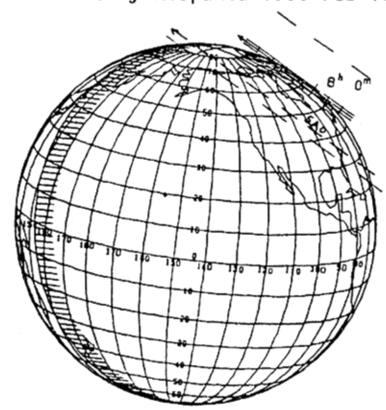


SAO 60650 by Hispania 1986 Feb 15

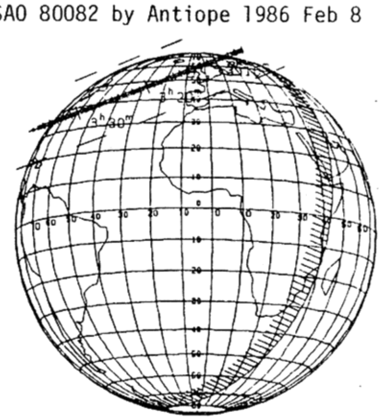


SAO 80082 by Antiope 1986 Feb 8

SAO 118942 by Sophrosyne '86 Feb 8

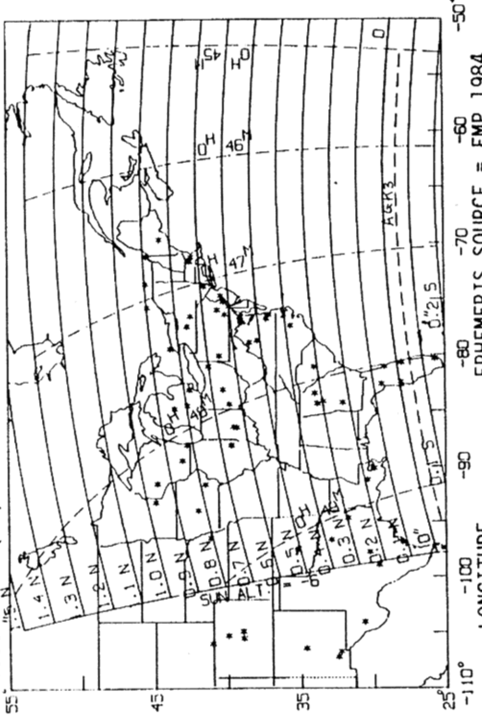


SAO 97838 by Doris 1986 Feb 21



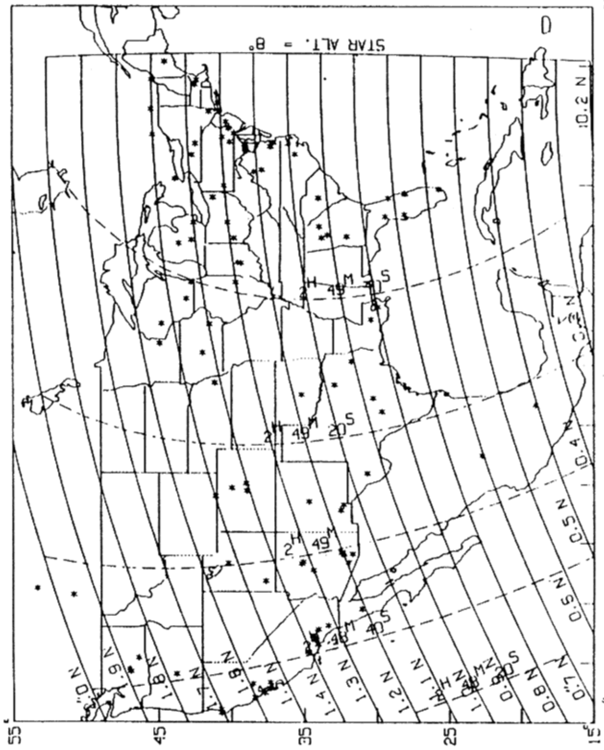
LS 1110 by Devosa 1986 Feb 22

1986 2 18 (90) ANTIOPE SAO 80082 DIAM 138 KM = 0".07



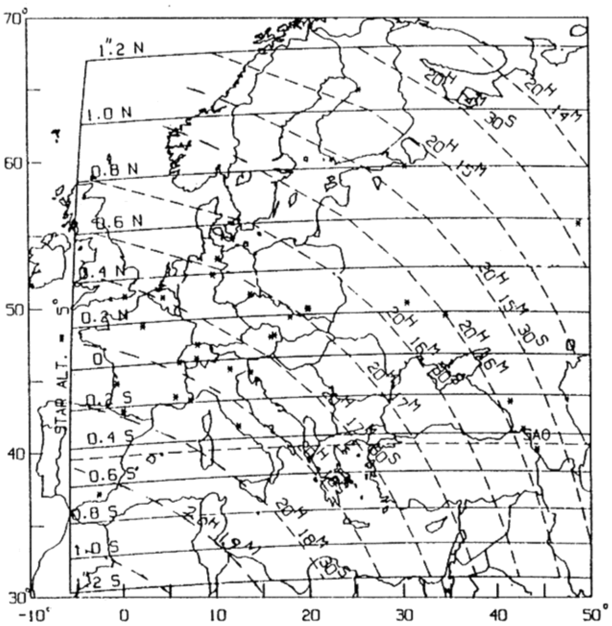
EPHEMERIS SOURCE = EMP 1984

1986 2 6 (87) SYLVIA SAO 110395
DIAMETER 275 KM = 0".11



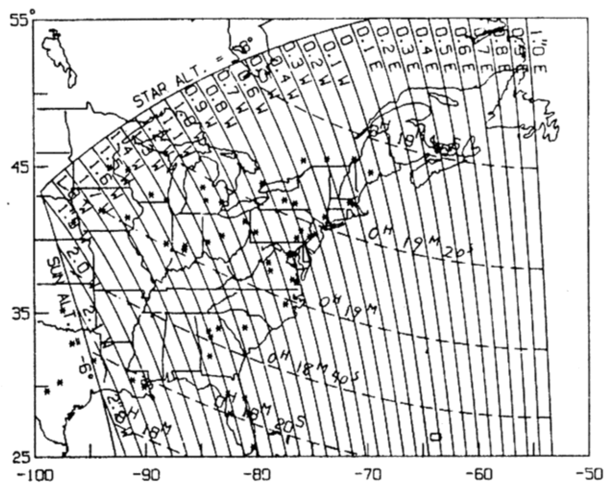
EPHEMERIS SOURCE = HERGET76

1986 2 18 (134) SOPHROSYNE SAO 118942
DIAMETER 107 KM = 0".09



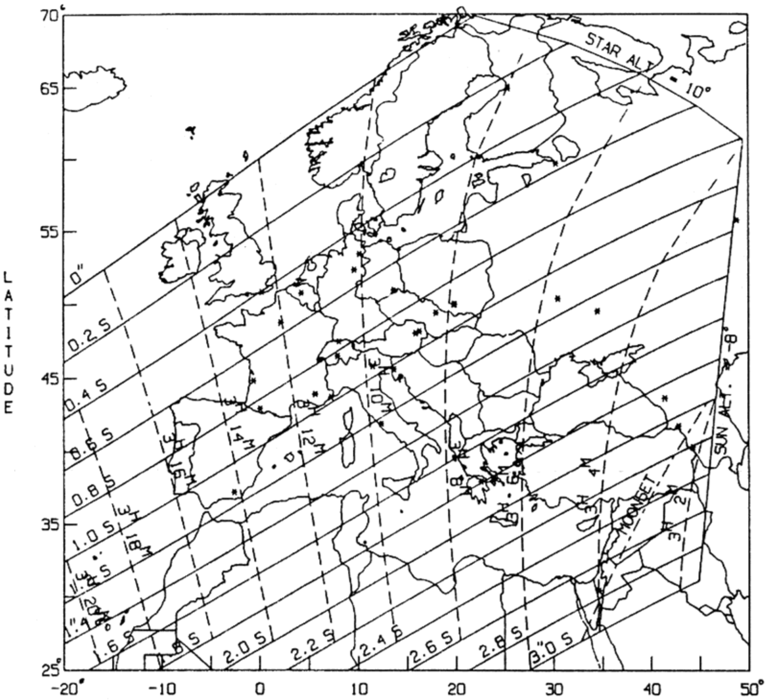
EPHEMERIS SOURCE = EMP 1984

1986 2 1 (2) PALLAS SAO 170643
DIAMETER 533 KM = 0".48



EPHEMERIS SOURCE = LANDGRAF

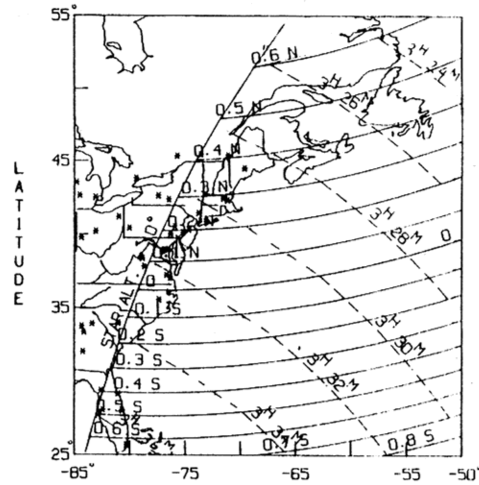
1986 2 22 (337) DEVOSA LS 1110
DIAMETER 107 KM = 0".10



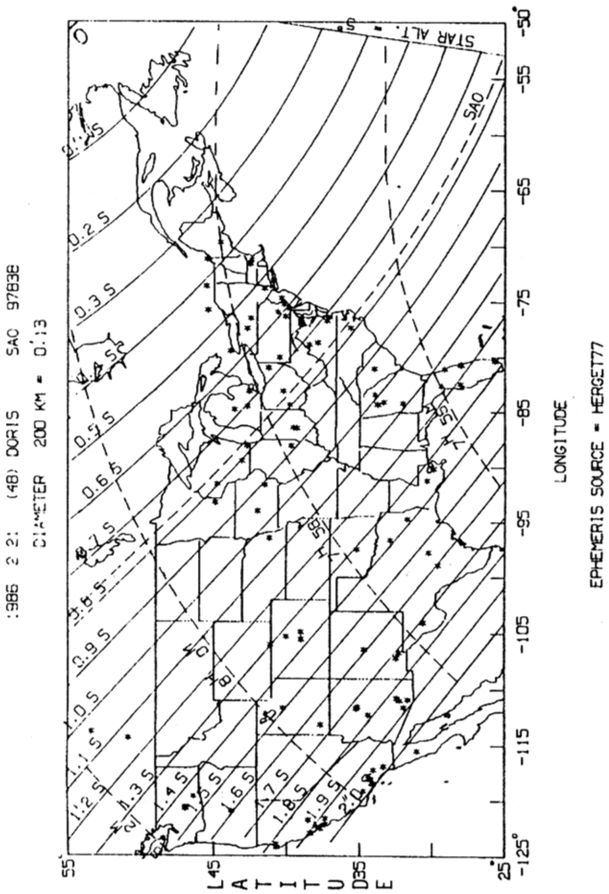
EPHEMERIS SOURCE = EMP 1981

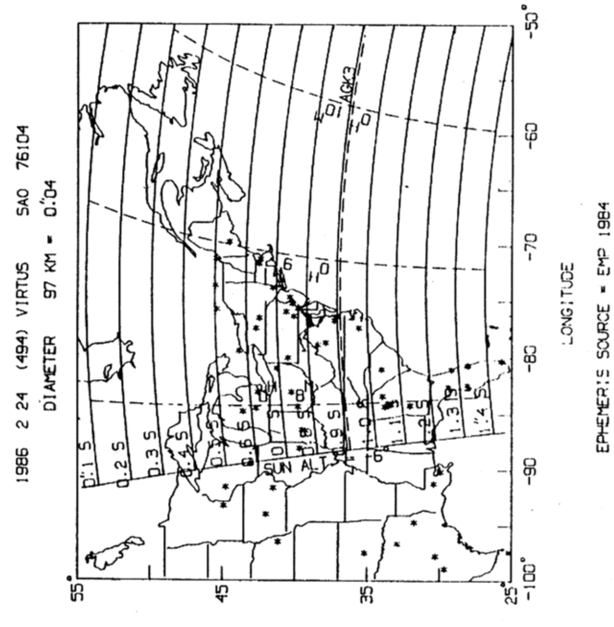
SAO 76104 by Virtus 1986 Feb 24

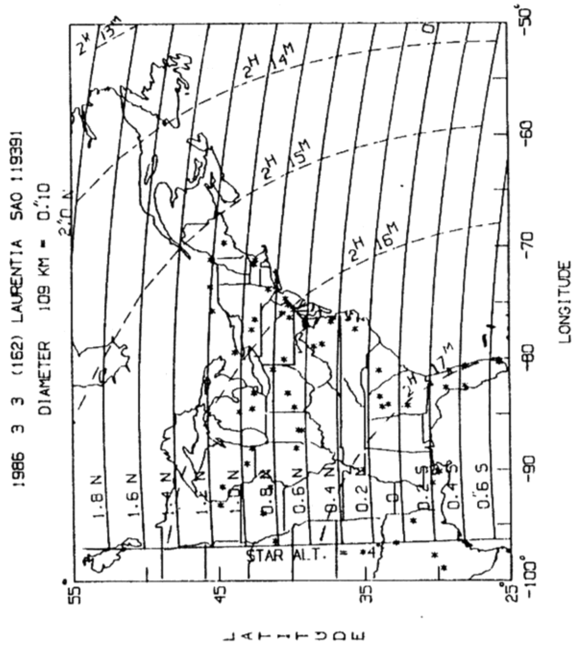
1986 2 22 (337) DEVOSA LS 1110
DIAMETER 107 KM = 0".10

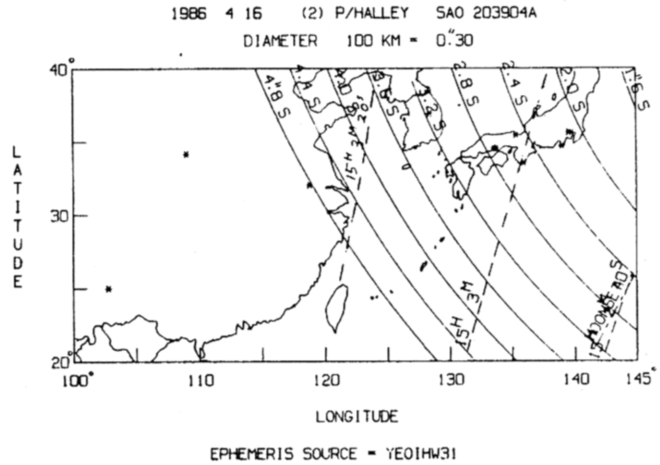


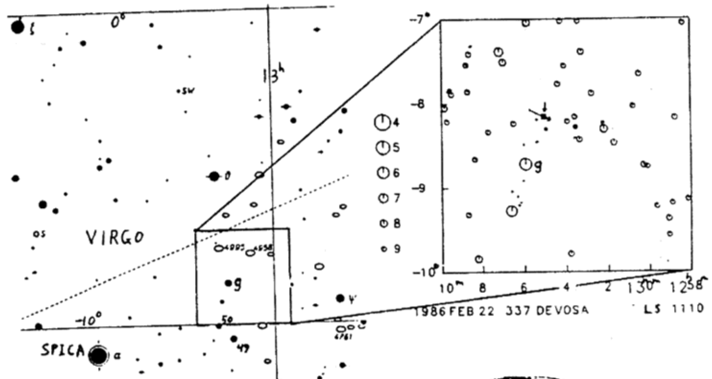
EPHEMERIS SOURCE = EMP 1981

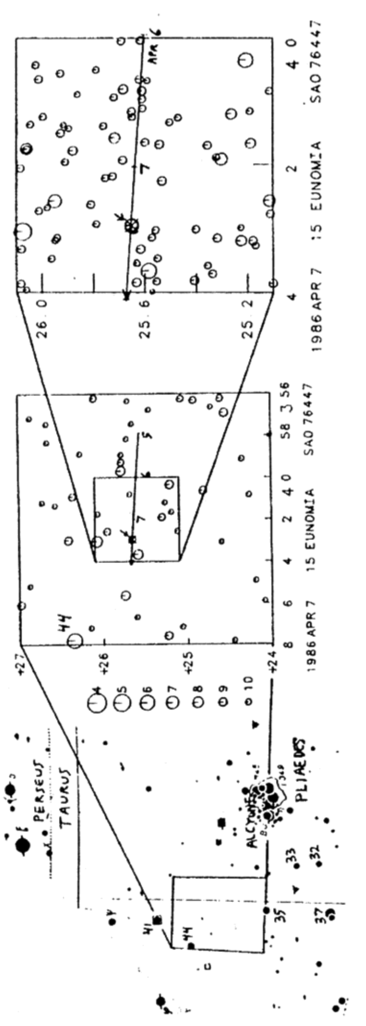


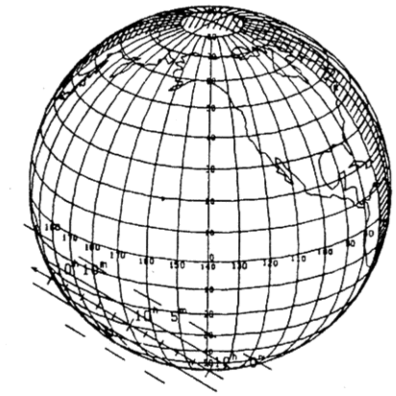




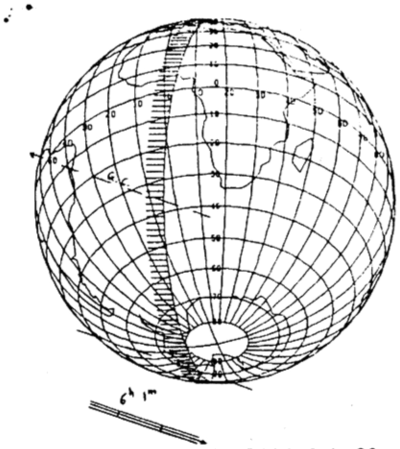




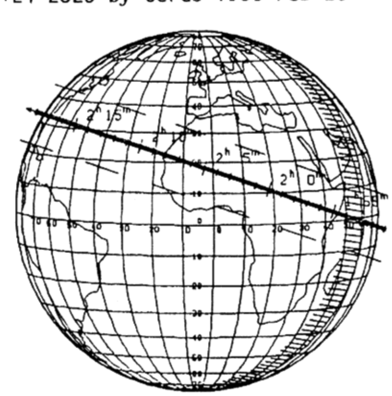




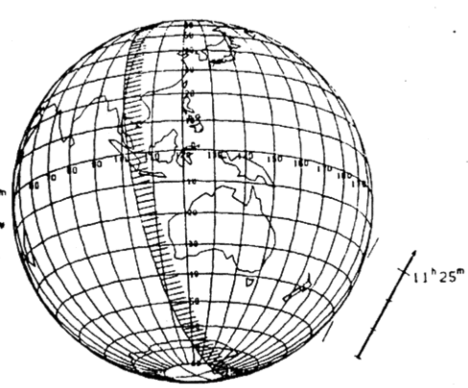
+24°2323 by Ceres 1986 Feb 26



SAO 208557 by Ursula 1986 Feb 22

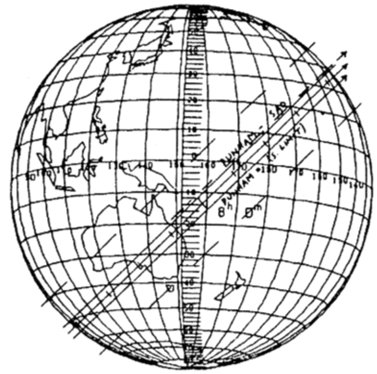


+04°2614 by Laurentia 1986 Mar 3

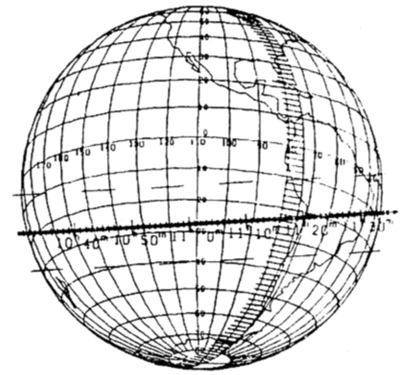


SAO 151324 by P/G-Z 1986 Mar 3

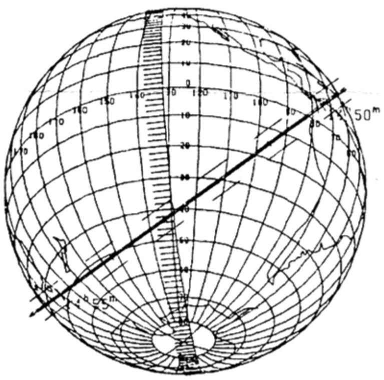
SAO 100323 by Faïna 1986 Mar 5



SAO 132993 by Pallas 1986 Mar 21

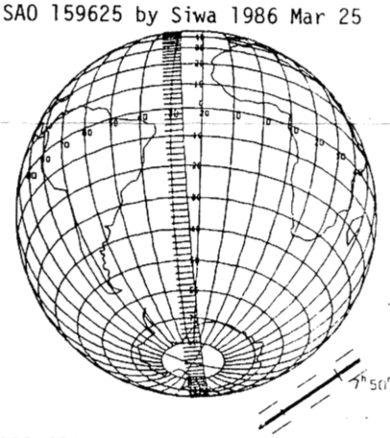


SAO 159625 by Siwa 1986 Mar 25

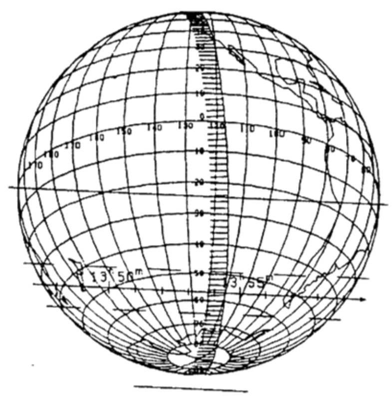


SAO 210769 by P/Halley 1986 Mar 28

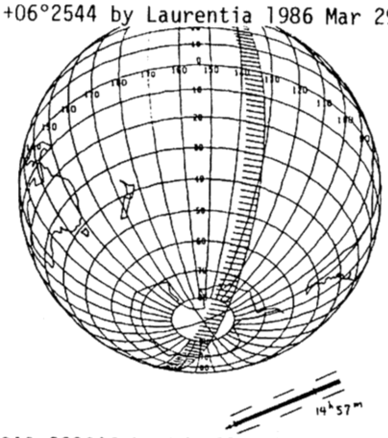
+06°2544 by Laurentia 1986 Mar 29



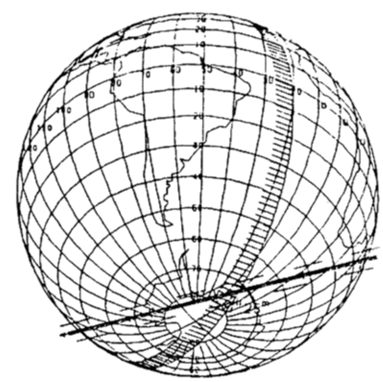
SAO 210652 by P/Halley 1986 Mar 29



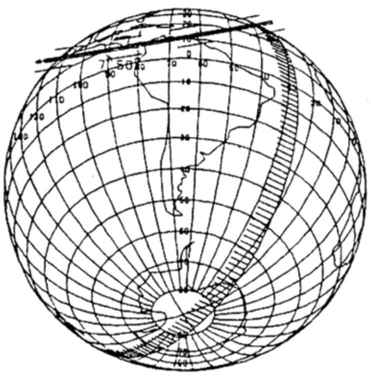
SAO 186404 by Mars 1986 Apr 1



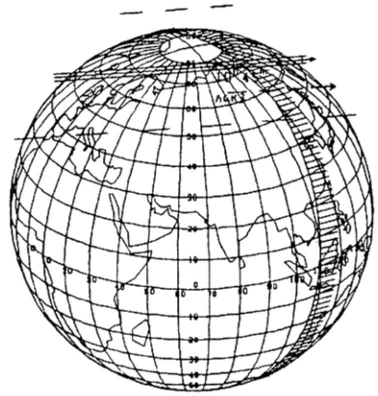
SAO 228046 by P/Halley 1986 Apr 4



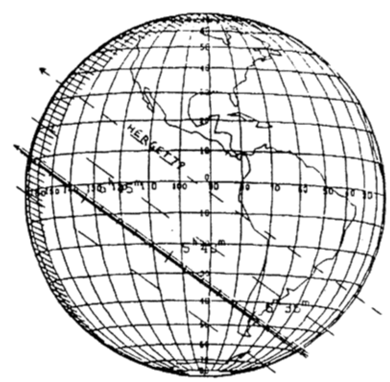
SAO 227471 by P/Halley 1986 Apr 6



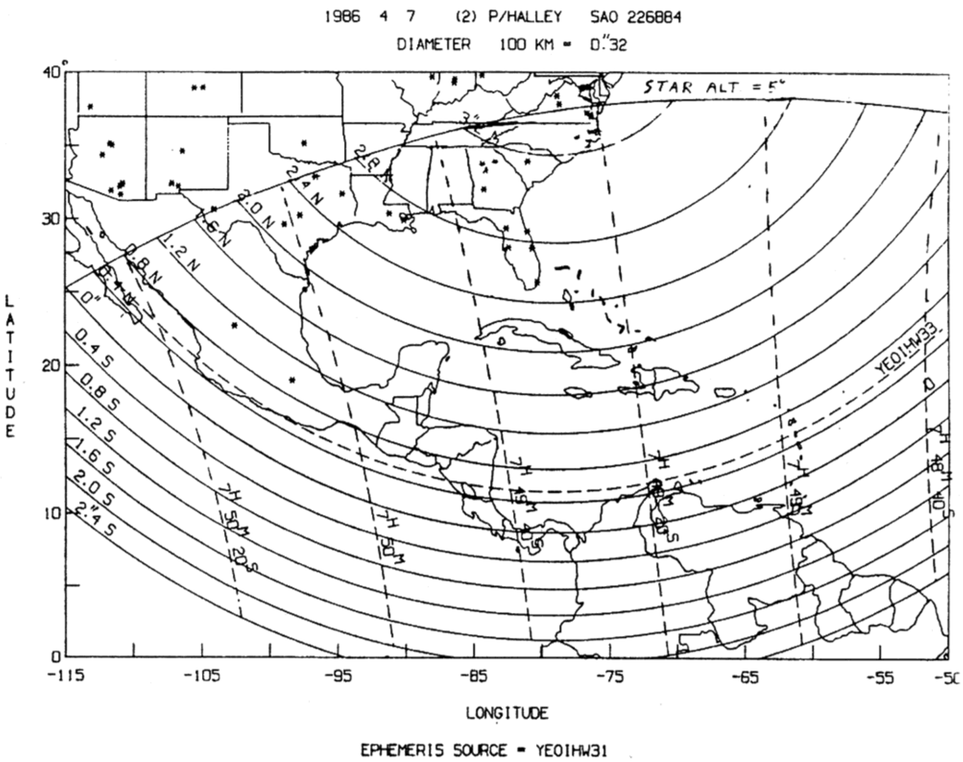
SAO 226884 by P/Halley 1986 Apr 7

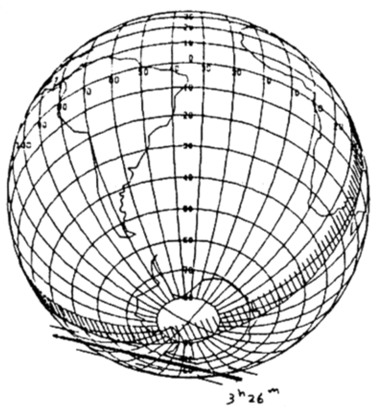


SAO 76447 by Eunomia 1986 Apr 7

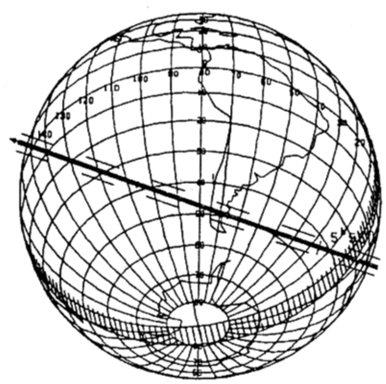


LS 211 by Melete 1986 Apr 11

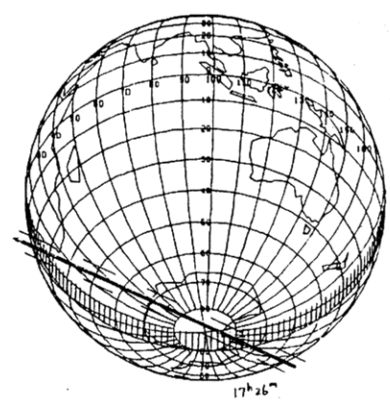




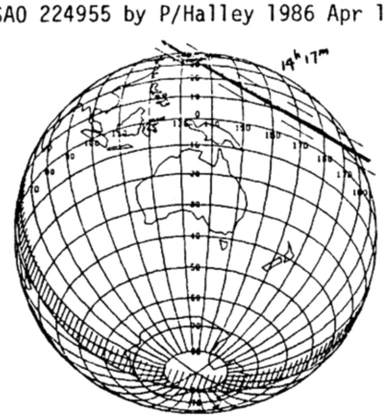
SAO 224955 by P/Halley 1986 Apr 12



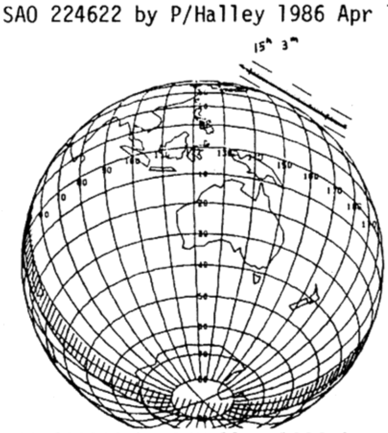
SAO 224622 by P/Halley 1986 Apr 13



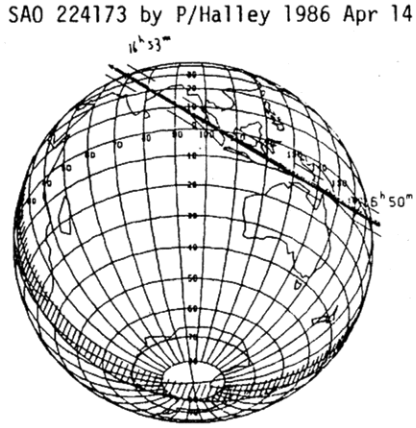
SAO 224173 by P/Halley 1986 Apr 14



SAO 203912 by P/Halley 1986 Apr 16



SAO 203904 by P/Halley 1986 Apr 16



SAO 203882 by P/Halley 1986 Apr 16