Occultation Newsletter

Volume II, Number 7 December, 1979

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 to the above, but send address changes, requests, matters of circulation, and other IOTA business to IOTA; P.O. Box 596; Tinley Park; IL 60477; U.S.A.

FROM THE PUBLISHER

For subscription purposes, this is the first issue of 1980.

O.N.'s price is $1/issue, or $4/year (4 issues) including first class surface mailing, and air mail to Mexico. Air mail is extra outside the U.S.A., Canada, and Mexico: $1.20/year in the Americas as far south as Colombia; $1.68/year elsewhere. Back issues also are priced at $1/issue. Please see the masthead for the correct odering address.

IOTA membership, subscription included, is $7/year for residents of North America (including Mexico) and $9/year for others, to cover costs of overseas air mail. European (excluding Spain and Portugal) and U. K. observers should join IOTA/ES, sending DM 12.-- to Hans J. Bode, Bartold-Knaust Str. 6, 3000 Hannover 91, German Federal Republic (but see the first paragraph of IOTA NEWS for change of address effective 1980 January 1). Spanish, Portuguese, and Latin American occultation observers may have free membership in IOTA/LAS, including *Occultation Newsletter en Español*; contact Sr. Francisco Diego Q., Ixpantenco 26-bis, Real de los Reyes, Coyoacán, Mexico, D.F., Mexico.

IOTA NEWS

David W. Dunham

European Section members should note that, starting 1980 January 1, Hans-Joachim Bode's address will be: Bartold-Knaust Str. 8, 3000 Hannover 91, German Federal Republic. Only the street number has changed (from 6); his telephone remains 0511-42 46 96.

It has been mentioned in an earlier issue that Hans-Joachim Bode will attempt to observe the 1980 February 16 total solar eclipse from a location near the southern limit in Kenya, and encourages others to join him in this effort. At last August's I.A.U. General Assembly, Dr. A. M. Sinzi told me that Japanese astronomers plan to obtain cinematography of the flash spectrum from three locations in Kenya, one near the central line, and the others just inside the predicted limits. I plan to compute accurate offsets of the actual limits, based on the lunar profile and other refinements, from the U. S. Naval Observatory's circular-moon published predicted limits, within a few weeks, and will provide the data to anyone who might be interested in observing near the edge of the path. Solar physicists have become very interested in using eclipse path-edge observations for monitoring small variations in the solar radius. Prospects currently look good that Alan Fiala, USNO, and I will receive support to travel to India to observe the eclipse from both limits, and to organize efforts by local observers to supplement our observations. I have received quarter-time support from Sabatino Sofio, Goddard Space Flight Center, to pursue work with eclipse-edge observations, especially to search the literature and various archives for possibly useful observations of previous eclipses.

I already have received a number of responses to the article about Royal Greenwich Observatory's planned discontinuance of most lunar occultation work in *O. N. 2* (5) 42. Reports of lunar occultations observed during at least the first half of 1980 should still be sent to the Royal Greenwich Observatory (RGO). Hopefully, another institution will be available to collect the 1980 year-end reports.

Any institution seriously interested in assuming many of RGO's current lunar occultation responsibilities should send the person who will direct the work to RGO for a few weeks to become intimately familiar with the current system and obtain copies of computer programs which might be converted from use with RGO's to the new institution's computer. Dr. Wayne Osborn, Physics Department, Central Michigan University, has volunteered his department for the collection and preliminary reduction of the observations, if there would not be too much difficulty in converting the appropriate part of RGO's software to run on their new large CDC computer. He says that they will not be able to produce graze maps, a job with which IOTA probably can help. The question also was asked as to to who is leading an effort to find a replacement for RGO's work. I suppose, by default, that would be RGO; if any other institute volunteered to lead a search effort, it would become a prime candidate for (even obligated to) taking on all of the work. I think that RGO would prefer that a government organization with long-term support, such as one of the Nautical almanac offices, take on the work. But if that is not possible, a university would be better than a largely amateur organization, such as IOTA. Note that Yale University was the world center for occultation work for many years, but at a time when there were many fewer observers, and when computers were not as ubiquitous as today. I think it probable that any institution taking on the work would appreciate the help of regional coordinators, for which we already have some volunteers. Victor Slabinski has suggested that observers be encouraged to submit their observations in keypunched form, when possible, the reward being that such observers would receive residuals of their observations quickly with the need for institutional keypunching eliminated. This may have some merit, but I feel that, in addition, a paper report on the adopted report forms must also be supplied in every case. RGO always has resisted the idea of observers keypunching their own observations, due to the variable quality of the keypunching job that would result, and a consequent possible large expenditure of time to identify and correct keypunch errors. In short, they feel that they would lose control if such a step were taken. But some economies probably will be necessary in the future, and as keypunch machines become more ubiquitous, observers increasingly may be asked to look at their computed residuals and correct their own keypunch errors.

I recently have written a computer program which computes local circumstances for asteroidal and planetary occultations. For each input event, the time (U.T.) and distance (in arc seconds, kilometers, and occulting object diameters) of closest approach are computed, along with the altitude and azimuth of the occulted star, the sun, and the moon. No data are printed if the star is below the horizon more than an amount which is proportional to an estimate of the occulting object's along-track (time) error, or if the star is fainter than 6th magnitude for a daytime prediction. These local lists are meant to supplement the general lists of all events published in *O.N.* (such as on pp. 63-65). Although I've created it, I don't want to use it (at least not very much), and would like a volunteer to adapt the program to a local computer, to offer this service to all IOTA members, and to others on a request basis for a fee (probably $1 per year).

In the most recent issue of *Telescope Making*, Russell M. Genet has published a good article entitled "Fairborn Observatory: It's Equipped for Photoelectric photometry." First, Genet discusses the basic requirements for a photoelectric telescope system, then goes into the design of his telescope, observatory, photometer, and supporting equipment. He briefly describes his photoelectric observing procedure, and discusses how he corresponded with many other amateur and professional photoelectric observers to develop a practical, relatively inexpensive photoelectric system. He gives several valuable hints, and includes a list of 15 useful references. He concludes, "I would be glad to answer any questions that I can, or provide references to some of the more experienced amateurs or professionals." His address is: Fairborn Observatory, 1247 Folk Road, Fairborn, OH 45324, USA.

Pat Wiggins, Hansen Planetarium, Salt Lake City, UT, has developed a device which, when used with a photoelectric photometer and WWV time source, automatically records the time of an occultation to 0^{s}001. He believes the device can be produced for about $200, not including the photometer. The device can not record the diffraction pattern, but is set to stop a WWV-synchronized timer when the light entering the photometer falls below, or rises above, a level set by the observer. It sounds as though it would be valuable for recording accurate occultation times, the only information obtainable from about 95% of conventional photoelectric records, without the need for a more expensive high-speed chart or tape recording system. Observers might use the device and simultaneously time occultations visually, to study reaction times and observers' ability to estimate them. I can think of a couple of useful modifications of the device: 1) Allow it to record two times at two different levels, one just below the full star intensity and the other slightly above the background level, to detect close double stars; 2) Allow it to record two (or several) times at the same level, so that it might be used for asteroidal and lunar grazing occultations. Mr. Hansen now is testing the system on lunar occultations, and plans to publish more details and results in a future issue of *Occultation Newsletter*.

During the night of October 26, when the waxing crescent moon passed through a rich southern Milky Way field, Graham Blow reports that he timed 66 disappearances, a record for one night, as far as I know. Many of the stars weren't even in the J-catalog. Mr. Blow also reports that members of the Occultation Section of the Royal Astronomical Society of New Zealand are working on an occultation manual which they plan to publish in sections in various issues of their circular during 1980. IOTA might adopt some of this work for its own manual.

Now that we are approximately on schedule (actually ahead of schedule, for the first time, I believe) with the publication of *O.N.*, perhaps we can establish, and stick to, a schedule for future issues. The next issue should be distributed in late March, to give the latest information about the April 6th occultation by Pluto. To do this, information on new double stars, grazes, and erroneous star positions should be sent to Dunham and to Herald by February 25th, and articles should be received by the editor by March 5th.

PLANETARY OCCULTATION PREDICTIONS

David W. Dunham

Predictions of occultations of stars by major and minor planets, and one of the former's satellites, most during 1980, are given in two tables. They are like the tables described in *O.N.* 2 (2) 16-18, except that in the second table, the geocentric angular velocity of the asteroid in degrees/day is listed with the position angle of motion under the common heading "Motion."

Under the S-column in the second table (source of star's position), "X" is used for *all* non-Z.C. and non-Perth 70 stars in the XZ-catalog, although those south of declination -3° in this category use SAO data. In this way, double star codes which might have been derived from lunar occultation and spectroscopic data are included. Some new codes are listed under "S", so all of the codes are described here: A, AGK3; H, positions of faint stars derived by Klemola from astrographic plates taken at Lick Observatory, Mt. Hamilton, CA; L, positions determined from plates taken at Lowell Observatory; P, Perth 70;R, positions determined from plates taken at the Royal Greenwich Observatory; S, SAO; X, USNO XZ-catalog for stars within 6°40' of the ecliptic, the limit for earth-based lunar occultations (with some exceptions; see *O.N.* 2 (6) 60); Y, Yale; and Z, Z.C. (but position improved with other catalog data for stars north of declination -4° during construction of the XZ catalog). The following codes are not in the current list, but may be used in the future:

C, Carte du Ciel (Astrographic Catalog); F, FK4; G, Albany General Catalog (via SAO; positions especially poor); J, USNO J-catalog; K, USNO K-catalog; and N, N30. All but the first two, and the last, listed events occur during 1980. Most of the events in the table were found by Gordon Taylor at the Royal Greenwich Observatory and published in his Bulletin 15 of I.A.U. Commission 20's working Group on Pre-

		PLANET			STAR					OCCULTATION						MOON		
DATE	UNIVERSAL TIME	NAME	m_v	Δ,AU	SAO No	m_v	Sp	R.A.(1950)	Dec.	Δm	Dur	df	P	Possible Area	El Sun	El	%Snl	Up
1979																		
Nov 14	23h40-48m	Winchester	11.9	1.9	117178	8.4	G5	8h47m.3	8°28'	3.5	19s	25	13	Arctic; n. Europe	100°	47°	21-	e 35°E
Dec 21	18 39m	Aspasia	12.2	2.73	157892	8.4	G0	13 20.0	-17 46	3.9	7	10	19	s.w. Australia	64	96	7+	none
1980																		
Jan 3	7 40	Ceres	8.9	2.75	128975	9.2	F8	0 47.4	-4 17	0.6	57	18	4	n.w. Pacific; n. Japan?n	88	103	99-	e145°E
Jan 3	14 50	Nysa	11.3	2.26		9.2	M0	0 20.8	-1 50	2.3	3	14	45	Mideast, s. central U.S.S.R.	82	112	98-	e 45 E
Jan 4	22 54-72	Doris	11.2	2.00	94441	8.2	F5	5 14.4	13 31	3.1	15	28	20	Mideast, s. Europe, e. N. America	154	55	93-	e 60 W
Jan 9	16 33	Vibilia	12.7	2.85	164575	9.0	K0	21 38.4	-17 47	3.7	3	7	32	Greece; w. Europe?n; Egypt?s	33	132	58-	none
Jan 14	1 25	Patientia	12.2	2.61	110282	8.6	F8	1 58.9	0 14	3.7	20	20	12	Alaska; w. U.S.A., Canada?s	95	144	17-	none
Jan 16	4 02	Eunomia	11.0	3.74	185342	9.1	A3	17 20.0	-29 29	2.0	6	9	22	Mideast	34	15	4-	all
Jan 26	12 31	Enceladus	11.9	8.78		9.3	K5	11 49.9	3 35	2.7	42	41	21	Hawaii?n; New Zealand, e. Australia	129	117	71+	w175°W
Jan 28	6 13-29	Daphne	11.0	1.63		10.9	K0	9 0.1	-1 30	0.8	16	22	13	n. S. America, Mexico; s.w. U.S.A.?n	159	55	86+	w 50 W
Jan 29	15 23-29	Antigone	11.0	1.95	98662	6.3	A0	9 33.1	14 36	4.7	9	21	25	Japan?n; China, s. cen. U.S.S.R.	168	41	94+	all
Feb 8	14 08	Psyche	11.1	3.37	146585	4.2	M0	23 11.7	-6 19	6.8	5	8	19	Patagonia?n; S. Africa?n; Indian O.	28	126	57-	w 20°W
Feb 10	16 46	Neptune	8.0	30.78		10.1		17 24.4	-21 50	.14	39m	51	1	n.w. Pacific	59	16	36-	all
Feb 13	17 14	Parthenope	10.6	1.76	118933	8.6	K0	11 32.8	7 27	2.1	16s	27	17	Japan?n; China, s. cen. U.S.S.R.	153	116	10-	none
Feb 14	6 56-70	Daphne	10.9	1.57		10.5	G0	8 45.5	0 44	1.0	14	20	13	S. America; Hawaii?s	160	158	6-	e 50°W
Feb 17	17 08-29	Juno	8.6	1.44		11.7	G	7 1.5	7 31	0.1	35	32	8	Mauritius, Mideast, w.USSR, Scandinavia	136	117	3+	none
Feb 19	20 31-45	Juno	8.7	1.46	114860	9.5	A2	7 1.5	7 53	0.4	35	33	8	n.w. Africa, w. Europe	134	86	17+	all
Feb 26	13 58-66	Parthenope	10.4	1.69	118854	8.6	K0	11 23.5	8 55	1.9	13	21	16	New Zealand?n, s. Australia	168	59	84+	w170°E
Feb 28	17 27	Massalia	11.5	2.90		10.3	F8	1 9.3	7 16	1.5	3	8	31	Sudan; e. Mediterranean?n	40	117	96+	all
Mar 10	0 18-31	Io	12.5	2.17	137555	8.8	G5	10 22.9	-2 14	3.8	10	19	21	S. Africa?n, W. Indies, e. U.S.A.?n	164	102	50-	e 5°W
Mar 20	4 29-42	Uranus(R)	5.5	18.16		13.0		15 30.8	-18 44	.02	88m	89	2	Africa, w. Europe, S. & e. N.America	124	171	17+	none
Mar 25	13 35	Iris	10.7	2.96	164340	8.9	G0	21 19.1	-12 35	2.0	5s	8	20	Tahiti?n	46	160	70+	none
Mar 26	11 26	Lutetia	11.4	1.70	139513	9.4	F8	13 41.1	-5 56	2.1	11	25	21	Hawaii?n; Japan	160	76	78+	all
Apr 6	6 26	Pluto	13.7	29.20		12.5		13 40.8	8 35	1.5	127	45	14	Africa, Europe, w. Asia, Brazil?	162	69	65-	e 20°W
Apr 9	20 28	Vesta	8.5	3.23		9.8	F0	3 59.6	17 55	0.3	14	9	9	Canary Islands; s.w. Europe?n	42	115	35-	none
Apr 15	10 03	Hebe	10.1	2.73	146599	8.9	K0	23 13.4	-7 10	1.5	4	7	21	Chile, Argentina	39	43	0+	none
Apr 23	4 42	Meliboea	13.0	2.81	127441	8.9	F2	22 16.0	0 37	4.2	4	9	29	w. S. Africa	57	157	61+	none
Apr 24	21 56-66	Neptune	7.9	29.59		11.8		17 25.5	-21 48	.03	59m	76	1	Asia, Europe, Africa	132	106	76+	w 70°E
Jun 10	19 15	Aurora	13.5	3.74	75795	9.2	F0	3 9.9	21 44	4.2	9s	9	29	Japan?s, Korea?s	29	9	6-	all
Jul 17	6 47	Marianna	13.3	2.76		11.6	K5	3 33.6	31 21	1.9	4	9	29	e. Brazil	57	112	23+	none
Jul 24	17 13	Hygiea	11.8	3.80	76043	6.8	A0	3 35.7	22 30	5.0	17	14	12	New Guinea; Phil.Is.?n; Queensland?s	65	153	89+	w150°E
Jul 29	2 31	Thalia	12.0	2.76	93855	9.3	G	4 15.8	17 43	2.7	3	10	35	southern Africa	61	102	98-	all
Aug 15	23 34-43	Uranus	5.5	18.77		12.3		15 15.3	-17 49	.02	104m	106	1	S. America, Africa, w. Europe	88	31	23+	w 20°W
Aug 16	2 33	Parthenope	11.9	3.18		9.9	G0	12 29.8	0 43	2.1	4s	9	30	cen. N. America; Mexico?s	44	15	24+	all
Aug 27	18 10	Hebe	8.9	1.46	111308	8.7	K0	3 35.7	1 18	0.9	12	15	11	Siberia?s	102	56	96-	all
Sep 3	0 01	Minerva	12.9	3.14	157922	8.7	K2	13 22.5	-13 3	4.2	4	9	27	South America	44	118	37-	none
Sep 4	11 08-19	Diana	12.5	1.98	75392	8.9	A2	2 25.9	23 39	3.6	24	48	21	Mexico, s. cen. USA; w. N. Amarica?n	119	64	23-	all
Sep 14	10 16	Aspasia	12.1	2.70	159307	5.8	K0	15 27.8	-16 26	6.4	6	10	19	Philippine Islands; e.China, Japan?n	62	8	21+	all
Sep 15	6 37-47	Hebe	8.6	1.30		9.8	A3	3 56.6	-0 57	0.3	18	22	10	cen.&e.Canada;e.USA?s:Cape Verde Is.	114	164	28+	none
Oct 6	12 52	Eunomia	9.9	2.33	187358	7.4	B9	18 48.1	-20 22	2.6	14	18	14	India, China, Japan?n; Siberia?n	88	116	6-	none
Oct 10	7 03	Kleopatra	9.6	1.21	128066	8.8	K0	23 12.6	8 31	1.2	26	26	8	w. Canada, n.w. U.S.A.	153	139	1+	none
Oct 26	10 28	Victoria	12.7	3.28		9.8	F5	10 32.4	1 29	3.0	4	11	35	cen. & e. Canada; e. U.S.A.	54	90	90-	all
Oct 26	15 25	Eunomia	10.0	2.55	162353	8.8	K0	19 11.8	-19 4	1.5	10	13	15	Mauritius?n; Indian Ocean	74	145	89-	e 80°E
Nov 6	8 17	Kleopatra	10.0	1.37	128081	9.0	K0	23 14.3	3 40	1.4	30	32	9	e. Siberia; Japan?s	127	142	2-	none
Nov 10	22 36	Bellona	13.0	3.69	161869	9.5	B8	18 46.6	-19 4	3.6	4	11	44	e. Canada, n.e. U.S.A.	53	18	9+	w 60°W
Nov 19	9 46	Fortuna	13.0	3.71	158406	9.1	F5	14 8.4	-13 5	4.0	5	9	25	n.w. Amazon basin	22	162	88+	none
Nov 20	7 16-22	Hebe	7.9	1.08	130705	9.2	K0	3 42.9	-9 11	0.3	25	27	8	n. South America	151	31	94+	w 50°W
Nov 21	1 03-16	Kleopatra	10.3	1.50	128184	6.8	K0	23 24.2	2 12	3.6	21	24	10	s. Mexico?n; n. South America	114	50	98+	all
Nov 24	4 04-23	Sophrosyne	11.8	1.38	74963	8.3	G5	1 47.3	29 13	3.5	17	33	17	n.w.Africa, Iberia, USA, n.w. Mexico	149	55	95-	all
Nov 24	10.0	Neptune	8.0	31.21	185377	8.7	F0	17 22.2	-21 51	0.5	1476	32	1	eastern Australia?	19	170	94-	none

dictions of Occultations by Satellites and Minor Planets. Derek Wallentinsen, comparing the SAO catalog manually with astrometric ephemerides supplied by me, found the two 1979 events and the following 1980 events: Feb. 8 (Psyche), Aug. 27 (Hebe), Oct. 10 (Kleopatra), Oct. 26 (Eunomia), Nov. 6 (Kleopatra), and Nov. 21 (Kleopatra). A few of Wallentinsen's events involving faint stars visible only from the Antarctic or from oceans with no known observers have been omitted. He has extended his results through the end of 1982 and has submitted them for publication in *Planetary Astronomy* (see *O.N. 2* (5) 47), probably to appear in the first issue. The January 3rd occultation by Ceres was found by Lowell astronomers and is included here for completeness, having been listed already in *O.N. 2* (4) 32. Larry Wasserman has devel-

Nov 28	17 50-62	Eugenia	11.5	1.97	94167	9.1	F8	$4^h48^m.8$	12°43'	2.5	17^s21	13	Phil.Is.,Indonesia;s.India?n; Africa	169°	77°	57- e 83°E
Dec 5	13 06	Laetitia	12.1	3.59	139356	8.2	A3	13 26.1	-4 12	3.9	5 11	32	w. Mexico; w. U.S.A.?n	52	29	4- e120 W
Dec 12	8 46	Euterpe	12.3	3.10	158606	9.3	K2	14 28.0	-13 23	3.0	3 9	39	West Indies?n; n. South America	41	97	22+ none
Dec 17	2 13-28	Alexandra	12.8	2.36	79914	8.8	K0	8 1.7	27 45	4.0	16 26	19	n.Africa; s.Europe?n; n.w.S. America	147	96	72+ w 6 W
Dec 26	1 44	Iris	9.0	1.51		9.2	K2	0 17.8	6 41	0.7	11 13	10	northern South America	93	141	79- e 60 W
1983																
May 29	4 41-58	Pallas	9.6	2.69	87010	4.8	B5	19 14.1	21 18	4.9	46 27	7	South Africa?n; southern U.S.A.	120	48	94- e118 W

	M I N O R	P L A N E T			MOTION		S T A R			STELLAR DIAMETER					COMPARISON DATA			A P P A R E N T	
DATE	No.	Name	km-diam.-"		RSOI	°/Day	PA	SAO No	DM No.	D	M"	M	Time	df	S	AGK3 No	Shift	Time	R.A.	Dec.
1979																				
Nov 14	747	Winchester	205	0.15	862	0.188	90°	117178	+08°2127		0.26	362	34	1.3	S	N 8°1189	0".55	$-1^m.0$	$8^h48^m.9$	8°21'
Dec 21	409	Aspasia	208	0.11	951	0.382	114	157892	-17 3833		0.20	386	12	1.2	Y		2.08	-1.5	13 21.6	-17 55
1980																				
Jan 3	1	Ceres	1020	0.51	12075	0.216	48	128975	-04 102		0.14	287	16	0.9	L				0 49.0	-4 8
Jan 3	44	Nysa	72	0.04	184	0.306	63		-02 45		0.55	905	43	3.1	X	S 1 31	-0.21	0.1	0 22.3	-1 40
Jan 4	48	Doris	148	0.10	676	0.163	274	94441	+13 848		0.16	233	24	0.8	S	N13 437	0.69	-4.3	5 16.1	13 33
Jan 9	144	Vibilia	130	0.06	400	0.540	71	164575	-18 5994		0.26	541	12	1.6	X				21 40.1	-17 39
Jan 14	451	Patientia	327	0.17	2186	0.205	39	110282	-00 305		0.15	276	17	0.9	S	N 0 181	-0.34	-0.3	2 0.4	0 23
Jan 16	15	Eunomia	246	0.09	1481	0.364	93	185342	-29 13461		0.06	150	4	0.4	X				17 21.8	-29 31
Jan 26		Enceladus	600	0.09	17848	0.054	286		+04 2534		0.45	2843	197	4.9	X	N 3 1555	0.01	-0.0	11 51.5	3 25
Jan 28	41	Daphne	177	0.15	781	0.230	295		-01 2190		0.11	129	11	0.5	A	S 1 1336			9 1.7	-1 37
Jan 29	129	Antigone	115	0.08	464	0.224	304	98662	+15 2077	A	0.18	257	19	0.9	Z	N14 1030	-0.64	-0.7	9 34.8	14 28
Feb 8	16	Psyche	252	0.10	1307	0.452	68	146585	-06 6170		5.94	14489	315	40.0	P		0.05	-0.0	23 13.3	-6 10
Feb 10		Neptune	50184	2.25	99999+	0.023	92		KLM 17		0.85	18911	885	17.3	H				17 26.2	-21 51
Feb 13	11	Parthenope	152	0.12	646	0.183	305	118933	+07 2460		0.31	402	41	1.5	X	N 7 1556	-0.15	-0.5	11 34.4	7 17
Feb 14	41	Daphne	177	0.16	766	0.261	307		+01 2171		0.07	76	6	0.3	A	N 0 1218			8 47.1	0 37
Feb 17	3	Juno	256	0.24	1192	0.168	354		+07 1579		0.04	40	6	0.2	A	N 7 918			7 3.2	7 28
Feb 19	3	Juno	256	0.24	1195	0.164	0	114860	+08 1634		0.05	49	7	0.2	S	N 7 917	0.05	-3.9	7 3.1	7 50
Feb 26	11	Parthenope	152	0.12	645	0.237	300	118854	+09 2492		0.40	489	40	1.9	X	N 8 1485	-0.15	-0.4	11 25.0	8 45
Feb 28	20	Massalia	137	0.07	460	0.477	68		+06 170		0.06	130	3	0.4	X	N 7 131			1 10.8	7 25
Mar 10	85	Io	147	0.09	721	0.228	304	137555	-01 2386		0.23	359	24	1.2	A	S 2 591	-0.62	1.6	10 24.5	-2 24
Mar 20		Uranus	50300	3.82	99999+	0.017	284		KMU 11	A	0.11	1489	158	1.8	H				15 32.5	-18 50
Mar 25	7	Iris	210	0.10	934	0.450	69	164340	-12 5976		0.14	300	7	0.9	X				21 20.7	-12 27
Mar 26	21	Lutetia	115	0.09	422	0.204	293	139513	-05 3755		0.10	123	12	0.5	X				13 42.7	-6 5
Apr 6		Pluto	3000	0.14	99999+	0.027	294				0.02	477	20	0.4	R				13 42.3	8 26
Apr 9	4	Vesta	549	0.23	4263	0.399	75		+17 671		0.06	131	3	0.4	X	N17 352			4 1.3	18 0
Apr 15	6	Hebe	186	0.09	669	0.549	75	146599	-07 5973		0.35	684	15	2.1	X				23 14.9	-7 00
Apr 23	137	Meliboea	143	0.07	533	0.425	67	127441	+00 4850		0.10	197	5	0.6	P	N 0 2797	0.06	-0.8	22 17.5	0 46
Apr 24		Neptune	50184	2.34	99999+	0.016	275		KLM 18		0.05	1106	78	1.0	H				17 27.3	-21 50
Jun 10	94	Aurora	188	0.07	962	0.388	71	75795	+21 422		0.08	224	5	0.6	X	N21 294	0.12	0.3	3 11.6	21 50
Jul 11	602	Marianna	137	0.07	488	0.435	67		+31 622		0.15	310	9	0.9	A	N31 343			3 35.5	31 27
Jul 24	10	Hygiea	450	0.16	4283	0.234	75	76043	+22 523		0.16	449	17	1.2	Z	N22 329	0.02	-0.8	3 37.5	22 36
Jul 29	23	Thalia	115	0.06	385	0.404	76	93855	+17 706		0.16	326	10	1.0	X	N17 380	-0.79	-0.6	4 17.5	17 48
Aug 15		Uranus	50300	3.70	99999+	0.014	107		KMU 12		0.11	1527	189	1.8	H				15 17.1	-17 55
Aug 16	11	Parthenope	152	0.07	614	0.402	114		+01 2711		0.24	558	14	1.6	X	N 0 1581	0.01	-0.0	12 31.3	0 33
Aug 27	6	Hebe	186	0.18	632	0.351	106	111308	+00 628		0.30	318	21	1.3	S	N 1 373	-0.08	-0.1	3 37.3	1 24
Sep 2	93	Minerva	168	0.07	706	0.416	114	157922	-12 3812		0.38	867	22	2.5	X				13 24.1	-13 13
Sep 4	78	Diana	140	0.10	560	0.096	14	75392	+23 330		0.06	89	15	0.3	S	N23 199	0.77	1.6	2 27.7	23 47
Sep 14	409	Aspasia	208	0.11	931	0.397	99	159307	-16 4099		1.46	2862	88	8.8	P		0.03	0.1	15 29.6	-16 32
Sep 15	6	Hebe	186	0.20	634	0.262	124		-01 569		0.05	45	4	0.2	A	S 0 418			3 58.1	-0 52
Oct 6	15	Eunomia	246	0.15	1248	0.244	76	187358	-20 5288	V	0.17	289	17	1.0	X				18 50.0	-20 19
Oct 10	216	Kleopatra	219	0.25	896	0.226	201	128066	+08 5029		0.36	319	38	1.5	S	N 8 3211	-0.21	-2.7	23 14.1	8 41
Oct 26	12	Victoria	135	0.06	567	0.334	116		+01 2457		0.08	186	6	0.5	A	N 1 1310			10 34.0	1 19

oped computer programs at Lowell Observatory to compare asteroid ephemerides with the SAO and AGK3 catalogs, and produce world maps (Mercator projection) of the paths. At the General Assembly of the I.A.U. in Montreal in August, he showed copies of the maps for occultations he had found for 1980 through 1983 for the following large asteroids: 1-10, 15, 16, 18, 24, 29, 31, 44, 45, 51, 52, 65, 107, 129, 170, 324, 349, 354, 451, 511, 532, and 704. By far the best of the events he found is the last one listed in the tables (1983), included early because of its unusual interest. The occultations of non-SAO stars by Uranus and by Neptune will be visible only with large observatory telescopes and were found by Arnold Klemola and Brian Marsden mainly for the purpose of detecting rings of those planets. The predictions for the occultations by Uranus were published in *Astronomical Journal 82* (1977) 849, with magnitude and visibility information given in articles in the following two issues, while the Neptune predictions were given in *Astron. J. 83* (1978) 205. For the Uranus occultations, stellar magnitudes are infrared (I), and the Δm is the I-magnitude drop in case of an occultation by the ε ring. (R) for the March 20th event indicates that only an occultation by the rings is expected, not by Uranus itself.

Oct 26	15	Eunomia	246	0.13	1228	0.322	77°	162353	-19°	5353		0.29	531	21	1.7	S					19^h	$13^m.6$	-19°	1'
Nov 6	216	Kleopatra	219	0.22	883	0.176	139	128081	+03	4844		0.33	327	45	1.4	S	N 3	2991	-0".45	$0^m.6$	23	15.9	3	50
Nov 10	28	Bellona	122	0.05	553	0.302	91	161869	-19	5179		0.01	40	1	0.1	X					18	48.3	-19	2
Nov 19	19	Fortuna	215	0.08	1148	0.390	109	158406	-12	3993		0.11	285	7	0.7	X					14	10.1	-13	13
Nov 20	6	Hebe	186	0.24	655	0.229	273	130705	-09	740		0.30	238	32	1.2	S					3	44.3	-9	6
Nov 21	216	Kleopatra	219	0.20	877	0.226	108	128184	+01	4724	K	0.93	1008	98	4.2	Z	N 2	2938	0.32	-0.0	23	27.7	2	22
Nov 24	134	Sophrosyne	116	0.12	368	0.166	243	74963	+28	304		0.36	364	52	1.6	S	N29	230	-0.56	0.2	1	49.1	29	22
Nov 24		Neptune	50184	2.22	99999+	0.036	94	185377	-21	4598		0.16	3625	107	3.3	X					17	24.0	-21	53
Nov 28	45	Eugenia	226	0.16	1286	0.225	263	94167	+12	665		0.11	160	12	0.6	S	N12	482	-1.07	1.5	4	50.5	12	46
Dec 5	39	Laetitia	163	0.06	826	0.315	105	139356	-03	3476		0.08	219	6	0.6	P			-0.31	0.2	13	27.7	-4	22
Dec 12	27	Euterpe	116	0.05	394	0.423	108	158606	-12	4068		0.29	643	16	1.9	X					14	29.7	-13	31
Dec 17	54	Alexandra	180	0.11	1006	0.162	276	79914	+28	1541		0.36	622	54	2.1	S	N27	875	-0.26	3.7	8	3.6	27	39
Dec 26	7	Iris	210	0.19	721	0.422	76		+06	24		0.33	366	19	1.5	X	N 6	28			0	19.4	6	51
1983																								
May 29	2	Pallas	538	0.28	5318	0.146	316	87010	+21	3713	A	0.32	615	52	1.9	P			-0.26	0.8	19	15.5	21	21

In his Bulletin 19, Gordon Taylor states: "Saturn will occult AGK3 + 4°1542 (m_{ph} 9.2, spectrum F5) on 1980 February 28.75. Because the star is so faint no detailed predictions have been calculated. The area of visibility is E Europe, S Central and E Africa, Asia and Australia. There will be no occultation by the Rings or the six largest satellites. If anyone does feel that observations are possible, please apply to the undersigned for predictions."

Sometimes, in addition to the nominal ("O") predicted path calculated using the primary star catalog star position indicated under "S", the path for comparison from another catalog (usually the AGK3; sometimes Yale or the G.C.-SAO) or from a recent astrometric update will be plotted as a dashed line or curve on the world and/or regional maps published in *Occultation Newsletter*.

About half of the asteroidal ephemerides I use are computed from osculating orbital elements computed by Paul Herget at Cincinnati Observatory, while the others were calculated at the Leningrad Institute for Theoretical Astronomy (I.T.A.), many of them supplied in advance of publication by V. Shor. For several minor planets, orbital elements from both places are available, in which case, I compute circumstances with both, but usually use the calculations based on the Cincinnati elements. In these cases, the paths usually agree within about 1", which is the expected accuracy for most of them. However, in a few cases, specifically for minor planets 19, 94, 95, and 747, the paths disagree by several seconds of arc, so that a prediction based on one set of elements often will not be visible anywhere on the earth's surface when computed with data derived from the other orbital elements. In order to help resolve these discrepancies, and decide which elements would be best to use for occultation calculations, I obtained recent (1974-1977) astrometric observations of these four asteroids from the Minor Planet Circulars, with some help from Brian Marsden and Robert Harrington; most of the observations are from a long series at Nice Observatory which was published recently. Comparison of these observations with ephemerides which I computed from the different orbital elements showed that for (19) Fortuna, I.T.A.'s elements satisfied the observations to within 1", whereas Cincinnati was off by about 1', while for the other three objects, it was the reverse, with the Cincinnati elements much better than I.T.A.'s elements, which produced path errors of several tens of seconds of arc. In these last three cases, the elements were derived from observations spanning less than 10 years made nearly thirty years ago, and perturbations by only Jupiter and Saturn had been used in the calculations. Shor had warned me about using that particular set of elements for occultations, obviously with justification! Even the Cincinnati elements for (95) Arethusa produced residuals in the path of about 5", so I conclude that for (95), none of the available orbital elements are accurate enough for occultation searches and calculations. Since Gordon Taylor uses only I.T.A. data for his calculations, the following occultations which he predicted will not occur and are not in my list: (747) Winchester on Feb. 13 (misses earth, 8" to the south) and (95) Arethusa on Nov. 29 (misses earth, 122" to the north). It happens that the Cincinnati and I.T.A. paths for (94) Aurora intersect near the time of the June 10th occultation, so that event will occur, but at a different time and much farther north than Taylor predicted. When possible, path and time prediction differences, in the sense I.T.A. - Cincinnati, are included in the notes for individual events.

A map showing my predicted paths of asteroidal occultations during 1980 in the U.S.A., southern Canada, and northern Mexico will be published in the 1980 January issue of *Sky and Telescope*. A similar map of the U.S.S.R. has been prepared and submitted for publication in a Soviet journal, along with an article about asteroid occultations prepared by Paul Maley and Robert McCutcheon, who translated it into Russian. Notes about individual events are given below:

1979 Nov 14: The Cincinnati elements were used to calculate this event. A regional map and essential information about the event were sent to Gordon Taylor and to Hans Bode for alerting European observers; I have not heard whether any observations were obtained.

1979 Dec 21: The star's SAO-Albany General Catalog position was used for the comparison; as shown in the table, this G.C. path is 2".08 north of the Yale path, which is probably the more accurate. John Phelps provided the G.C.-Yale comparison data. Sôma used the SAO-G.C. position for the world map, but I drew in the Yale line, which was taken for nominal in the map of Australia which I prepared and sent to David Herald for local distribution, since this issue will not reach Australian observers before the event.

Jan 3, Ceres: See *O.N.* 2 (4) 32.

Jan 4: In Bulletin 16 of the I.A.U. Working Group on Occultations, Gordon Taylor notes that this "will be an important event since the track could cross areas of high potential observer density." The prediction is rather uncertain due to the relatively large disagreement in the star's position between AGK3 and SAO catalogs. But due to the possibility of recording secondary occultations by objects near Doris, as many observers as possible, preferably in closely spaced pairs, are encouraged to observe in any case. A "last-minute" refinement in the prediction will be calculated from astrometry to be attempted at the Royal Greenwich Observatory and in the U.S.A., and if the path is not too far north, I plan to lead an expedition from the DC area to observe the event. The refined prediction can be obtained by telephoning either me at 301,585-0989 or 301,589-1545, ext. 358, or Martha Warren at 301,474-0814, or Gordon Taylor at R.G.O. at 032-181 3171, ext. 252 (Jan. 3 and 4 between 9^h and 12^h, and between 14^h and 16^h U.T.). A finder chart for the occultation will appear in the January issue of *Sky and Telescope*, which might not reach some readers in time. In Working Group bulletin 19, dated 1979 Oct. 5, Taylor states: "A recent plate of Doris shows that this minor planet is within ½" of its predicted position. If anything, the indications are that the track of the occultation could be shifted a few degrees (of latitude) north." The 8.2-mag. of the star in my list is the V-mag. from SKYMAP, which is bright enough for easy visual observation, considering the 3-mag. occultation Δm, but not as bright as the AGK3 visual mag. of 7.4 quoted by Taylor.

Jan 26: Having passed eastern elongation less than three hours before the occultation, Enceladus will lie about 33" east of Saturn's center (Saturn's diameter will be 17") and on a line with the nearly edge-on rings.

Jan 28: The prediction based on the I.T.A. orbital elements gives a path 0".46 north with Daphne 3.8 minutes late with respect to the prediction based on Cincinnati elements, which I used.

Jan 29: SAO 98662 = 7 Leonis = Z.C. 1415 = A.D.S. 7448. The 10th-mag. secondary, 41".2 from the primary in p.a. 80°, will not be occulted.

Feb 8: SAO 146585 = ϕ Aquarii = Z.C. 3412. The comparison data for the shift and time difference calculation given in the second table were from the FK4. The sun is above the horizon west of longitude 70° East. No astrometric improvement of the prediction will be possible due to the relatively small elongation from the sun.

Feb 14: The I.T.A. prediction is 0".93 north and 3.2 minutes later than my prediction using Cincinnati orbital elements. A 1".0 north shift from the I.T.A. prediction would put the path over Mexico and California.

Feb 28: The I.T.A. prediction is 0".09 south and 2.9 minutes earlier than my Cincinnati-element prediction.

Mar 10: The comparison data are from the Yale catalog. The comparison data for the SAO-G.C., which is almost certainly in error, is 2".40 north for the path, which would move it into southern Quebec and Maine. The I.T.A. prediction is 0".47 north and 2.2 minutes late with respect to my Cincinnati-element prediction. The occulting object is Io, the asteroid, *not* the Galilean satellite of Jupiter.

Apr 6: The star is shown well in the chart of Pluto's path published in the *Handbook* of the British Astronomical Association. Astrometric plates have been taken at RGO to refine this prediction, but it is still uncertain whether an occultation by either Pluto or its satellite Charon will occur from any part of the earth's surface. This question should be answered by early February, after further plates are taken with the objects very close to each other. If an occultation does appear likely, some expeditions probably will be organized hastily to try to observe the event photoelectrically.

Jun 10: The I.T.A. prediction is 2".1 north and 54 minutes late with respect to my Cincinnati-element prediction. As noted above, the I.T.A. ephemeris of (94) Aurora does not agree with recent observations.

Sep 2: The I.T.A. prediction is 0".15 north and 0.4 minute late with respect to my Cincinnati-element prediction.

Sep 4: Paul Maley plans to organize a chain of observers in or near Texas to intercept this occultation, wherever the last-minute astrometry indicates it may be.

Sep 14: SAO 159307 = 34 Librae = Z.C. 2213. The comparison data are from the Z.C. The occultation will occur shortly before sunset west of longitude 117° East.

Oct 6: Spectroscopic evidence indicates that the star is probably a close double, according to Wilson's catalog of radial velocities.

Nov 10: The I.T.A. prediction is 0"05 south and 1.5 minutes early with respect to my Cincinnati-element prediction. I plan to lead expeditions to observe this occultation, and the one by (12) Victoria on Oct. 26th, if last-minute astrometry is obtained which shows that the events will occur in the eastern U.S.A.

Nov 19: My prediction uses I.T.A. orbital elements. The prediction based on Cincinnati elements, which do not agree with recent observations, misses the earth's surface by 30", but is certainly wrong. Last-minute astrometry will be prevented by the small solar elongation.

Nov 21: This is the brightest star to be occulted by an asteroid during 1980 in the Western Hemisphere. If astrometry indicates that the path will shift somewhat (or a great deal) to the north, there probably will be an expedition from the U.S.A. A "gradual" disappearance observed visually during a lunar occultation of the star in South Africa in 1935 indicates that the star may be a close double.

Nov 24: This event, probably the best which will occur in the U.S.A. during 1980, was not in Bulletin 15, but Gordon Taylor gave me his computer prediction of the event at the I.A.U. General Assembly last August. Since issuing Bulletin 15, he may have found some other 1980 events in other parts of the world which I don't know about. Several expeditions are planned.

1983 May 29: SAO 87010 = 1 Vulpeculae = ADS 12243. Yerkes spectroscopists report the radial velocity to be variable, indicating possible close duplicity. The faint visual companions (B, mag. 11.8, sep. 39" in p.a. 12°, and C, mag. 13.0, sep. 43½" in p.a. 155°) will not be occulted by Pallas. Wasserman's predicted path is farther north, across southern Canada, but he said his Pallas ephemeris was not accurate like the one I use.

[Ed: Some of the figures for this article had not been received by the time the arrangement of the rest of the articles had to be finalized. Therefore, all of this article's figures will be found at the end of the issue.]

GRAZES REPORTED TO IOTA

David W. Dunham and Joan Bixby Dunham

Report forms for grazing occultation observations are available from either the IOTA Secretary-Treasurer (P.O. Box 596; Tinley Park, IL 60477; U.S.A.) or from us. Completed reports should be sent to David Dunham at: P.O. Box 488; Silver Spring, MD 20907; U.S.A. If possible, a copy of the report (or, preferably, one written on their report form) should also be sent to: H. M. Nautical Almanac Office; Royal Greenwich Observatory; Herstmonceux Castle; Hailsham, Sussex BN27 1RP; England, the world center for reporting all occultation observations. Please indicate on your report whether copies have been supplied to IOTA and/or HMNAO. If this is not done, we will assume that no copy has been sent to the other.

The development of new IOTA graze report forms will be suspended for a few months, until it becomes clear who will be collecting occultation observations on an official basis after the Royal Greenwich Observatory stops collecting them at the end of 1980. Hopefully, the new form can be designed so that it will satisfy the needs of both IOTA and the new collecting agency.

Observers should check the prediction basis of their ACLPPP profiles; it should be 78A (the prediction version of the limit predictions themselves makes no difference; final corrections are all applied by ACLPPP). Some of the ACLPPP input cards, which are generated at USNO, were produced with version 80B by mistake. The empirical corrections applied by ACLPPP are not compatible with 80B, and can result in bad predictions. If your profiles do not say "78A", inform your computor so that steps can be taken to compute 78A-version profiles.

The table lists successful, or partly successful, expeditions for grazing occultations, reports of which have been received since the last published list (*O.N.* 2 (3) 27), where the format of the current list is described.

Probably the best-observed graze of 1979 is the September 12 graze of Aldebaran (Z.C. 692). In addition to the listed expedition, this spectacular graze was also observed from 13 stations organized by David Hale near Arvin, CA, south of Bakersfield; details of this effort are not yet available. Unfortunately, most, if not all, expeditions east of California for this graze, one of the most favorable of Aldebaran during the current series, were clouded out by a weather front which coincided with the northern limit for much of its length. Over two hours before the Aldebaran graze, several members of both expeditions in California recorded a graze of 6.7-mag. Z.C. 680, whose limit was very close to Aldebaran's. Several total occultations of Hyades stars also were timed. For Z.C. 680, the observers near Arvin established stations over a considerable distance to record a possible north shift, as had been reported for a few previous Hyades grazes. A small south shift occurred, causing a few observers to have a miss. Although most of the observers were 1000 or more feet apart, two of them decided to separate by only 200 feet in case Z.C. 680 might have been a close double. The southern of these two observers timed only a ten-second occultation, while the northern one saw a close miss! For Aldebaran, the observers were then deployed from the predicted limit southward, most 500 feet apart. Everyone timed multiple events except the northernmost observer, who had only a three-second occultation!

Most observers reported numerous gradual events, partial blinks, and faint flashes, caused by Aldebaran's 0"021 angular diameter. But in addition, a number of very faint events, at about the 7th-magnitude level, were reported. I concluded from these that Aldebaran might be surrounded by an extended envelope of reflecting material, as noted in articles which I have published in the 1979 December and 1980 January issues of *Sky and Telescope*. In the latter article, "Occultation Highlights for the Year 1980," I recommend that photoelectric observers set the gain of their equipment to more sensitive than normal levels to record faint phenomena during total occultations of Aldebaran; the faint phenomena likely would not be apparent in normal photoelectric records set to measure the full intensity of the star's light for recording the entire pattern to determine the star's diameter. I still recommend this, to help resolve the issue, but it is possible that the observed phenomena are only caused by the normal tail end of the Fresnel diffraction pattern. If one observer reported the faint phenomenon at the same time that another observer slightly deeper into the moon's shadow timed a full event of Aldebaran (or, more precisely, the center of a gradual event of the star), the angular distance from the center of Aldebaran could be calculated and the intensity calculated from the theoretical diffraction curve for a ".021-diameter star (William Stein and I have calculated such a curve). From this intensity relative to the unocculted light, the magnitude can be predicted and compared to the threshold magnitude for the occultation. If the observed light was brighter than predicted, an extended envelope would be likely. Unfortunately, the above-described observation was not made, even by the closest pair of observers near Arvin (200 feet = 0".04). As is the case also for obtaining information about close double stars, setting up stations at equal separations is very detrimental for this study; for future Aldebaran grazes, when conditions are good enough to observe faint phenomena, observers might be spaced somewhat irregularly, with some very close pairs. I have made a statistical study of some of the observations, simply by calculating the ratio of the total duration of reported faint phenomena (from about 6½ to 8th mag.) to the total duration of gradual events (from mag. 6½ to 1.1). This ratio should be approximately equal to the ratio of these ranges according to the theoretical diffraction curve for a ".021 diameter star, if there is no envelope, but the observed ratio would be larger if an envelope did exist. The observed ratio is slightly larger, but not significantly so, considering the accuracies of visually estimating the rapidly changing magnitude. Since the position angle of graze was slightly different for the two expeditions, observations like the one supposed several sentences above may exist for two observers who were not in the same expedition. But it will not be possible to check this until precise geographical coordinates are determined for all stations and a detailed reduction profile of the observations computed. A detailed photoelectric record of the faint part of a total occultation of Aldebaran probably would settle the question sooner.

Mo	Dy	Star Number	Mag	% Snl	CA	Location	# Sta	# Tm	C C	Ap cm	Organizer	St	WA	b
1976														
8	28	1925	1.2	15+	7S	Gibsonton, FL	1	6	7	6	Tim Kenyon		171	21
1977														
3	28	096681	8.2	57+	N	Kiev, Ukraine	1	2		24	V. I. Mazur			
5	13	3502	7.4	22-	N	Srednee, Ukraine	1	1		7	A. G. Kirichenko			
9	22	2969	3.2	77+	-N	Kozel'shchina,Ukr.	1	2		8	A. K. Osipov			
9	22	2969	3.2	77+	-N	Novye Sanzhary,Ukr.	3	3		8	V. M. Kirpatovskii			
12	19	0215	6.7	71+	S	Kazan, Russia	1	2		24	V. V. Il'in			
1978														
9	16	146772	9.0	5E	48U	Veno City, Japan	1	6	8	8	Hirokazu Kitagawa		181	-01
9	22	0692	1.1	67-	-5S	Valkadia, FL	2	3	7	8	Wyck Hoffcer		184	67
10	7	2454	7.2	24+	4S	Silverdale, N. Z.	4	10		15	G. Allcott			
12	20	1549	5.2	61-		Gotemba Cty,Japan	5	17	6	5	Toshio Hirose	10N	184	20
1979														
1	19	1802	7.1	68-	5S	Blenheim, N. Z.	1	1		8	Graham Blow			
1	24	160044	6.6	24-		St. Germain, Que.	2	15	6	11	Andre Coulombe			
2	18	2128	5.8	63-	7S	Willunga, Austrl.	2	11	4	11	David Steicke	40N	186	-61
3	4	093628	8.6	38+	3N	Murray Br,Austrl.	5	3	4	15	David Steicke		5	57
3	7	0985	6.9	67+	0S	Murray Br,Austrl.	3	4	4	15	David Steicke		178	57
3	9	097477	8.3	83+	8N	Mountain View, CA	1	1	4	15	Richard Nolthenius			
4	1	093895	7.8	22+	-3S	Murray Br,Austrl.	2	3	3	15	David Steicke		187	59
4	1	093901	7.8	22+	3N	Rosario, Philipns	1	4		8	Ernesto Calpo			
4	1	1006	6.9	23+	2N	Blenheim, N. Z.	9	41	8	6	Graham Blow			
4	4	096034	8.0	47+	5N	Brampton, Ontario	2	9	8	15	Andreas Gada			
4	4	096378	8.1	47+		Canberra, Austrl.	1	4	2	20	M. Ashley			
4	15	2247	5.6	92-	13S	Plattville, IL	3	5	6	13	John Phelps	8S	186	-57
4	15	2247	5.6	92-	14S	Dundas, VA	2	6	6	13	David Dunham	C5S	187	-57
4	16	2495	6.0	79-	12S	Uniondale,S.Africa	1	18	8	20	Jan Hers		188	-42
4	19	3322	6.4	41-	0S	Warkworth, N. Z.	3	5	9	15	Gerry Allcott		183	
4	20	3019	5.9	43-	5S	Gum Tree, VA	2	6	6	13	David Dunham	C5S	187	-57
4	20	3019	5.9	43-	5S	Onancock, VA	1	3	9	20	Thomas Townsend			
4	29	0741	5.7	7+	-1S	Calamba, Philipns	2	3		8	Ernesto Calpo			
4	30	0814	5.3	13+	0N	Lafoons Corner,VA	8	43	8	13	David Dunham	CO	6	71
4	30	0886	7.0	17+	3N	San Fernando,Phlp	1	2		8	Rodrigo Nievo			
5	1	0970	6.5	21+	-2S	Waynesburg, OH	2	9	9	10	Robert Clyde		185	
5	1	0970	6.5	21+	-2S	Millsboro, DE	5	6	5	10	Emil Volcheck			
5	2	096647	8.1	30+	4N	Danbury, TX	1	4	7	25	Don Stockbauer	5S	5	60
5	4	098232	7.8	49+	5N	Scottsmoor, FL	1	6		15	Harold Povenmire			
5	20	146591	8.0	34-	5S	St. Petersburg,FL	8	45			Tom Campbell			
6	1	098580	7.9	33+		Toronto, Ontario	3	3	4	20	Robert Radko			

After the Aldebaran graze, Richard Nolthenius and a couple of other observers from the Los Angeles area who were in the Arvin expedition, observed a graze of an 8.3-mag. star; the position of the limit and time of the event just conveniently happened to fit the return schedule. So Nolthenius obtained multiple events during three grazes that night.

Three grazes of the close double star Z.C. 814 = 115 Tauri have been recorded from multiple-station expeditions this year. In September, we were surprised to have a 0".5 south shift, while in April, there was no shift. Consequently, the two northernmost observers out of seven had no occultation. I had only a 0^{s}.8 occultation of the primary component, while Hank Sielski, at a site only 300 feet to the south, recorded four brief occultations of the primary component, during only one of which the secondary also disappeared (that event corresponding to my event). Robert Bolster, at the next site ¼ mile to the

Mo	Dy	Star Number	Mag	% Snl	CA	Location	# Sta	# Tm	C C	Ap cm	Organizer	St	WA	b
6	4	1712	3.8	62+	-2N	Danvers, IL	2	4	7	20	Homer DaBoll	1N	357	-8
6	20	0393	6.8	17-	0N	Gregory, TX	1	1	7	15	Don Stockbauer	1N	357	62
6	28	098715	8.1	16+	5N	Plettenb.Bay,S.Afr	1		8	20	Jan Hers		2	-8
7	1	+3°2522	9.2	36+	1S	Lick Obs., CA	1	3	8	15	Richard Nolthenius			
7	2	1770	5.9	45+	2S	Swan, TX	2	8	6	15	Don Stockbauer		177	-20
7	13	3325	6.7	84-	5S	Danevang, TX	1	7	5	25	Don Stockbauer	2S	188	5
7	14	0004	6.3	68-		Horsley, Austrl.	3	13	8	15	Roger Giller			
7	18	093523	8.1	25-		Penshurst,Austrl.	2	3	4	15	Roger Giller			
7	19	093806	8.2	20-	3N	Eastgate, TX	1	0	8	25	Don Stockbauer	7S	353	72
7	30	1864	6.8	31+	-1S	Mahurangi, N. Z.	1	8		20	Gerry Allcott			
7	31	1941	4.8	42+	N	Cardinal, Ontario	3	14		15	H. J. Widdop			
7	31	1941	4.8	38+	-0N	Oak Ridge, ME	1	6	7	10	David Dunham	0	358	-39
8	13	0322	5.7	64-	8N	South Salem, TX	1	6	8	25	Don Stockbauer		355	59
8	16	0671	3.6	37-	2N	Falkenburg,Sweden	1	2		15	N. P. Wieth-Knudsen		356	77
8	18	095913	7.7	15-	5N	Olanthe, KS	7	18	5	8	Robert Sandy		350	63
8	31	2454	7.2	58+	5S	Coonalpyn,Austrl.	5	2	4	15	David Steicke	12N	176	-71
9	6	146395	9.2		47U	Lake Gregory, CA	2	14	7	15	Richard Nolthenius		359	9
9	6	146457	8.3	28E	61U	Auckland, N. Z.	3	7	7	15	Gerry Allcott		359	
9	6	-6°6132	9.8	0E	31U	Lyndoch,Australia	2	1	3	15	David Steicke	2N	4	4
9	6	3360	6.3	8E	93U	Carnestown, FL	1	2		25	Harold Povenmire			
9	10	0410	6.3	79-	11N	Humble Camp, TX	1	2	6	25	Don Stockbauer		353	64
9	12	0659	6.4	59-	10N	Elverson, PA	2	8	8	13	Emil Volcheck			
9	12	0677	4.8	59-	9N	Oregon, MO	5	33	7	15	Robert Sandy	5S	353	74
9	12	0677	4.8	59-	9N	Janesville, WI	2	14	9	20	John Phelps	5S	353	74
9	12	0692	1.1	58-	10N	China Lake, CA	17	76	9		James McMahon	1S	351	73
9	13	0814	5.3	48-	7N	Marye, VA	6	31	9	25	Wayne Warren	5S	353	70
9	17	1371	6.4	11-		L. Hartley,Austrl.	1	2	2	20	Roger Giller			
9	28	2494	7.9	38+	1S	Laceola, TX	1	3	7	25	Don Stockbauer	7S	178	-59
9	29	161426	8.1	50+	5S	Silverado Can.,CA	1	1	5	15	Richard Nolthenius		180	-33
9	30	162571	7.9	61+	6S	Hacienda Hts., CA	1	2	7	15	Richard Nolthenius		177	-45
10	26	unknown	11.1	27+	6S	Black Birch, N.Z.	1	3	9	40	Graham Blow			
10	27	162024	8.5	33+	2S	Harmony, IL	1	2	5	20	Homer DaBoll		178	-46
10	27	2758	7.0	33+	-2N	Weston, OH	1	5		15	David Dobrzelewski			
10	28	163175	8.5	45+	4S	Hacienda Hts., CA	1	12	7	15	Richard Nolthenius		180	-33
10	28	163142	8.7	44+	5S	Concrete, TX	1	4	7	25	Don Stockbauer	4S	177	-36
10	28	163364	8.6	48+	4S	Auckland, N. Z.	1	4		20	Gordon Herdman		178	
10	29	164030	8.8	56+	6S	Algota, TX	1	1	6	25	Don Stockbauer	2S	177	-22
10	29	3064	6.0	56+	2S	Yorba Linda, CA	3	8	7	15	Richard Nolthenius		180	-20
10	31	3405	7.0	81+		Bundeewa,Australia	1	3	5	20	Roger Giller			
11	7	0814	5.3	89+	14N	Fairfax, MO	3	17	4	15	Robert Sandy	5S	353	70
11	25	163768	7.1	29+	S	Lansing, MI	2			15	David Dobrzelewski			
11	30	0192	5.3	83+	4S	Jupiter, FL	1	1		15	Harold Povenmire			

south, timed 15 events, but they came so fast that he wasn't sure that he got all of them. During the April graze, we had a similar experience, when for a short time, it was not possible to keep up with the description of the events involving the two components, just calling out "There! There! There!" as the events occurred.

The April and September grazes of Z.C. 814 were both at the northern limb, but on opposite sides of the lunar north pole. When Robert Sandy learned of our south shift in September, he set his expedition up south of the nominal prediction, since his November graze occurred at a Watts angle of central graze similar to ours in September. A ½" south shift did occur again in November, when the northernmost observer timed all of his several events during a period of only about ten seconds.

In April, we were fortunate to be able to observe grazes of three fifth-magnitude stars. The first two of these involved stars with good catalog positions (FK4 and Perth, 70), and both were southern-limit grazes during the waning phases of the moon. Also, both of them occurred in the same region of the moon, in an area with a transition from Cassini data obtained from previous graze observations to regular data from Watts' limb correction charts. We set up for the April 20th graze on the assumption that there would be a south shift similar to the one we recorded five nights before, and we were quite successful. Future waning-phase southern-limit Cassini grazes also probably will shift south with respect to our current predictions using version 78A; the Cassini region there does not seem to be as low with current predictions as the early Cassini-graze observations indicated.

Frank Fekel reports that part of a graze was recorded photoelectrically at McDonald Observatory, Texas, in July. As far as I know, this is the first time that multiple events during a graze have been recorded photoelectrically. Some of the events occurred in steps, indicating duplicity of the star. Details of the observation are not yet available.

At the I.A.U. meeting in Montreal in August, Leslie Morrison told me that he hopes soon to submit a paper on the results of an analysis of about 200 of the best-observed grazing occultations, which he has performed at the Royal Greenwich Observatory. He has found strong dependence of the observed-minus-computed residuals in height with latitude libration, similar to those which I described in "Important Notice for Profile Plotters - December 17, 1973" and which have since been included in IOTA predicted profiles, now automatically by the Automatic Computer Lunar Profile Plotting Program. He said that he has found no discontinuity in Watts' data near the north pole, like the one suspected by Ronald Abileah in the course of his analysis of graze observations in 1971. But if there is no discontinuity, how are different shifts like those observed for Z.C. 814, discussed above, explained. Morrison found that the full precision inherent in graze observations can not be utilized due to star position errors. This implies that grazes where star position errors are less significant (as for FK4 and Perth 70 stars), or can be eliminated (by observations of many grazes of the same star), have special value for studies of the moon's motion and shape. In the future, our knowledge of star positions and proper motions will improve, due to current large astrometric undertakings (such as the Zodiacal survey being conducted at

USNO) and the high potential accuracy of astrometry planned for artificial satellites (ESA's HIPPARCOS and NASA's Space Telescope), and the usefulness of current and past graze observations will increase.

H. DaBoll notes that the experiments conducted at Lowell Observatory (*O.N. 2* (6) 52) imply that there probably is no such thing as a visually observed condition-code 9 graze. That is, visual observers can't detect a 10% drop in light with any degree of reliability. When new graze report forms are prepared, the condition-code definitions probably will be modified to reflect these results.

Graze observers should note that daytime events were not included in USNO's (and IOTA's) data for 1980 predictions. Daytime grazes of Aldebaran (Z.C. 692) and Regulus (Z.C. 1487) are quite easy to observe with small telescopes if the elongation from the sun is greater than about 20° and the altitude above the horizon is reasonable. You can find out about them from the maps published by RGO or from "Graze Nearby" messages in USNO total occultation predictions. If you want to observe one, request a prediction from your graze computor, or from Joseph Senne. If one person in a region requests predictions for a particular daytime graze, all observers in that region close enough to the path will be sent predictions. The following 1980 daytime grazes already have been requested: Aldebaran, March 21, A and E regions; Regulus, June 18, F and E regions; Aldebaran, August 5, D region.

Reproduced below is a check list which we distribute to observers at local graze expeditions, along with a station report form, a list of the observing condition codes, and an event schedule.

Before the graze, be sure that:

1. Your flashlight works.
2. Your tape recorder works.
3. You have enough tape to record the graze.
4. Your radio works.
5. You can record the radio broadcast and your event calls while observing; test and play back to be sure.
6. You can follow the star; try different eyepieces
7. When you start to record for the graze, be sure that the dynamic mike switch (if there is one) is on and that the tape is moving (the reels are turning).
8. Keep tape recorder warm (in heated car or under your coat, perhaps hung by a cord or string around your neck).

During the graze,

1. Estimate and record reaction times and accuracy for as many events as possible, especially for ones when you think you were slow.
2. A D followed in less than 0^{s}5 by an R is a blink
3. An R followed in less than 0^{s}5 by a D is a flash
4. Record any interruptions in observing due to any cause, such as clouds, adjusting telescope, or passing vehicles. Note starting and ending times of interruption.
5. Note gradual or stepwise events, if any; estimate durations.
6. Note when sunlit lunar features interfere.
7. Estimate the quality of your ability to see the star.
8. Identify yourself, the date, the star, and the place, on your tape.

After the graze,

1. Play back part of your tape to see if you recorded your events and the radio broadcast satisfactorily. If not, write down as much as you can remember, or any watch timings.
2. Carefully mark your position with stones, cans, etc., or measure its distance from the road centerline and nearby landmarks shown on the detailed map, or wait for the expedition leader to accurately record the location.
3. Report approximately how many events you timed to the expedition leader.
4. (This can be done after you return home) Play back your tape a few times to determine accurate times for all events. Write these on the report form and give it to the expedition leader. Do this soon, before you forget possible important details which may not have been recorded.

[Expedition leader address]

NEW DOUBLE STARS

David W. Dunham

The table lists additions and revisions to the special double star list of 1974 May 9 not listed in previous issues. The columns and general format were described on p. 3 of *O.N. 2* (1).

Earlier, I had confused the bright Hyades stars Z.C. 667 and Z.C. 677, leading to an incorrect statement about the discovery of the duplicity of Z.C. 677 in the second paragraph of IOTA NEWS in *O.N. 2* (5), 41. The star which was resolved photoelectrically at McDonald Observatory, the data listed as an improvement in the table below, was actually Z.C. 667 = SAO 93950 = 75 Tauri, whose duplicity was first suspected from visual observations by Rick Binzel in 1978 September (see *O.N. 2* (1) 3). Consequently, the first indication of duplicity of Z.C. 677 = SAO 93975 was claimed by Robert Sandy during last September's graze of the star, as given in the table. The star's duplicity was also suspected by Berton Stevens and John Phelps, who observed the same graze from Wisconsin several minutes after Robert Sandy's expedition. Since diffraction phenomena can cause gradual phenomena like the ones described, the star is listed as only a probable double, but Sandy feels there is no doubt that the star is a close double. Hopefully, some photoelectric records of the reappearance were obtained which will provide more quantitative information.

Another interesting close double to watch, which is often occulted the night after a Hyades passage, is Z.C. 814 = SAO 94554 = 115 Tauri. Three grazes of the star have been observed quite successfully this year, as described in the article on grazes on page 68; one of the more interesting graze observations of the duplicity will be mentioned also in the double star section of "Occultation Highlights for the Year 1980" which will appear in the 1980 January issue of *Sky and Telescope*. The graze data indicate that the 6.8-magnitude component is still 0."10 from the 5.6-mag. primary, but at a somewhat smaller position angle, 52°.

According to *Acta Astronomica 26* (4), 390, P. Heinzel, at Cracow Observatory, on 1974 Aug.8, observed that about 0^{s}2 was required for the emersion of Z.C. 3482 = SAO 128281 = 16 Piscium. The observation suggests that the 0".01 nominal angular separation expected from spectroscopic data may be too small, implying that the trigonometric parallax determination may be too small.

Richard Nolthenius discovered the duplicity of SAO 94961 on 1977 March 27; see *O.N. 1* (11) 120. The confirming photoelectric observation given in the table can't be combined with the original observation since orbital motion almost certainly would be significant during the two intervening years. The listed observation of SAO 95728 is in good agreement with another Texas photoelectric observation made a few months earlier, reported in *O.N. 2* (3) 26. The magnitudes were in exact agreement and the two projected separations have been combined to form the "true" separation and position angle, which are given in the table. The observed 1979 Feb. separation was 0".049 in direction 45°.5. The listed photoelectric observation of SAO 95748 refines Paul Maley's visual discovery data obtained 7 months earlier, as

(Text continues on page 72)

NEW DOUBLE STARS, 1979 DECEMBER 5

SAO/BD	ZC	M	N	MAG1	MAG2	SEP	PA	MAG3	SEP3	PA3	DATE, DISCOVERER, NOTES
77615		E	U	9.4	9.4	".001					1978 Dec 11, A. Harris, Wrightwood, CA
92922	0352	P	K	7.4	10.2	.031	230°				1979 Jan 7, B. Smith, McDonald Observatory, TX
93652		T	K	9.6	9.6	0.05	116				1978 Feb 15, J. Ferreira, Fremont, CA
93757		T	K	9.0	9.0	0.15	90				
93806		T	V	8.6	9.4	0.2	226				1979 Apr 1, J. Ferreira, Livermore, CA
93950*	0667	P	V	5.4	7.9	.024	238				1979 Mar 5, T. Barnes, McDonald Observatory, TX
93975	0677	G	X	5.6	5.6	0.02	344				1979 Sep 12, R. Sandy, Oregon, MO
94424		T	X	9.7	9.7	0.2	90				
94678		T	K	7.7	8.7	0.8	96				1979 Mar 6, D. Steicke, Murray Bridge, Australia
94897	0884	T	K	8.6	8.6	0.05	90				1979 Feb 7, G. Blow, Black Birch, New Zealand
94903		T	K	9.3	9.3	0.1	90				
94961*		P	V	8.3	10.2	.020	219				1979 Apr 3, D. Evans, McDonald Observatory, TX
95645		T	X	9.9	9.9	0.2	90				1979 May 1, P. McBride, Green Forest, AR
95701		T	K	9.9	9.9	0.1	33				1979 May 1, J. Ferreira, Livermore, CA
95728*			V	9.6	9.7	.066	88				1979 Feb 8, D. Evans, McDonald Observatory, TX
95748*		P	V	8.1	8.6	.052	43				1978 Nov 18, B. Smith, McDonald Observatory, TX
96596		T	K	9.6	10.4	0.05	166				1978 May 12, J. Ferreira, Fremont, CA
96757		T	K	9.8	9.8	0.05	136				1979 May 2, J. Ferreira, Livermore, CA
96785		T	K	9.9	9.9	0.1	54				1979 May 2, J. Ferreira, Livermore, CA
96793		T	K	9.8	9.8	0.15	76				1979 May 2, J. Van Nuland, San Jose, CA
97098		T	K	9.4	9.4	0.05	33				1979 Apr 5, J. Ferreira, Livermore, CA
98073		T	K	9.5	9.5	0.07	71				1979 May 31, R. Nolthenius, Mountain View, CA
98519		P	X	8.7	9.6	.232	280				1979 Apr 7, D. Evans, McDonald Observatory, TX
98622		T	X	9.1	9.6	0.4	158				1979 Jun 1, J. Van Nuland, San Jose, CA
109142		T	X	8.7	8.7	0.04	115				1978 Dec 8, D. Steicke, Murray Bridge, Australia
109901*		T	X	9.6	9.6	0.07	282				1979 May 22, D. Steicke, Murray Bridge, Australia
118171		T	K	8.8	8.8	0.1	90				
118232		T	K	8.7	8.7	0.04	137				1979 Jun 2, R. Nolthenius, Mountain View, CA
118476		T	K	8.9	8.9	0.1	90				1979 Jun 30, P. McBride, Green Forest, AR
118517		T	K	8.9	9.5	0.06	303				1979 Jun 30, R. Nolthenius, Mountain View, CA
118571		P	V	8.0	8.8	.034	105				1979 Apr 9, D. Evans, McDonald Observatory, TX
138944		T	K	9.6	9.6	0.05	90				1979 Jun 5, G. Blow, Black Birch, New Zealand
139011		T	K	9.3	9.3	0.3	119				1978 May 19, J. Ferreira, Fremont, CA
139154	1882	T	K	9.1	9.1	0.15	50				1979 Jul 3, P. McBride, Green Forest, AR
146344		T	K	8.6	8.6	0.1	90				
146971*	3519	T	X	8.2	8.7	0.05	269				1979 Jul 14, D. Steicke, Murray Bridge, Australia
158804		P	X	9.0	9.3	.008	80				1978 Jul 15, B. Smith, McDonald Observatory, TX
159188		P	K	7.8	8.9	.246	311				1978 Jun 18, B. Smith, McDonald Observatory, TX
159933		P	X	9.3	10.6	.189	266				1978 Aug 13, B. Smith, McDonald Observatory, TX
160044*	2396	T	V	7.1	7.5	0.04	141				1979 Jul 7, R. Nolthenius, Mountain View, CA
160226	2447	T	K	8.2	8.7	0.04	132				1979 Aug 31, D. Steicke, Murray Bridge, Australia
160517		T	K	9.6	10.0	1.0	320				1979 Mar 20, D. Steicke, Murray Bridge, Australia
160522		T	K	9.6	9.6	2.5	91				1979 Sep 28, J. Van Nuland, San Jose, CA
161338		T	X	7.4	9.0	0.9	315				1979 Mar 21, D. Steicke, Murray Bridge, Australia
161754	2715	P	X	6.7	9.3	0.6	54				1979 Apr 18, R. Radick, Prairie Observatory, IL
162033		T	V	9.0	10.0	0.25	53				1979 Oct 27, P. Maley, Alvin, TX
162076	2768	T	K	9.2	9.2	0.1	90				
162251		T	K	9.2	9.2	0.1	90				
162883	2876	T	Y	6.2	6.2	0.1	90	8.9	45.6	42°	(3rd* ADS 12767)
164623		T	K	9.5	9.5	0.1	90				
+19°1601		V	A	8.6	9.2	3.0	75				1912.06, R. Jonckheere ADS 5779
+18 0901		P	V	9.0	10.8	.774	217				1979 Feb 7, D. Evans, McDonald Observatory, TX
+18 1010		V	A	8.8	8.8	3.0	152				1831.19, Struve ADS 4490
+17 1619		P	V	10.2	10.5	.271	63				1979 Apr 5, D. Evans, McDonald Observatory, TX
+16 1667		V	A	8.5	9.2	1.4	350				1881.31, E. Pettit ADS 6668
AC-19°51151		T	V	10.6	10.6	1.4	111				1979 Sep 29, G. Blow, Mt. John Observatory, New Zealand

given in *O.N. 1* (15) 160; orbital motion may have been significant between the observations. B. Smith also notes that there was a distant third component which he could see visually, but it is not listed in the Lick I.D.S. Steicke gives more quantitative information about SAO 109901, now upgraded to a probable double, than was given during a "gradual" occultation noted in South Africa in 1928. A similar situation occurred for SAO 146971, noted in South Africa in 1931. Yet another star in this category was SAO 160044, first noted in 1925 August.

A.C. -19° 51151 = J05703, whose 1950 R.A. is $18^h31^m 33^s.4$, Decl. -18°20'47". BD +19° 1601 = X10426; BD +18° 901 = X07257; BD +18° 1010 = X07838; BD +17° 1619 = X11377; and BD +16° 1667 = X12435.

During the evening of 1979 August 6 U.T., the moon occulted four 6th-magnitude stars at Washington, DC; their Z.C. numbers were 2773, 2774, 2791, and 2794. Conditions were reasonably good, although the waxing moon was 94% sunlit. Thomas Van Flandern and Rick Binzel recorded the events photoelectrically, while I also assisted with visual observations with the guide telescopes. Van Flandern and Binzel both noted that one event was gradual, of about ½-second duration, not a stepwise disappearance. The photoelectric record of the event showed nothing unusual; the chart recorder pen had a time constant of nearly 0.1 second. We don't have an explanation for this, but it seems to cast doubt on visual "gradual" occultations, as opposed to occultations seen to occur in steps. But one can be fooled even then. For 5.4-mag. Z.C. 2791, I noticed that "something happened in a stepwise manner" about ½ second before the disappearance, and without other information, I would have claimed it as a double. The photoelectric trace did indeed show a drop in the light several tenths of a second before the disappearance, but after a few tenths of a second, the light returned to full brilliance, then disappeared in the normal sharp pattern. The drop was almost certainly a seeing fluctuation; at a cusp angle of 55°S, a grazing-type event by a high mountain would be very unlikely.

The duplicity of SAO 77615 was discovered by A. W. Harris on the same night that he measured the light curve of (18) Melpomene and watched for its possible occultation of SAO 114159. He found that SAO 77615 was an eclipsing binary, as noted in *Sky and Telescope 57* (5) 429. The separation is very uncertain, but is probably too small to be detected even by photoelectric observation of a lunar occultation. "E" is a new method code used for this: Eclipsing nature discovered from a photoelectric light curve.

A few new discoveries of duplicity of unidentified stars are not included because the stars have not yet been identified. Wayne Warren reminds observers that his work in identifying stars is facilitated considerably if, in addition to the necessary data for the unknown star, the (predicted or observed) U.T. of occultation, P.A., C.A., and SAO and/or DM numbers are given for one or two stars occulted the same night, preferably bracketing the unknown star as closely as possible in time and P.A. An estimated (with respect to predicted stars) magnitude of the unknown star is also helpful.

Originally, I had started preparing the list of double stars for publication in the August issue of *O.N.*, and keypunched the basic data about each star, but I did not finish preparing the list. Unfortunately, when I resumed the work for the present list, I had the computer cards, but misplaced some of the original reports. That is the reason for the blanks in the "Date, Discoverer, Notes" column. If you were the one to claim possible duplicity for any of these stars, please send me another copy of your observation so that your discovery can be properly credited and documented. I apologize for the inconvenience this may cause.

The photoelectric record of the step disappearance of SAO 93925 = Z.C. 659 = 70 Tauri obtained at McDonald Observatory, TX, on 1979 March 5 agreed well with the separation of the components as computed from orbital elements for this visual double, but the components, mag. 7.0 and 7.3, should be reversed (or, 180° added to the p.a.). Another Texas photoelectric observation by L. Coleman on 1978 December 13 is in good agreement with data computed from orbital elements, but the component magnitudes should be revised to 7.4 and 8.0.

Scott Donnell independently discovered the duplicity of SAO 161754 = Z.C. 2715 when he observed a stepwise occultation at Eau Claire, WI, on 1979 Sept.2.

Paul Schmidtke, Ohio State University, recently has published a list of stars with composite spectra which are susceptible to lunar occultations (*P.A.S.P. 91* (543) 674). He finds 68 systems, of which 48 are SAO stars. Of these, over half are already in IOTA's special double star list, some having been resolved during occultations, but most known from being flagged as spectrum binaries in the Z.C., SAO, and Wilson radial velocity catalogs. The stars with the following SAO numbers are not in IOTA's list, but will be added shortly: 76548 = Z.C. 633 = 53 Tauri, 78094 = WY Geminorum, 93042 = Z.C. 395, 94942 = Z.C. 888, 96739, 97457, 97757 = Z.C. 1255, 110539, 128186 = Z.C. 3453 = κ Piscium, 146979, 161631 = Z.C. 2695, 164560 = Z.C. 3171 = γ Capricorni, 185363, 186289, 186458, 187022, and 188460. For all but two of the non-SAO stars, Schmidtke gives only HD or HDE numbers; they will be added to IOTA's list later, after DM numbers are found, and perhaps also USNO X, K, or J numbers. S. Ridgway has computed predictions of occultations of the twenty non-SAO stars for Kitt Peak for 1979 to 1983. He found four favorable events, one of which occurred last November 8th. The other three are dark limb disappearances given in the table below;

Date	U.T.	Star	Mag.	Sp	%Snl	Alt
1980 Apr 20	3^h 47^m	HDE 257897	10.5	F8	30	38
1981 Mar 14	4 11	HDE 258998	10.2	F8	62	65
1982 Mar 5	4 18	HDE 267604	10.3	F2	75	76

LUNAR OCCULTATIONS OF SEYFERT GALAXY NUCLEI

Paul C. Schmidtke

A number of months ago, I was asked to investigate the potential use of lunar occultations in determining the angular diameters of Seyfert galaxy nuclei. Much of the light of a Seyfert galaxy is concentrated in a point-like nucleus (quasars are recognized as extreme cases where an underlying galaxy is not readily apparent), and a typical spectrum shows strong emission lines of HI and [OIII] (among others). Astronomers interested in Seyferts would like to place a constraint on the size of the energy-generating volume. Therefore, if an upper limit to the angular diameter of the emission-line region could be obtained, a better understanding of the nature of Seyfert nuclei may be at hand. The problem seems worthy of pursuit; the answers regarding the observability of such occultations, however, are not optimistic.

Consider the number of Seyfert galaxies. Of the 88 Seyferts listed by Weedman,[1] only seven are close enough to the ecliptic to be occulted. Information on these seven is listed below. The equivalent magnitude is the magnitude of the Hα emission line (usually the strongest) compared to the continuum of an AOV star of visual magnitude 0.0. The data for this comparison are from de Bruyn and Sargent[2] and Tüg, White and Lockwood.[3]

Name	Equiv. Mag.
I Zwicky 1	12.2
Markarian 372	14.1
3C227	*
Arakelian 223	*
Markarian 50	13.8
NGC 7603	13.2
Parkes 2349-01	13.9

* implies too faint to be observed by de Bruyn and Sargent; these two Seyferts can be ignored.

Because I Zwicky 1 is so much brighter than the other six galaxies, let us consider only the circumstances surrounding its lunar occultation. I Zwicky 1 is about two minutes of arc from the northern limit of the occultable band in the sky. Any visible event would be seen only from a very southern observatory (the best site being the 24" telescope at Mount John in New Zealand) and would be at or near grazing. Predictions have not been obtained because the event is so unlikely to occur and because of the considerations below.

The equations of Ridgway[4] are used to estimate the minimum measurable angular diameter under a given set of circumstances. One parameter is the linear velocity of the shadow of the moon. A typical value is 800 m/sec, but for a near-graze the velocity is considerably smaller. For the calculations a value of 80 m/sec is assumed (a still smaller value would enhance the observability). Other parameters that can vary are the background light intensity and the efficiency of the detector. For all reasonable combinations of parameters, the minimum measurable angular diameter is substantially greater than one arc second. Such a measurement would not yield any usable information. This result may change if one considers satellite-based observations or very high efficiency detectors (other than photomultiplier tubes).

In conclusion, (even under very favorable conditions) the brightest of the Seyfert galaxies can not yield a usable angular diameter of the emission-line region; for the fainter Seyferts the result can only be worse.

Dept. of Astronomy, Ohio State Univ.

References:

1. Weedman 1977, *Ann. Rev. of Astron. and Astroph.* *15*, 69.
2. de Bruyn and Sargent 1978, *Astron. J. 83*, 1257.
3. Tüg, White and Lockwood 1977, *Astron. and Astroph. 61*, 679.
4. Ridgway 1978, *Astron. J. 82*, 511.

IN MEMORIAM

David Laird, Terrace Park, OH, became ill with leukemia in early October, and passed away on November 8th. David was especially active in leading expeditions for some of the first successfully observed grazes in the early sixties, and was one of the first grazing occultation computors. He was very effective in fostering interest in astronomy in general and occultations in particular among his students at the Cincinnati Country Day School. We extend our sympathy to Mrs. Cynthia Laird for her loss.

D. W. D.

LUNAR OCCULTATION COUNTS FORM

David W. Dunham

On the lunar occultation counts form, observers are reminded that the number of events which were reappearances are requested on the last line on the left side of the form. Many observers are leaving this blank; no reappearances will be assumed in this case, which may give a lower rating than deserved.

OCCULTATIONS OF ASTROGRAPHIC CATALOG STARS BY (27) EUTERPE

David W. Dunham

1980 DATE Mar	U.T.	m_{pg}	R.A.(1950)	Dec	Δm	Dur	Possible Area	El Sun	Moon El	Moon %Snl	Moon Up
4	11^h46^m	12.0	$5^h36^m.4$	24°02'	0.5	8^s	Siberia; Japan?s	110°	107°	94-	e128°E
18	11 27	12.1	5 57.5	24 15	0.6	6	Australia	92	68	4+	w120 E
23	9 53	11.5	6 5.8	24 16	0.9	6	Japan;w.Pacific	89	5	49+	all
25	19 20	12.2	6 10.0	24 16	0.6	5	U.S.S.R.	87	29	72+	all

Hans Bode has pointed out that (27) Euterpe will cross the southern part of M35 on 1980 March 23, following a path similar to that of (24) Themis in November - December (see *O.N. 2* (5) 43). The 11th-magnitude asteroid, whose diameter is expected to be 116 km, will occult only one of the cluster members, but 3 other occultations during March were found. The Δm's given in the table are photographic. Finder charts, and probably world maps, will be included in an IOTA special bulletin which I hope to distribute to observers in probable areas early in 1980.

COMMENTS ON THE ANALYSIS FROM "DOWN UNDER"

Clifford J. Bader

The year-to-year spread of Mr. Herald's standard deviations can be satisfactorily explained as consistent with the distribution of variances to be expected in samples taken from a parent distribution with a standard deviation of 0.74 arc seconds (his overall value). On the other hand, the result obtained for his northern vs. southern declination comparison is improbable enough to suggest the existence of a real effect and to spur further investigation.

I therefore examined 71 of my own residuals for southern declination stars, and was surprised to find a marginally significant negative shift; i.e., the variance is *smaller* than my overall variance. This result implies that the declination effect, if it exists, is opposite for Northern Hemisphere observers.

A possible explanation is provided by N. P. Wieth-Knudsen's data, which incidentally have demolished the 'geographical effect'. Dr. Wieth-Knudsen's 1022 observations have a standard deviation of 0".70, and group statistically with Mr. Herald's results rather than with those previously reported for Northern Hemisphere observers.

It is tempting to suspect that the high standard deviations have a common cause, and a likely candidate is the fact that both Herald and Wieth-Knudsen observe non-ZC occultations as a sizable majority. In contrast, my low standard deviation of 0".62 applies to observations including only 30% non-ZC stars. Further confirmation is provided by Wieth-Knudsen's separate breakdown of 130 high-quality ZC-only disappearance timings, which exhibit a standard deviation of only 0".51.

In addition to providing a basis for observer-to-observer differences in standard deviation, the non-ZC effect also leads to a declination dependence if the observer times a greater proportion of fainter, non-ZC stars under favorable high-altitude conditions than under the low altitudes corresponding to an opposite declination. This is true in my case (22% non-ZC for southern declinations and 34% for northern declinations), and if true for Mr. Herald, would at least partially explain his result.

A correlation between ZC status and standard deviation does not exonerate the observer as a cause, since one might expect the non-ZC observations to offer greater average difficulty and to be subject to greater timing error than that for brighter stars. However, one would also expect increased difficulty and larger residual variance at low altitudes, in opposition to the previously described declination effect. Furthermore, an increase in standard deviation from 0".6 to 0".7 requires an additional average timing error of about ± 1^s, and it is unlikely that an experienced observer would fail to notice such large uncertainties. Thus, the increased standard deviations for observers with a high proportion of non-ZC timings are likely to be due principally to large positional errors for the fainter stars.

THE SECRETS OF THE ASTEROIDS

O. Latifi

Summary: Tadzhik astronomers A. Naimov and V. Rakimov, members of the Astrophysical Institute of the Academy of Sciences of the Tadzhik S.S.R., have discovered a previously unknown satellite of the asteroid Cybele.

"Our investigations are carried out within the framework of an international program for the study of asteroids," says Doctor of Physical-Technical Sciences O. V. Dobrovol'skii, Chairman of the Department of Comet Astronomy. "There are various hypotheses about their origin. Some investigators consider them to be fragments left over from the disintegration of the mythical planet Phaeton, which should have been located between Mars and Jupiter."

The Phaeton hypothesis has been checked by mathematical calculations. It turns out that indeed there should be a planet between Mars and Jupiter. But if such a planet did exist, then why did it disintegrate? What could have caused the catastrophe? Perhaps there was a collision with another celestial body, or possibly the planet tore itself apart as a result of internal processes. In a word, for the time being, it is only possible to guess!

The study of asteroids should help to clarify the picture. Among the various observational methods, one is especially valuable: observation of the "eclipse" which occurs when asteroids pass in front of stars. However, this phenomenon cannot be seen everywhere, but rather is observable only from within a narrow band on the earth. Three such points are located in Tadzhikistan - in Dushanbe, the Shakristan Pass, and in the city Ura-Tyube. It is necessary, of course, that the sky be perfectly clear at the time of observation.

This autumn has been favorable for the Tadzhik astronomers, as there have been many clear nights. The result — a new discovery. Up until this time, the existence of satellites had been established for only a few asteroids. Now another has been discovered. Usually, the stellar eclipse occurs quickly. For example, the shadow of the asteroid Nemausa, as observed by astronomers in Dushanbe, almost instantaneously covered the star. The light from Cybele, however, was extinguished slowly, evenly.

The observations have shown that the asteroid is not alone: It is being circled by a satellite located some 90 km from the asteroid center. A full revolution is completed in roughly a day. In contrast to Cybele, whose diameter is 310 km, the satellite is small; its cross section is only eleven kilometers. It is thought that the asteroid is surrounded also by other small bodies and perhaps even by a cloud of dust material.

The information which has been obtained has more than just insignificant importance for the previously mentioned program for observation of the minor bodies of the solar system — asteroids, comets, meteors, and meteorites — using cosmic techniques.

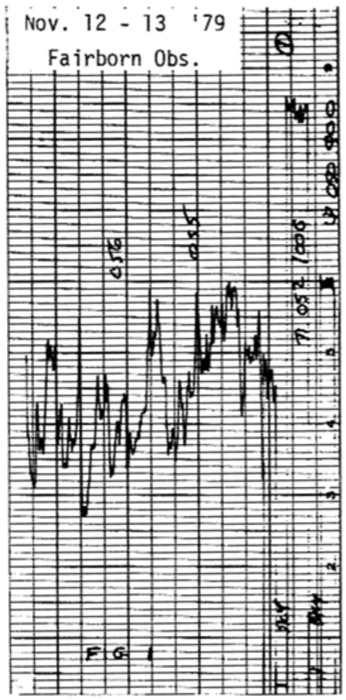
[D.W.D.: The above is Robert McCutcheon's translation of an article in the 1979 Nov. 14 issue of *Pravda*, called to our attention by Paul Maley. There is some error, since it is stated that the satellite is 90 km from (65) Cybele's center, which would be under the asteroid's surface. We have written, asking about this, and for more details of the observations, as well as about the occultation by (51) Nemausa, about which we have no previous knowledge. The gradual events noted for Cybele almost certainly were caused by the stellar angular diameter, which was expected to require 0^{s}23 to be covered in the case of a central occultation; see *O.N. 2* (2), 17.]

OCCULTATION OF ψ ANDROMEDAE

Russ Genet

Most observed occultations are lunar occultations, with some occultations of stars by planets and asteroids reported.[1] The problem with lunar occultations is that they are confined to a zone near the ecliptic, and furthermore, the bright moon makes the stars hard to see. Occultations of stars by planets and asteroids are so rare that significant sample sizes are impossible.

These serious difficulties can be entirely overcome in the occultation of stars by clouds. Not only can stars at any position of the sky be examined, but the bright light of the moon does not have to be contended with. Research at Fairborn Observatory[2] has shown that high cirrus clouds are ideally suited for this task, as one can easily get multiple occultations in a single observing session. After a five-year site survey, southern Ohio was chosen as having the most frequent occurrence of high cirrus clouds, an ideal situation for a serious researcher of stellar occultations.



This highly instructive interaction between stellar emissions and planetary atmospheric circulations has gone unstudied previously due to the unfortunate siting of major observatories in deserts and mountain tops. Some supposedly eminent astronomers have even suggested that the interaction of starlight and clouds is to be avoided.[3,4]

Shown in Fig. 1 is a typical light curve of a star being occulted by a high cirrus cloud. Analysis of this curve shows a mean amplitude variation of 1^m357, with most of the variation occurring at 0.35 Hz. It has been found that the frequency of maximum variability is independent of the direction of cloud travel, but is related to the velocity of the clouds and the zenith angle by the following formula:

$$f_{max} = 0.713 \sec Z + 3.71 \times 10^5 V_c$$

where

f_{max} is the frequency of the peak of the power spectral density function - Hz

Z is the local zenith angle - degrees

V_c is the velocity of the clouds in cm/sec.

Not yet fully understood is the relationship between f_{max} and cloud height (MSL). Studies of stellar occultations by cumulonimbus clouds have been reported by C. Front.[5] Due to the high attenuation of starlight by this class of clouds, it was necessary to use a nine-stage image intensifier in front of the photomultiplier tube. Unfortunately, a photon overload occurred as the result of an atmospheric static discharge of the type often associated with clouds of this class.

References:

1. *Ap. K. 187*, 32-41.
2. Fairborn Observatory Note #17A.
3. A.A.S. Proceedings, Oct 1871.
4. *R.A.S.P. 31*, 117-119.
5. *Weatherman, Vol. 5*, No. 17.

JUNO OCCULTATION BEST OBSERVED YET, EVEN VISUALLY; SOVIETS CLAIM SATELLITE OF CYBELE; FIRST INTERNATIONAL ASTEROIDAL OCCULTATION EXPEDITION (FOR METIS) PARTLY SUCCESSFUL; OTHER LATE 1979 OCCULTATION ATTEMPTS

David W. Dunham

(65) Cybele and B.D. +19°1399, October 17: Gordon Taylor said in his Bulletin 19; "Predictions of this event, based on recent RGO plates, have been issued to observers in Israel, Iraq, southern USSR and China and arrangements to transmit last-minute predictions have been made." Yaron Sheffer reports that visual observation was fruitless in Israel due to low altitude, and that no occultation occurred at Wise Observatory, where the star was monitored photoelectrically. See p. 74 for an account of the successful Soviet observations.

(4) Vesta and SAO 110541, November 23: I distributed regional maps for this small-Δm event to photoelectric observers in North America and northwestern Europe. According to a USNO plate showing both objects on Nov. 19, the path was 0."5 north of my nominal prediction, putting it across Alaska, Greenland, and northern Norway. The National Space Science Data Center sent a telex message to Taylor giving this result. At USNO, Van Flandern monitored the event photoelectrically, while some visual observers in the DC area attempted to "shadow" each other by setting up alongtrack to possibly confirm secondary occultations. Unfortunately, nobody shadowed USNO, where one brief dip to the asteroid alone level was recorded. The dip was only about 0.s4 long, implying an object only a few kilometers in size which was too small to cause an event at other sites where observations were attempted. The "V" shape of the drop is not convincing to me; the need for effective shadowing is again emphasized. In some low areas, moisture in the air caused bad seeing, preventing visual observations. But in most areas around DC, the seeing was good and the star could be separated from Vesta for effective monitoring. Robert Bolster, using the National Capital Astronomers' 14-inch Celestron, estimated that the least separation was more than the 2."0 expected from the USNO astrometry. During the first half of the observation period, I was watching Vesta, but mistook a star 1' away to be the star which was to be occulted. I used a low-power eyepiece to positively identify the star field, but then should have used a high-power eyepiece to examine the field near Vesta in more detail. When I finally did this, I located the star very close to Vesta and was able to follow it rather well as the separation increased.

(24) Themis and A.C. +24°6^h0^m 581, November 27: Although no astrometry was obtained for Themis, William Penhallow took a plate of M35 to measure current-epoch positions for this star, as well as of #187 and #667, which also were to be occulted; see

O.N. 2 (5) 43. The corrections to the A.C. positions were gratifyingly small, less than 1"; the path shifts, all north, for #667, 581, and 187 were 0".78, 0".82, and 0".45, respectively. This indicates that the A.C. positions usually are good enough to use for asteroidal occultation catalog searches. Seeing conditions were good that night in the DC area, but but this occultation was impossible to monitor visually because Themis was brighter than the star. However, the light of the 11th-mag. star in the field was quite steady as seen with my 25-cm reflector, and I feel that an occultation of one of them with a Δm greater than 1 would have been quite observable. Perhaps there is some hope for visual observation of the December 29 occultation by Themis, but the other events listed on page 43 are probably not worth any effort, at least visually. Astrometry is planned for the December 29 event; if a prediction update is obtained, it might be procured from Wayne Warren at 301,474-0814 or 344-8310.

(27) Euterpe and SAO 77426, December 8: A plate by Penhallow in mid-November indicated that Euterpe was about 0".65 south of its predicted path, indicating that the path might cross northern Scandinavia. Gordon Taylor and observers in the area were notified by mail.

(9) Metis and SAO 80950, December 11: Plans for this event, the first international (and intercontinental) expedition for an asteroidal occultation, and the next one, were discussed in *O.N. 2* (5) 44. Astrometry obtained during the two weeks preceding the event showed a larger-than-expected 0".6 south shift, putting the path across northern Guyana and the relatively remote southeastern part of the Venezuelan state of Bolivar, in which Angel Falls are located. Paul Maley, Houston, TX, and Walter Nissen, Takoma Park, MD, travellled to Georgetown, Guyana, where they observed a 26s.7 occultation from opposite sides of the roof of the hotel where they stayed. Maley noted that both D and R were not instantaneous, but lasted about 0s.1. For a star as bright as SAO 80950, the toe of the diffraction pattern likely would be visible two fringe spacings away from Metis' surface, probably explaining the observation. In addition to visual timings, Maley photographed the occultation as a break in the star's trail on an unguided (stationary) exposure with a Celestron-90 1000-mm focal length camera, the first time this has been sucessfully accomplished. Earlier experiments had shown that occultations as short as ½ second could be recorded with this equipment. No secondary occultations were seen. They had hoped to observe from more widely separated positions, but security considerations prevented it. Guyana is an impoverished nation with a high crime rate, and they were told that no dark location in the area where they could travel was safe at night. The occultation was apparently nearly central at Georgetown, which was near the average of the astrometric results by Klemola, Taylor, Penhallow, and Herald.

William Hubbard and Venezuelan student Humberto Campins, of the Planetary Sciences Department of the University of Arizona, worked with me and Jurgen Stock, Director of the Centro de Investigacion de Astronomia (CIDA) in Merida, Venezuela, to plan the logistics for observing this occultation with the University of Arizona's three portable photoelectric telescopes, along with American and Venezuelan visual observers. Due to the logistical problems created by the southward path shift, the University of Arizona decided to use the photoelectric equipment in the southwestern U.S.A., for the occultation by Juno. Also, weather prospects were not as favorable in Bolivar as in the originally intended northwestern part of Venezuela. Nevertheless, Campins and four other visual observers from the U.S.A. (Daniel and Jane Overbeek, Joan Dunham, and I) travelled to Ciudad Bolivar, where the governor, Alberto Palazzi, and his wife, Tatiana, made available a Cessna aircraft, a four-wheel-drive Blazer, and a station wagon, to reach remote airfields and villages in the expected occultation path. It was discovered that Metis crossed an AGK3 plate boundary on December 7, which cast some doubt on the astrometry done before then. Later astrometric results from David Herald in Australia and William Penhallow in Rhode Island were relayed by Wayne Warren, National Space Sciences Data Center, to Ciudad Bolivar, where I updated the prediction. We established pairs of stations at Tumeremo, El Dorado, and Luepa. Although the sky cleared well at El Dorado 45 minutes after the time of the occultation, overcast skies prevented observations at the three Venezuelan sites. Nevertheless, we gratefully acknowledge the valuable support, without which the effort would have been impossible, given by the following: Palazzi, the Governor of Bolivar, and his wife; their aides, Guillermo Wenzel and Torrebo; General Coello, the regional commander of the Venezuelan armed forces; Rodriguez Lopez, commander of the army engineering brigade at Tumeremo, the main base for the expedition; Dr. Stock, Jack MacConnell, and Hans, CIDA, for their help at our arrival in Caracas; and Victor Rodriguez, Caracas.

(3) Juno and SAO 115946, December 11: Several Astrometric plates obtained one to two weeks before the occultation, when Juno was near its stationary point in R.A. and close to the star, all agreed that the path was nearly 1".0 south of the plot on page 45, extending from upper Michigan to the Los Angeles, CA, area, and crossing Hawaii, as well. But astrometry by Taylor on December 4, after all the other plates were taken, showed the path to be 0".7 south, a full diameter north of the earlier result, derived mainly from Klemola's data. Over a dozen chords were observed, mostly with portable photoelectric telescopes from Lowell Observatory, the University of Arizona, Massachusetts Institute of Technology, and the University of California at Santa Barbara, at sites in southern California. The occultation also was recorded photoelectrically at Mauna Kea and Kaleakala, HI, and at Eau Claire, WI. Richard Nolthenius observed the occultation visually from the Mojave Desert, noting that the 0.5-mag. fade and brightening were distinct and easy to time accurately. Moreover, an observer with no previous occultation experience, with Nolthenius, also saw the event. We were wrong to discourage visual observations of this occultation; they should have been encouraged. A visual observation at Coso Junction, CA, apparently got the northernmost chord, duration 30s. Mauna Kea was probably the southernmost, with a similar duration. Table Mountain had the longest duration reported so far, 67s.5; this was near Klemola's predicted center. A preliminary solution from the University of Arizona data gives a diameter of 282 km, but the shape seems to be approximately elliptical, with the major axis approximately in the direction of motion. No secondary occultations have been reported. Robert Millis, Lowell Observatory, P. O.

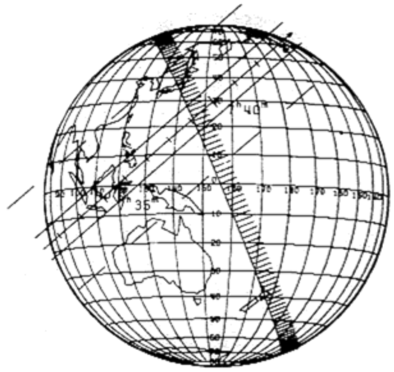
Box 1269, Flagstaff, AZ 86001, is collecting all observations of the event for a comprehensive analysis.

ERRATUM

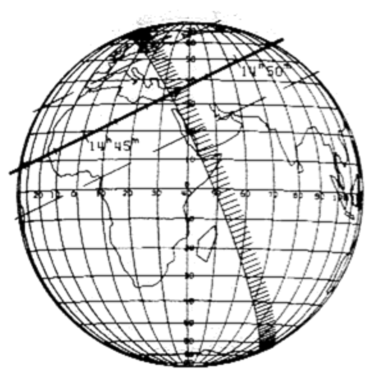
David Dunham has pointed out the omission of one line of information from the first half of the table in *O.N.* *2* (5) 43. This line refers to an event now in the past, but is given here for completeness.

Dec 22 12^h 13^m-20^m Themis 11.3 1.90 5^h44^m 83 12.1 0.4 17^s 22 13 New Zealand?s; Australia

PLANETARY OCCULTATION PREDICTIONS
(continued from page 67)

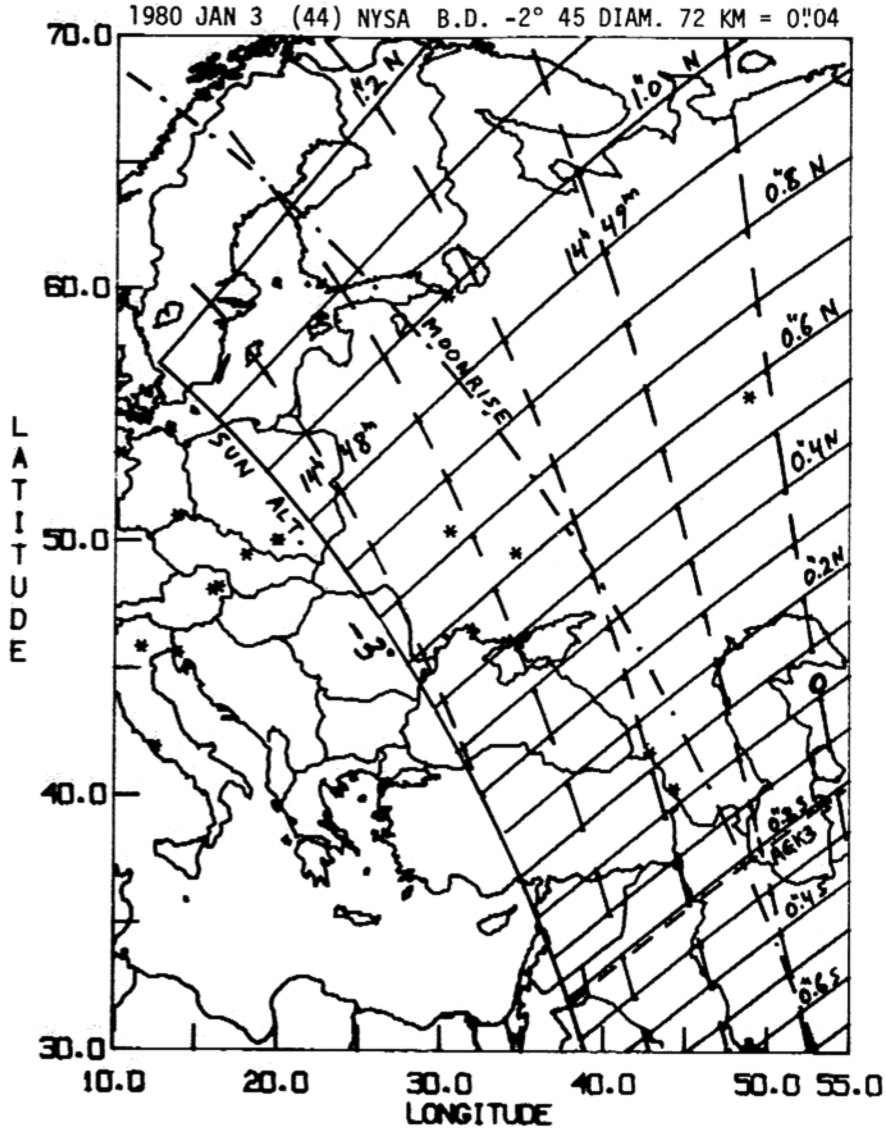


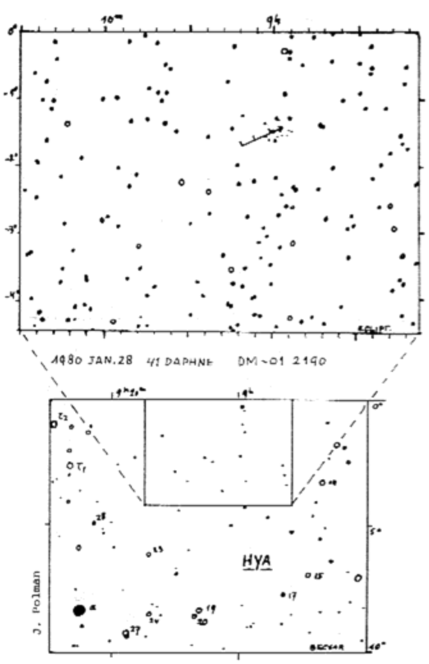
10 128975 by Ceres 1980 Jan 3

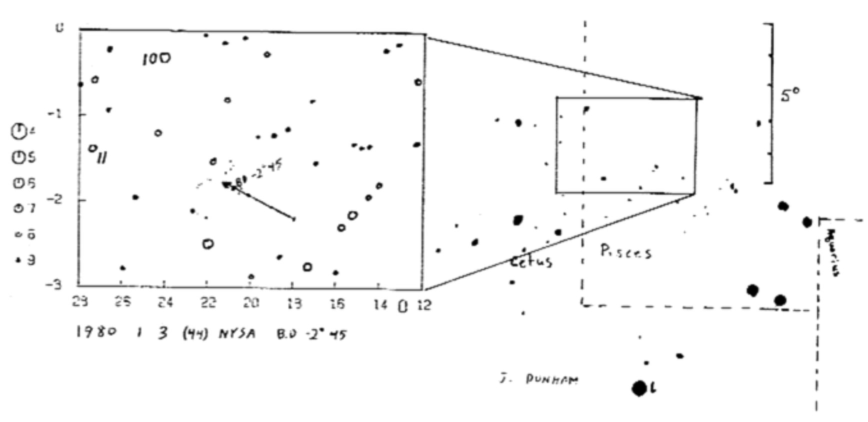


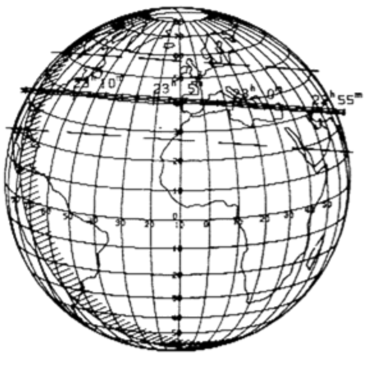
)2° 45 by Nysa 1980 Jan 3

1980 JAN 3 (44) NYSA B.D. -2° 45 DIAM. 72 KM = 0".04

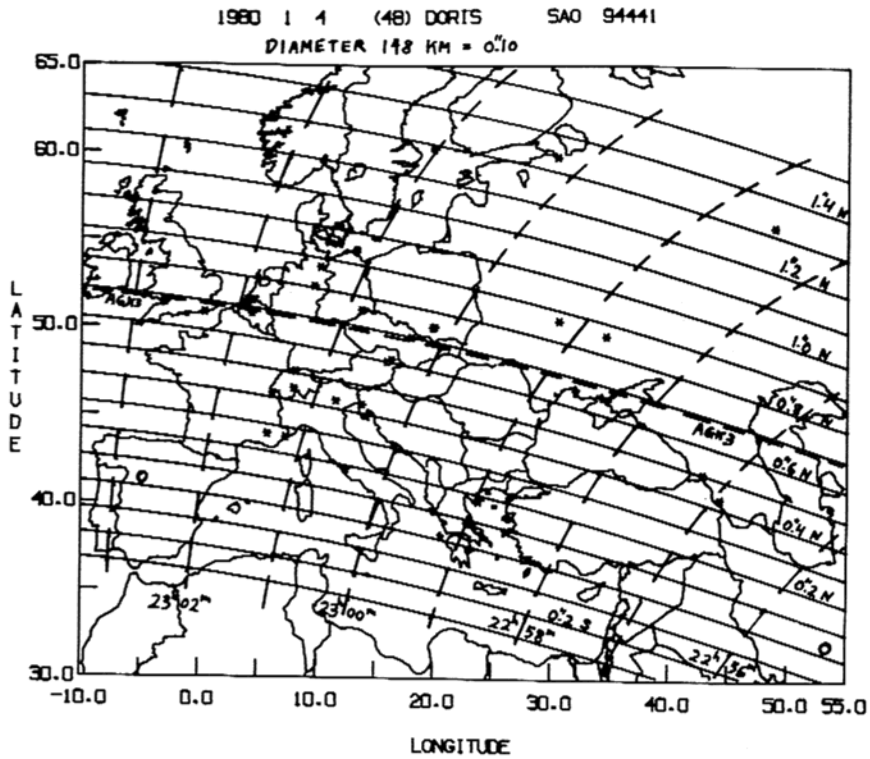


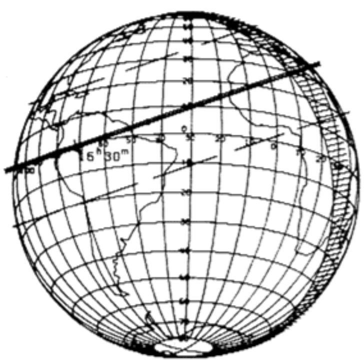




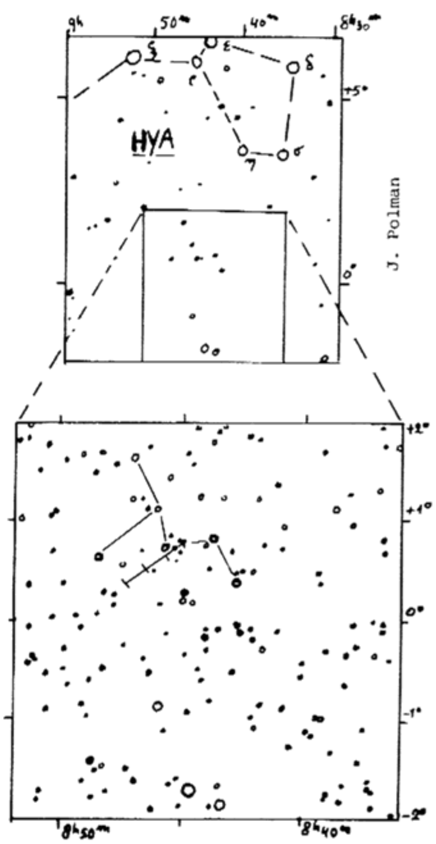


SAO 94441 by Doris 1980 Jan 4

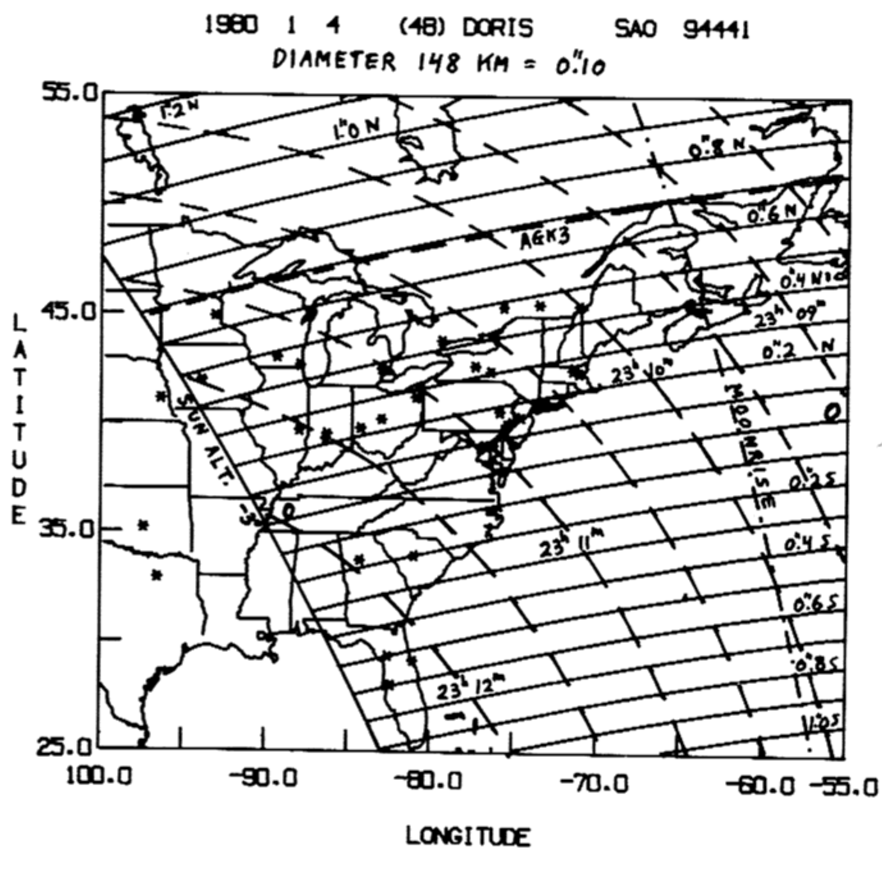




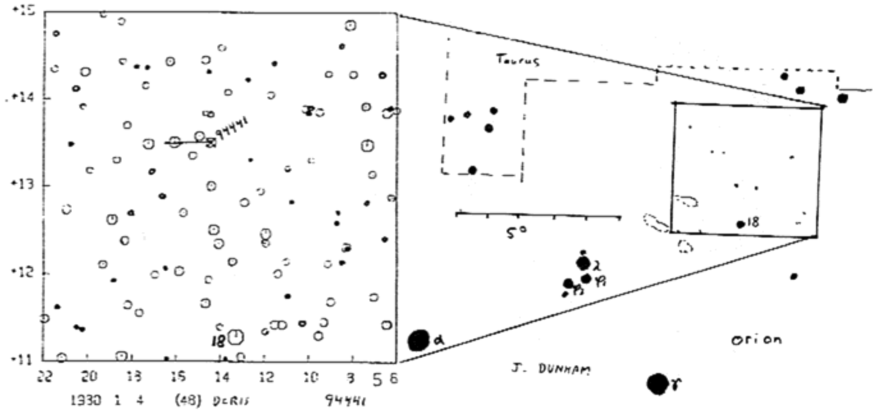
SAO 164575 by Vibilia 1980 Jan 9

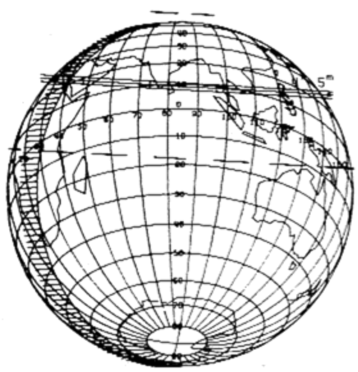


1980 FEV. 14 41 DAPHNE DM+01 2171

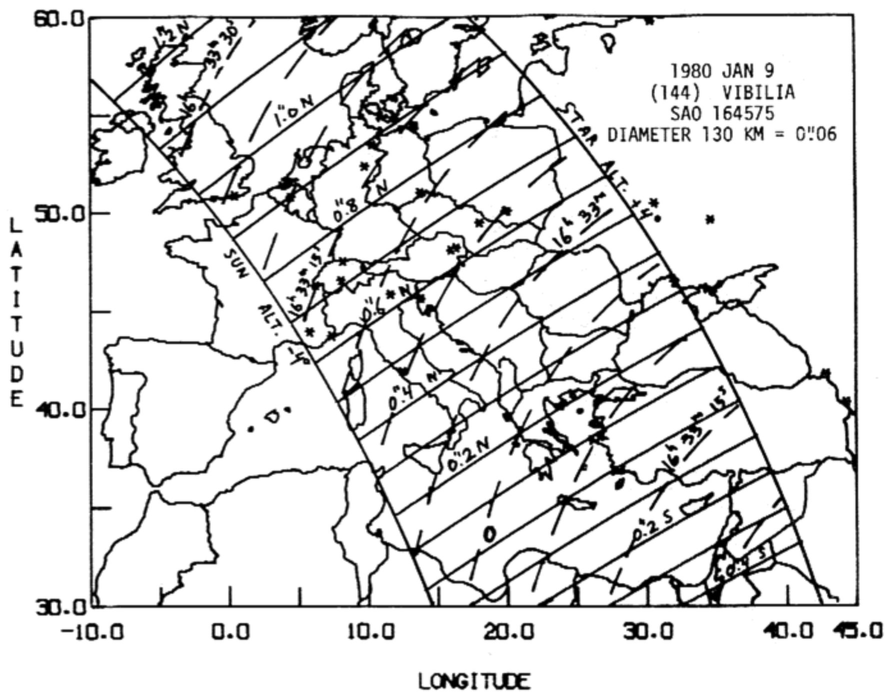


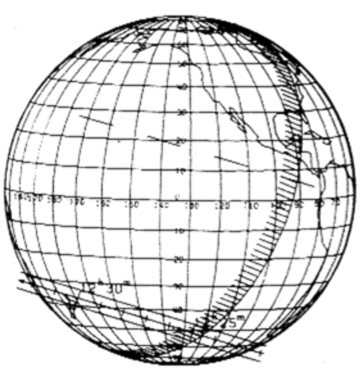
SAO 110282 by Patientia 1980 Jan 1



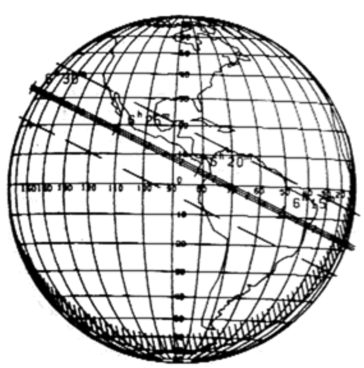


SAO 185342 by Eunomia 1980 Jan 1

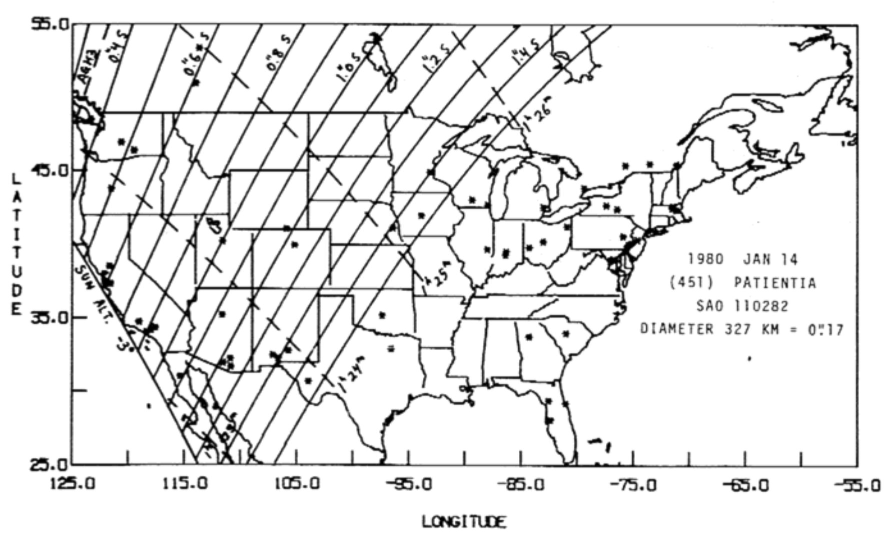


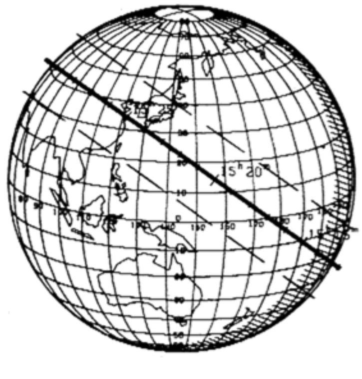


+04° 2534 by Enceladus 1980 Jan 2

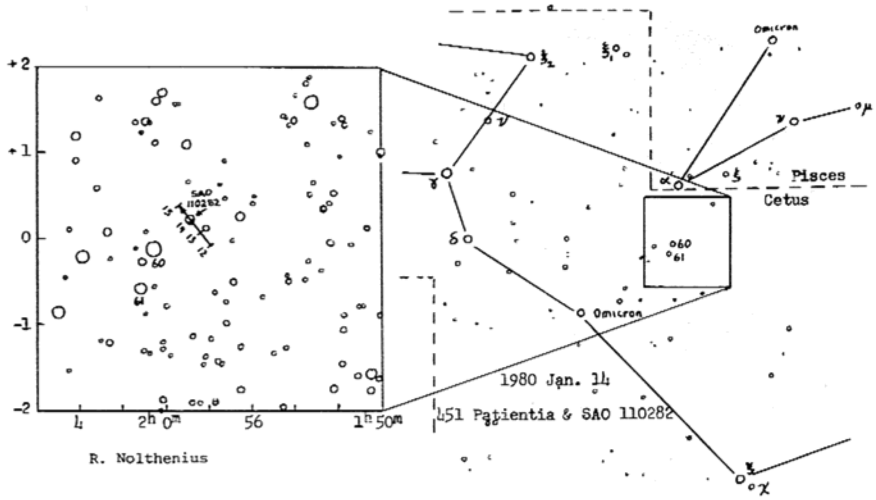


-01° 2190 by Daphne 1980 Jan 28

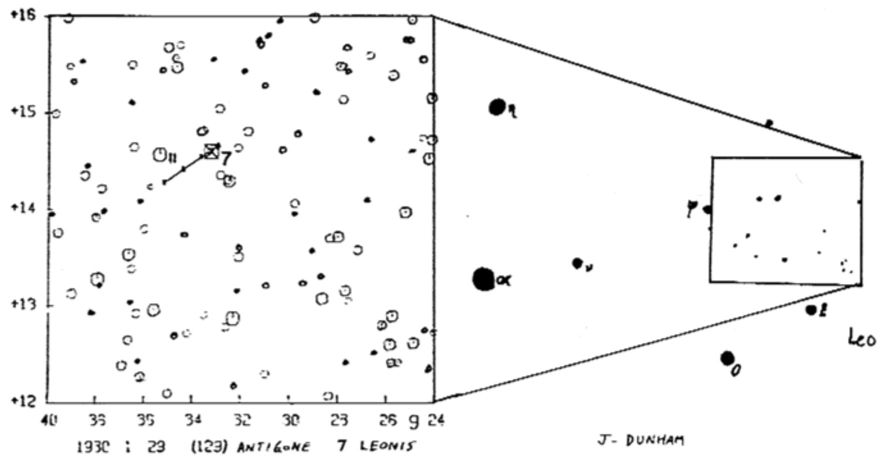


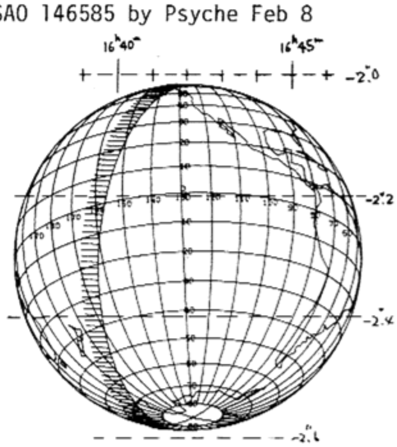


SAO 98662 by Antigone 1980 Jan 2



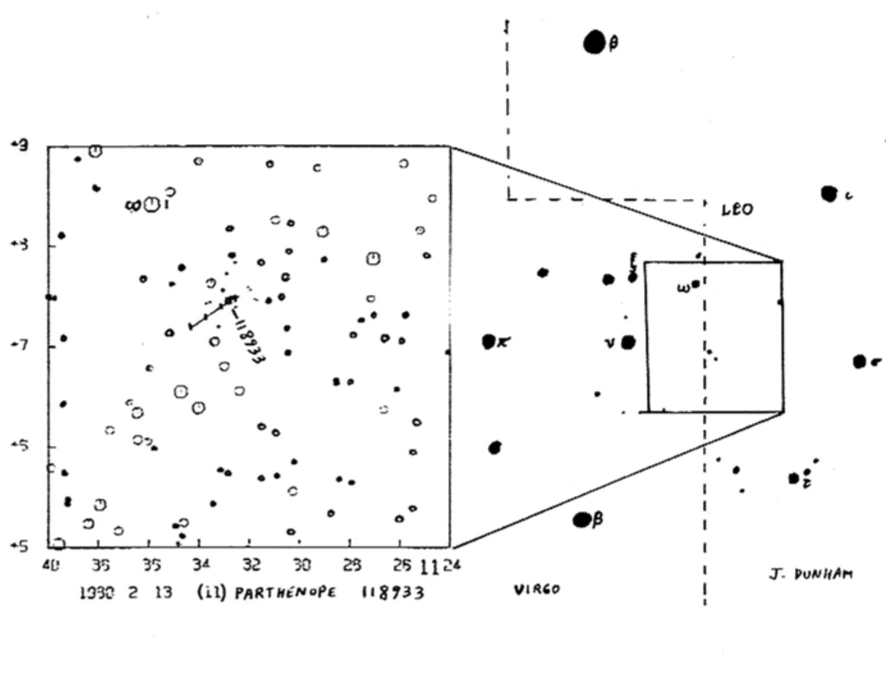
SAO 146585 by Psyche Feb 8

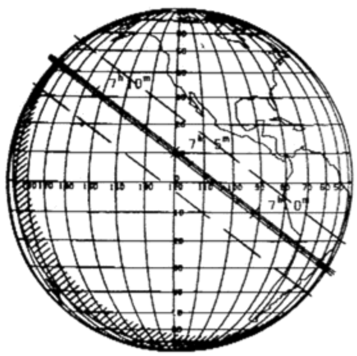




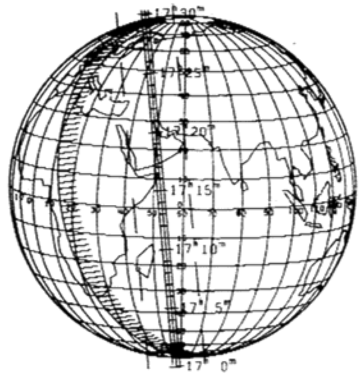
KLM 17 by Neptune 1980 Feb 10

SAO 118933 by Parthenope 1980 Feb 1

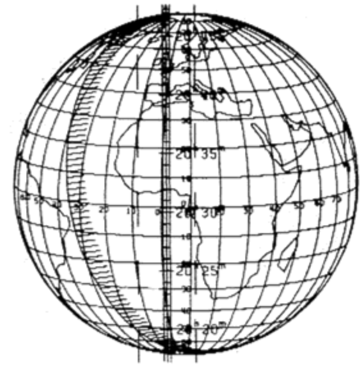




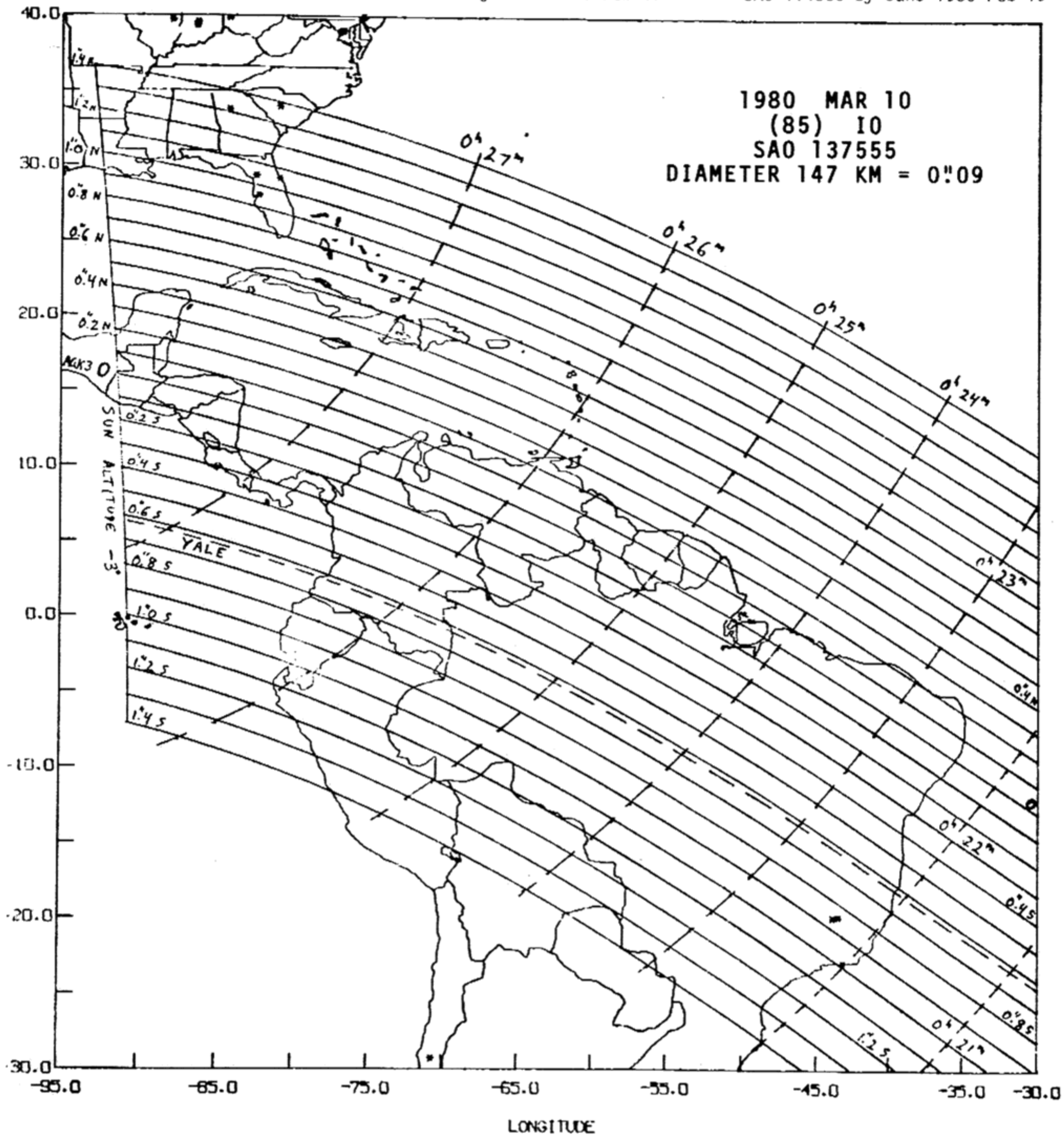
+01° 2171 by Daphne 1980 Feb 14



+07° 1579 by Juno 1980 Feb 17

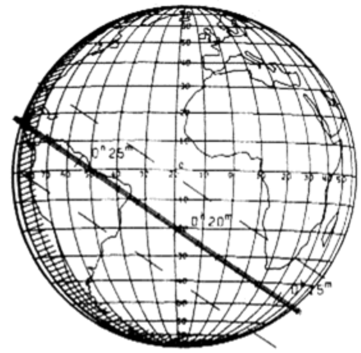


SAO 114860 by Juno 1980 Feb 19

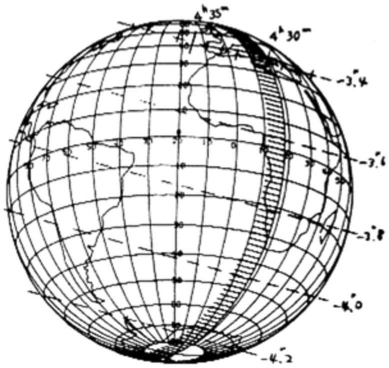


SAO 118854 by Parthenope 1980 Feb 2

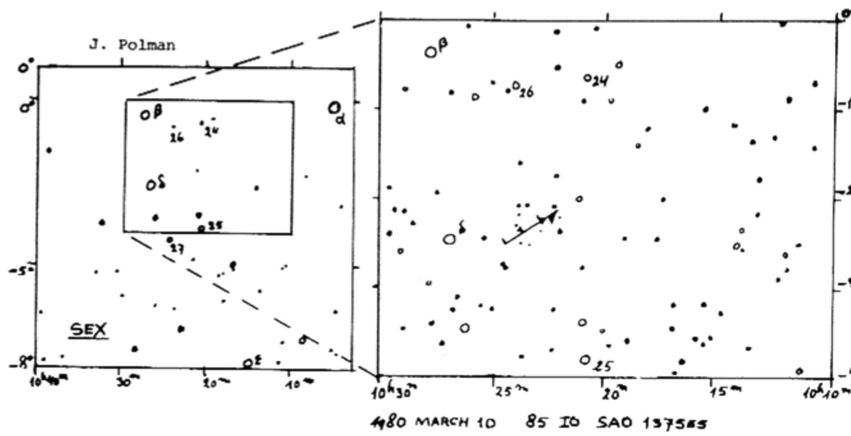
+06° 170 by Massalia 1980 Feb 28

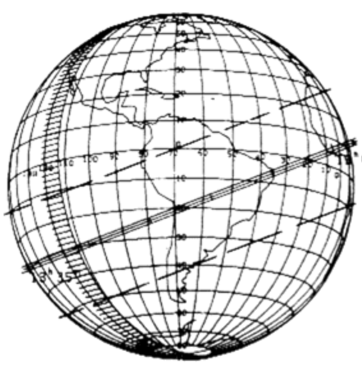


SAO 137555 by Io 1980 Mar 10

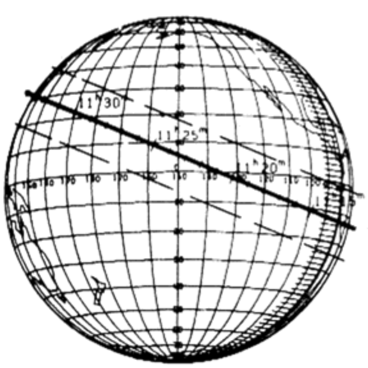


KMU 11 by Uranus 1980 Mar 20





SAO 164340 by Iris 1980 Mar 25



SAO 139513 by Lutetia 1980 Mar 26X

1980 APR 9 (4) VESTA B.D. +17° 671 DIAM. 549 KM = 0".23