Occultation Newsletter

Volume III, Number 2 December, 1982

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 fourth and final issue of 1982.

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

IOTA membership, subscriptions included, is $11.00/year for residents of North America (including Mexico) and $16.00/year for others, to cover costa of overseas air mail. European and U. K. observers should join IOTA/ES, sending DM 20.-- to Hans-J. Bode, Bartold-Knaust Str. 8, 3000 Hannover 91, German Federal Republic.

IOTA NEWS

David W. Dunham

The successful efforts for the asteroidal occultations in November, as well as preparation for my annual articles for *Sky and Telescope*, and the computer-production of graphics for this issue, took much more time than I had anticipated, delaying publication of this issue to much later than I had hoped. By the time you receive this, I probably will be with my parents in Los Alamitos, CA, for the holidays and for the December 30th eclipse. Hence, it will be impossible to turn around any new requests for predictions for the eclipse. However, this should not be a problem, since a call for special eclipse prediction requests was published in the last issue. Unfortunately, most subscribers probably will receive this issue after Christmas, and some will miss it, having left home for the holidays. To the latter, I express my sincere apologies.

The November asteroidal occultations also delayed the mailing of the 1983 data needed by the grazing occultation computors. This, combined with the fact that the number of computors has dropped from seven to five this year, with no new computors becoming operational, means that some of the graze predictions for early 1983, especially the profiles, may be distributed late. We sincerely appreciate the efforts of the currently active computors, who each now are shouldering a larger burden than a year ago: Joseph Senne, Rolla, MO; Walter Morgan, Livermore, CA; Tom Webber, Auburn, WA; Hans Bode, Hannover, German Federal Republic; and Walter Nissen, Takoma Park, MD (who distributes graze predictions which I compute). Two prospective computors are nearing an operational status, and are likely to achieve it in time to help with the 2nd quarter 1983 predictions. This should help eliminate the recurrent problem of late predictions.

John Phelps has prepared a new roster of IOTA members and *O.N.* subscribers. It probably will be distributed soon after this issue. We have tried to include maps and finder charts for asteroidal occultations through the end of 1983 March in this issue, but we probably will distribute the next issue late in February. I promise to include the much-delayed article on new double stars, as well as another summary of grazing occultations, in that issue. In the meantime, we wish all of you happy holidays and clear skies for the December 30th eclipse.

SELECTION OF ASTEROIDS FOR OCCULTATION SEARCHES

David W. Dunham

Most astronomers who are comparing ephemerides of minor planets with star catalog data (usually by computer) to search for asteroidal occultations consider objects according to their expected size. Gordon Taylor recently has been conducting searches for about 180 asteroids with diameters greater than 100 km, while Andrew Lowe has compared ephemerides manually for several objects larger than this size, which Taylor apparently has not considered. My own work, described below, shows that there are over 250 asteroids with diameters greater than 100 km.

In *Astronomical Journal 86*, (12), 1974 (1981 December issue), L. Wasserman, E. Bowell, and R. Millis (of Lowell Observatory) limited their computer searches to 91 objects, most of them 150 km or more in diameter. They argued that these larger asteroids are less likely to deviate significantly from ellipsoidal shapes, so that it is possible to obtain more accurate mean diameters by fitting elliptical models to observations of occultations by these objects. This effect, however, depends on the unknown mass, composition, and material adhesiveness of the asteroid. Some large objects, such as (3) Juno with a diameter of 267 km determined from the well-observed occultation of 1979 December 11 reported in *Astron. J. 86*, 306, have outlines which can deviate substantially from ellipses. Also, the mean diameter is not the only parameter which we try to determine from occultations. We are also interested in unusual shapes, such as those expected for contact binary models predicted for asteroids such as (624) Hektor; secondary events indicating possible satellites; and stellar parameters (angular diameter and close duplicity), all of which are independent of the asteroid size. Alan Harris also points out that the current indirect techniques for determining diameters of asteroids should be calibrated with occultations for some small objects as well as for the larger ones, and suggests that some effort be made to identify favorable occultations by some relatively small asteroids which might occur in areas with many observers.

Secondly, the Lowell astronomers point out that occultations by larger asteroids are more likely to be observed due to the wider ground tracks for these objects. There is no doubt that larger physical size helps, but the occultations that are most likely to be well-observed are those which are predicted most accurately in terms of the path width from last-minute astrometry, and this depends on the angular diameter of the asteroid. Hence, occultations by smaller asteroids can be accurately predicted and observed if they pass close to the earth, as Wasserman *et al.* admit. Consequently, I believe that the maximum possible angular diameter should be considered also when selecting asteroids for occultation searches, not just the physical size.

In the table, I have ranked the asteroids by both physical and maximum angular diameter. The rank is given in the first column. In the second, third, and fourth columns, respectively, the minor planet's number, diameter in km, and maximum angular diameter (computed for opposition at aphelion, assuming that the asteroid is in the ecliptic and the earth is exactly 1 A.U. from the sun) are given for asteroids ranked by physical size (third column). In the last three columns, the same information is given, respectively, for asteroids ranked by maximum angular diameter (last column). The physical diameters are usually those given in the TRIAD file as published in *Asteroids* (University of Arizona Press, 1979, T. Gehrels, ed.). During the last three years, the albedoes (ratios of reflected to incident light, from which diameters can be calculated if absolute magnitudes are also known) and/or types of several asteroids, for which only approximate data are given in TRIAD, have been determined. These usually involve objects ambiguously classified as CMEU, but which now can be assigned C, M, or the new P classification, which has the spectral characteristics of M-type objects, but which are dark (and hence large for their brightness) like C objects. Using the latest information, Edward Tedesco, now at the Jet Propulsion Laboratory, has prepared tables of the types and diameters of all asteroids which probably have diameters of 100 km or more. Tedesco presented these results at I.A.U. Colloquium 75, "Planetary Rings," at Toulouse, France, just after the 18th General Assembly of the I.A.U. in Patras, Greece, where he gave me a copy of the tables, which I have used to update my files. When available, I have used diameters determined from occultation observations instead. If a diameter is not given in either Tedesco's tables or in TRIAD, one has been computed from the magnitude at unit distance, assuming a dark (class C) albedo. Approximate osculating orbital elements, used to calculate the minimum distances needed for the maximum angular diameters, were provided to me in machine-readable form by Conrad Bard-

RANK	NO.	DIAM. KM	ANG. DIAM.	NO.	DIAM. KM	ANG. DIAM
1	1	1025	0".912	1	1025	0".912
2	4	555	0.664	4	555	0.664
3	2	538	0.664	2	538	0.664
4	10	443	0.333	324	256	0.450
5	2060	400	0.073	3	267	0.373
6	704	338	0.295	7	222	0.366
7	511	335	0.279	10	443	0.333
8	65	311	0.210	15	261	0.314
9	52	291	0.231	6	206	0.304
10	451	281	0.212	747	208	0.297
11	87	275	0.177	19	226	0.295
12	31	270	0.257	704	338	0.295
13	250	270	0.219	511	335	0.279
14	3	267	0.373	41	204	0.275
15	15	261	0.314	194	195	0.271
16	324	256	0.450	31	270	0.257
17	107	252	0.155	8	160	0.257
18	45	250	0.229	344	147	0.257
19	16	249	0.227	18	148	0.256
20	13	245	0.251	1036	39.8	0.254
21	130	235	0.226	13	245	0.251
22	624	234	0.081	433	23.0	0.238
23	24	228	0.179	532	217	0.235
24	165	228	0.167	88	222	0.232
25	19	226	0.295	52	291	0.231
26	153	224	0.131	45	250	0.229
27	7	222	0.366	16	249	0.227
28	88	222	0.232	130	235	0.226
29	532	217	0.235	12	135	0.226
30	702	217	0.144	250	270	0.219
31	423	209	0.148	164	111	0.213
32	747	208	0.297	89	168	0.213
33	6	206	0.304	451	281	0.212
34	41	204	0.275	9	168	0.212
35	386	203	0.199	65	311	0.210
36	154	201	0.149	54	177	0.209
37	121	201	0.137	654	112	0.201
38	48	200	0.143	29	199	0.201
39	375	200	0.150	386	203	0.199
40	29	199	0.201	372	196	0.199
41	334	199	0.103	56	142	0.198
42	76	196	0.156	173	169	0.197
43	372	196	0.199	356	157	0.197
44	194	195	0.271	132	86.3	0.194
45	409	194	0.193	521	136	0.194
46	94	191	0.144	409	194	0.193
47	185	188	0.187	393	117	0.188
48	241	187	0.148	185	188	0.187
49	92	184	0.129	405	126	0.186
50	96	183	0.153	105	129	0.186
51	776	183	0.174	36	124	0.185
52	361	181	0.119	78	144	0.185
53	790	178	0.134	70	153	0.185
54	54	177	0.209	419	126	0.184
55	22	175	0.149	247	143	0.183
56	49	175	0.172	14	155	0.182
57	120	175	0.123	410	142	0.182
58	690	175	0.148	20	140	0.182
59	804	175	0.167	187	143	0.181
60	1143	173	0.064	444	167	0.180
61	93	170	0.172	85	149	0.179
62	173	169	0.197	24	228	0.179
63	9	168	0.212	11	155	0.178
64	89	168	0.213	51	156	0.178
65	95	168	0.144	87	275	0.177
66	211	168	0.150	144	132	0.177
67	488	168	0.146	139	165	0.175
68	444	167	0.180	776	183	0.174
69	59	165	0.163	27	118	0.173

RANK	NO.	DIAM. KM	ANG. DIAM.	NO.	DIAM. KM	ANG. DIAM
70	139	165	0".175	49	175	0".172
71	190	165	0.100	93	170	0.172
72	196	162	0.109	192	98.9	0.168
73	8	160	0.257	46	133	0.168
74	39	158	0.149	165	228	0.167
75	617	158	0.063	804	175	0.167
76	1583	158	0.055	556	146	0.164
77	356	157	0.197	471	145	0.163
78	47	156	0.144	59	165	0.163
79	51	156	0.178	111	156	0.162
80	111	156	0.162	694	94.6	0.162
81	117	156	0.113	216	128	0.162
82	354	156	0.147	23	118	0.162
83	11	155	0.178	712	128	0.162
84	14	155	0.182	42	104	0.162
85	238	155	0.130	313	108	0.157
86	911	155	0.056	455	101	0.157
87	70	153	0.185	76	196	0.156
88	137	153	0.144	675	137	0.156
89	146	153	0.137	107	252	0.155
90	536	152	0.094	796	88.3	0.154
91	420	151	0.090	96	183	0.153
92	849	151	0.133	97	109	0.152
93	168	150	0.094	21	114	0.151
94	381	150	0.114	211	168	0.150
95	85	149	0.179	375	200	0.150
96	18	148	0.256	39	158	0.149
97	344	147	0.257	154	201	0.149
98	566	147	0.099	22	175	0.149
99	556	146	0.164	84	86.6	0.148
100	349	145	0.120	423	209	0.148
101	471	145	0.163	241	187	0.148
102	78	144	0.185	690	175	0.148
103	187	143	0.181	141	117	0.148
104	247	143	0.183	145	137	0.147
105	56	142	0.198	354	156	0.147
106	410	142	0.182	5	116	0.146
107	758	142	0.111	488	168	0.146
108	159	141	0.108	47	156	0.144
109	20	140	0.182	779	111	0.144
110	1867	140	0.049	94	191	0.144
111	595	139	0.097	137	153	0.144
112	268	139	0.115	95	168	0.144
113	308	139	0.116	602	139	0.144
114	466	139	0.089	702	217	0.144
115	508	139	0.092	48	200	0.143
116	602	139	0.144	118	108	0.143
117	90	138	0.119	387	113	0.142
118	360	138	0.130	554	104	0.142
119	2241	138	0.050	326	90.3	0.141
120	675	137	0.156	115	94.5	0.141
121	145	137	0.147	53	110	0.141
122	150	137	0.117	40	118	0.140
123	200	137	0.138	626	96.4	0.140
124	209	137	0.094	74	113	0.140
125	521	136	0.194	337	107	0.140
126	12	135	0.226	1021	96.4	0.139
127	618	135	0.098	80	84.2	0.139
128	104	134	0.115	68	128	0.139
129	596	134	0.128	114	131	0.139
130	46	133	0.168	200	137	0.138
131	212	133	0.102	121	201	0.137
132	144	132	0.177	50	88.3	0.137
133	171	132	0.105	146	153	0.137
134	184	132	0.096	156	109	0.135
135	772	132	0.107	751	113	0.135
136	1437	132	0.047	81	122	0.135
137	114	131	0.139	790	178	0.134
138	279	131	0.057	83	118	0.133

well in 1976. Apollo objects with perihelia less than 1 A.U. were not considered. These objects are very small and would require more complex calculations for their minimum distances. Since they pass very close to the earth, the minimum possible distance also would vary considerably as the orbital elements were perturbed by the planets.

It is interesting how some small Amor objects, such as (1036) Ganymed and (433) Eros, can pass close to the earth and have large possible angular diameters, while the large remote object (2060) Chiron has an angular diameter of only 0".073. Only the first 138 rankings are included in the table published here. I can supply a longer list upon request; the rankings were computed for 837 objects with diameters greater than 60 km or with angular diameters possibly larger than about 0".06. I found 256 objects with diameters of 100 km or more (only one, 1981 LK, is an unnumbered minor planet, a Trojan with a diameter of 120 km, assuming a low albedo typical of Trojans, rank 166, and a maximum angular size of 0".044, rank 732; orbital elements based on observations made in 1975 and 1981 are given in MPC 6468), and 591 with diameters of 60 km or more (six of these are unnumbered). 236 asteroids had maximum possible angular diameters of 0".1 or more, while 543 objects were found with maximum angular diameters of 0".06 or more (only one, 1969 OZ), is unnumbered, a main-belt asteroid with maximum angular size of 0".065, rank 478, and diameter 65.8 km, if it has an albedo typical of C-type asteroids; the orbit given in MPC 4716 is based on 3 observations spanning only 28 days in 1969). Since predictions from last-minute astrometry often have been accurate to only a few hundredths of an arc second, it seems that occultations can be predicted for many more objects than have been considered heretofore. I feel that predictions should be extended to some of these smaller asteroids, at least for the brighter stars. But for these objects, the ephemeris errors are generally larger than for the bright objects, possibly so large in some cases that searches for occultations would be meaningless. Also, the accuracy of last-minute astrometry for occultations of bright stars by the smaller (and consequently fainter) asteroids would be degraded by errors introduced by magnitude equation or compensating diffraction gratings. Last-minute astrometry is also hindered by the usually relatively fast angular motion of small but close objects, which also causes short occultation durations. Hence, it is often difficult to time such events to the necessary accuracy (preferably less than 3% of the central occultation duration), especially by visual means.

ASTEROIDAL OCCULTATIONS OF UNCATALOGUED STARS DURING 1983

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

The identification of additional occultations of uncatalogued stars by seven of the largest asteroids, found by scanning photographic plates at Lowell Observatory, was noted on p. 9 of the last issue. A list of 33 events during 1983, found during this search, has been submitted for publication in *Astronomical Journal*, along with a description of the method employed, and notes and a map showing the predicted tracks for some of the more promising events. Since several of the events occur early in

1983 DATE	UNIVERSAL TIME	PLANET NAME	PLANET m_v	PLANET Δ,AU	STAR Lowell #	STAR m_v	STAR R.A.(1950)	STAR Dec.	OCCULTATION Δm	Dur	df	P	Possible Area	El SUN	MOON El	MOON %Snl	MOON Up	Ephemeris Source
Jan 19	12^h27^m-34^m	Europa	10.1	1.79	679853	10.2	$8^h11^m.5$	18°13'	0.7	25^s	22	9	New Zealand, Australia	177°	124°	24+	none	Herget78
Feb 2	14 41	Europa	10.2	1.81	679733	12.3	7 59.8	19 27	0.2	26	24	9	Alaska	165	78	72-	all	Herget78
Feb 6	0 32	Interamnia	12.2	3.24	692822	11.3	13 52.8	-31 26	1.3	28	29	14	Mideast, eastern Africa	98	31	38-	all	EMP 1977
Feb 8	23 25-44	Europa	10.3	1.84	679736	10.5	7 55.2	19 58	0.7	29	27	9	Africa; s.e.USA?n; w. Indies?s	158	158	14-	none	Herget78
Feb 9	19 05-21	Europa	10.3	1.85	679737	12.3	7 54.6	20 02	0.2	30	28	9	China, w. U.S.S.R., Scandinavia	157	168	9-	none	Herget78
Feb 13	5 03-20	Europa	10.4	1.87	679740	11.1	7 52.5	20 17	0.5	33	30	9	Patagonia, Marquesas Islands	153	150	0+	none	Herget78
Feb 17	5 04	Interamnia	12.1	3.08	692831	12.3	13 54.9	-32 33	0.7	40	40	13	Mediterranean?w; n. Africa?w	108	146	16+	none	EMP 1977
Mar 18	7 15-21	Interamnia	11.8	2.74	692849	11.4	13 48.1	-34 17	1.0	36	35	12	southern Brazil?n; Patagonia	135	155	13+	none	EMP 1977
Mar 19	9 46-73	Europa	11.0	2.20	679758	11.7	7 46.5	21 54	0.5	66	66	11	Japan, Alaska?n; California	117	61	22+	150°W	Herget78
Mar 27	17 52	Davida	12.6	3.82	680704	10.8	19 20.5	-18 26	2.0	16	19	17	Antarctica; Austrl?n; New Zlnd?n	77	117	98+	w164 E	EMP 1982

Table 1 is above.

Table 2 is below.

1983 DATE	MINOR PLANET No.	NAME	PLANET km-diam.	-"	RSOI	MOTION °/Day	PA	COMPARISON DATA A. C.	Number	Shift	Time	APPARENT R.A.	Dec.
Jan 19	52	Europa	291	0.22	1774	0.219	294°	+18°	8^h08^m92	-2".34	1.9	$8^h13^m.4$	18°07'
Feb 2	52	Europa	291	0.22	1777	0.201	295					8 01.8	19 21
Feb 6	704	Interamnia	339	0.14	2830	0.125	149					13 54.7	-31 36
Feb 8	52	Europa	291	0.22	1778	0.178	296	+20°	7^h52^m82	-1.78	2.2	7 57.1	19 53
Feb 9	52	Europa	291	0.22	1778	0.174	296	+20°	7 52 69	-3.25	6.2	7 56.6	19 56
Feb 13	52	Europa	291	0.21	1779	0.158	297	+20	7 52 31	-1.57	5.7	7 54.4	20 12
Feb 17	704	Interamnia	339	0.15	2828	0.092	170					13 56.8	-32 42
Mar 18	704	Interamnia	339	0.17	2820	0.114	259					13 50.0	-34 26
Mar 19	52	Europa	291	0.18	1789	0.067	71	+22°	7^h44^m70	-1.36	4.2	7 48.5	21 49
Mar 27	511	Davida	335	0.12	2945	0.177	88					19 22.4	-18 22

1983, predictions for January through March are being published here prior to their appearance in *Astron. J.*, to give observers more time for planning. Events during the last nine months of 1983 will be published in the next issue, by which time they should have appeared in *Astron. J.* Some information about the two events most favorable for visual observers in North America, involving (52) Europa on April 26 and (451) Patientia on September 14, will be given in Dunham's article on 1983 planetary occultations in the January issue of *Sky and Telescope*. All of these events are included in the planetary occultation appulse local circumstance predictions for 1983 now being distributed by Joseph Carroll. All events were found by the first four authors at Lowell, but the predictions listed here were calculated by Dunham. There is good agreement with Lowell calculations for most events, with some differences caused by slightly differing ephemerides.

The format of the two tables is the same as that for the other 1983 events listed on pages 10-13 of the last issue, with the following changes: The star number assigned by Lowell is given in place of the SAO number, since none of the stars are in either the SAO or AGK3 catalogs. The first four digits specify the Lowell plate, while the last two give its number on the plate. The spectral types of the stars are unknown, so that column is omitted. Note that Δm's less than 1 will be difficult to detect visually. For these relatively faint stars, Δm's less than 0.7 likely will be impossible visually.

The second table is shorter, since no information about the stellar diameters is available. The type of all seven asteroids involved is C. Although some of the brighter stars may be in the B.D. or C.D. catalogs, we have not checked this, so the DM No. column has been omitted. Also, we have not checked for stellar duplicity, and measurements from Lowell plates are the source for all of the star positions (source L). Positions from *Astrographic Catalog* (A.C.) data are available for most of the stars occulted by (52) Europa, so comparison data and A.C. identifications are given for these stars. The first three A.C. numbers specify the equinox 1900 plate center (degrees of declination and hours and minutes of right ascension) of the Paris Observatory plate, while the fourth number is the star's number on the plate as given in the A.C. There is a rather large systematic discrepancy between the Lowell and A.C. positions, with the latter farther north (shifting the paths south). Measurements of Lick Observatory plates, reduced to the FK4 via AGK3R reference stars, will result in better positions for some of these stars, and resolve the discrepancies.

Finder charts for some of these occultations will be published in this, and future, issues of *O.N.* The charts for the occultations by (52) Europa have been prepared from Paris A.C. data, which extend approximately to photographic mag. 12.5. Underlined stars on the A.C. plots are stars in the AGK3, not double stars, which are underlined on the more frequent AGK3 and SAO-based finder charts. Some regional maps also are published here. World maps by Sôma will be published when they become available, probably in time to appear in this issue.

Notes about Individual Events

Jan. 19: If the A.C. position for the star is used, the path misses the earth's surface to the south.

Feb. 8: The A.C. path crosses South Africa and northern South America.

Feb. 9: The A.C. path crosses northwestern

Australia and northern Africa.

Feb. 13: The A.C. path crosses no land in the southeastern Pacific Ocean.

Mar. 19: The A.C. path lies entirely within the Pacific Ocean, passing just north of Hawaii.

1978 TOTAL OCCULTATION TALLY

Joseph E. Carroll

The following two tables — one by country and one by individual — present the ordered counting of total occultations reported for the year 1978. In the individual list, the Japanese photoelectric observations (probably the Sirahama Observatory) and the McDonald Observatory observations (also photoelectric) are due to multiple observers. The leading lone observer, therefore, is K. G. Fuhr from Cape Town, South Africa, followed by Hays of the USA and Wieth-Knudsen of Denmark.

The values again were computed (as since 1975) via the formula: Value = Total + C × Reappearances, where C is the ratio of total disappearances to total reappearances minus one. In 1978, 494 plus (the number of U.S.S.R. observers is unknown) observers from 35 countries reported 9966 observations, of which 2657 were reappearances. That makes C = 1.75, or reappearances are weighted over disappearances by the factor 2.75. (Country names as of 1978.)

RNK	VALUE	TOTAL	R'S	COUNTRY	OBS.
1	4317.0	2903	808	U.S.A.	108
2	1797.8	1047	429	Japan	26
3	1054.8	766	165	New Zealand	40
4	866.8	592	157	U.S.S.R.	?
5	822.5	539	162	South Africa	6
6	736.0	616	80	Australia	31
7	734.0	503	132	England	47
8	505.5	306	114	Denmark	13
9	460.0	271	108	Rhodesia	5
10	407.0	316	52	Germany	29
11	320.3	231	51	Portugal	5
12	319.3	244	43	Italy	19
13	305.5	176	74	Belgium	10
14	264.3	203	35	Netherlands	19
15	248.3	194	31	Austria	40
16	178.5	168	6	Czechoslovakia	45
17	170.0	93	44	Canada	6
18	165.5	106	34	Argentina	2
19	161.0	119	24	Spain	3
20	150.5	98	30	Switzerland	5
21	143.3	103	23	Philippines	6
22	128.3	109	11	Brazil	5
23	92.5	75	10	Namibia	1
24	78.5	61	10	Norway	8
25	34.3	29	3	Yugoslavia	1
26	28.8	20	5	Eire	1
27	22.0	15	4	Greece	2
28	21.0	14	4	Finland	3
29	17.5	14	2	Mexico	2
30	11.0	11	0	Iraq	1
31	10.3	5	3	Scotland	1
32	9.5	6	2	Israel	1
33	6.0	6	0	Dominican Rep.	1
34	4.8	3	1	Bermuda	1
35	4.0	4	0	Chile	1
TOTALS		9966	2657		494+?

In the table of individual observers, blanks for names occur where observations were listed on the

(text continues on page 29)

RNK	VALUE	OBSERVER	LOCATION	TOTAL	REAP
1	692.5	PHOTOELECTRIC	JAPAN,	409	162
2	574.2	K. G. FUHR	S. AFRICA, CAPE TOWN	324	143
3	459.7	ROBERT H. HAYS, JR.	U.S.A., WORTH, ILLINOIS	255	117
4	421.5	DAVID EVANS, ET AL	U.S.A., MCDONALD OBS., TEX.	313	62
5	293.7	N. P. WIETH-KNUDSEN	DENMARK, TISVILDELEJE	145	85
6	266.0	J VINCENT	RHODESIA, SALISBURY	154	64
7	240.5	ALFREDINA DO CAMPO	PORTUGAL, LISBON OBSERVATORY	160	46
8	207.5	T. ZYO.	JAPAN,	99	62
9	207.2	NOEL MUNFORD	NEW ZEALAND, PALMERSTON NOR.	132	43
10	198.2	ROBERT CLYDE	U.S.A., STREETSBORO, OHIO	95	59
11	189.5	ROBERT LASCH	U.S.A., GREEN VALLEY ARIZONA	95	54
12	189.2		U.S.A., DENVER, COLORADO	107	47
13	187.7	PAUL L. MCBRIDE	U.S.A., GREEN FOREST, ARKANS	137	29
14	179.5	Y. KIMOTO	JAPAN, SIMAGAWA	127	30
15	178.5	ROBERT H. SANDY	U.S.A., KANSAS CITY, MISSOURI	112	38
16	178.5	BEN HUDGENS	U.S.A., CLINTON, MISSISSIPPI	154	14
17	174.0	JEAN BOURGEOIS	BELGIUM, MONTIGNES-LE-TILLEU	90	48
18	171.7	K BLACKWELL	ENGLAND, WESTHAM, SUSSEX	100	41
19	161.0	DAVID HERALD	AUSTRALIA, CANBERRA	112	28
20	147.2	A MORRISBY	RHODESIA, SALISBURY	79	39
21	142.7	RICHARD NOLTHENIUS	U.S.A., MOUNTAIN VIEW, CALIF.	92	29
22	135.2	AMBROSIO JUAN CAMPONOVO	ARGENTINA, BUENOS AIRES	81	31
23	134.5	JAMES H. VAN NULAND	U.S.A., SAN JOSE, CALIF.	124	6
24	129.5	DAVID D. BROWN	CANADA, MCGILL UNIV. OBS.	63	38
25	123.7	T. MIY.	JAPAN,	73	29
26	123.5	HANS-JOACHIM BODE	GERMANY, HANNOVER	92	18
27	122.7	GRAHAM L. BLOW	NEW ZEALAND, BLACK BIRCH	79	25
28	122.7	P ANDERSON	AUSTRALIA, BRISBANE	121	1
29	120.7	T. YAT.	JAPAN,	49	41
30	116.5	Y. KOM.	JAPAN,	57	34
31	110.0	A. SUZUKI	JAPAN, SIRAHAMA	61	28
32	107.7	G. HERDMAN	NEW ZEALAND, AUCKLAND	57	29
33	106.7	F ZEHNDER	SWITZERLAND, BIRMENSTORF	63	25
34	104.7	DON M. STOCKBAUER	U.S.A., VICTORIA, TEXAS	75	17
35	99.5	JOSEPH E. CARROLL	U.S.A., MINNETONKA, MINNESOTA	40	34
36	92.5	E SAWYER	NAMIBIA, WINDHOEK	75	10
37	91.0	LIONEL E. HUSSEY	NEW ZEALAND, CHRISTCHURCH	56	20
38	86.5	STEVE J. ZVARA	U.S.A., WHITTIER, CALIFORNIA	69	10
39	85.7		NETHERLANDS, STREEFKERK	63	13
40	83.0	JOSE RIPERO OSORIO	SPAIN, MADRID	69	8
41	82.0	CLIFFORD J. BADER	U.S.A., WEST CHESTER, PA.	47	20
42	80.5	PAUL J. NEWMAN	U.S.A., DALLAS, GARLAND, TEXAS	49	18
43	78.7	L PAZZI	S. AFRICA, NIGEL TVL.	56	13
44	76.5	JAMES L. FERREIRA	U.S.A., FREMONT, CALIF.	66	6
45	76.2	J DOMMANGET	BELGIUM, BRUSSELS, R. OBS.	50	15
46	75.0		U.S.A., DENVER, COLORADO	47	16
47	74.0	DOUGLAS HALL	ENGLAND, LEICESTER	53	12
48	73.5	RICHARD BINZEL	U.S.A., ST. PAUL, MINNESOTA	42	18
49	72.0	ALFRED C. WEBBER	U.S.A., CHADDS FORD, PA.	58	8
50	72.0	H KRUMM	S. AFRICA, LANGEBAAN	72	0
51	68.0	RICHARD RADICK	U.S.A., OAKLAND, ILLINOIS	33	20
52	65.7		ITALY, ROME	50	9
53	63.2	Y. GANEKO	JAPAN, TOKYO	44	11
54	61.5	GLEN ROWE	NEW ZEALAND, GISBORNE	58	2
55	61.2		AUSTRALIA, COOTAMUNDRA	35	15
56	61.2	P. MAEGRAITH	AUSTRALIA, MAGILL	42	11
57	61.0	M BECH	DENMARK, COPENHAGEN	47	8
58	61.0	B BRIDGE	AUSTRALIA, BRISBANE	61	0
59	60.0	FRANK OLSEN	U.S.A., MARION, IOWA	46	8
60	59.7	JOSEPH ZODA	U.S.A., MAPLE PARK, ILL.	30	17
61	56.5	ROBERT N. BOLSTER	U.S.A., ALEXANDRIA, VA.	39	10
62	55.5	E KARKOSCHKA	GERMANY, STUTTGART SWABIAN	31	14
63	52.7	JORGE POLMAN	BRAZIL, RECIFE	51	1
64	52.0		ITALY, ROME	31	12
65	50.5	H. F. DABOLL	U.S.A., ST.CHARLES, ILL.	26	14
66	49.5	HARRY WILLIAMS	NEW ZEALAND, AUCKLAND	39	6
67	49.5		AUSTRALIA, BRISBANE	46	2
68	49.0	JUAN D. SILVESTRE	PHILIPPINES, QUEZON CITY	49	0
69	45.7	A MACDONALD	AUSTRALIA, TOWNSVILLE	44	1
70	45.0		SPAIN, SAN FERNANDO OBS.	24	12
71	43.7		NETHERLANDS, ZOETERMEER	35	5
72	43.7	GERRY ALLCOTT	NEW ZEALAND, AUCKLAND	35	5
73	43.5	CESARIO E. TAGANAS	PHILIPPINES, QUEZON CITY	19	14
74	42.2	RADICK AND LIEN	U.S.A., OAKLAND, ILLINOIS	16	15
75	42.0	EZEQUIEL CABRITA	PORTUGAL, LISBON OBSERVATORY	35	4
76	42.0	JAN HERS	S. AFRICA, RANDBURG	35	4
77	39.5	L BRUNDLE	ENGLAND, HAYWARDS HEATH	22	10
78	39.5	TOM VAN FLANDERN	U.S.A., WASHINGTON, D.C.	29	6
79	38.5		S. AFRICA, JOHANNESBURG	35	2
80	38.2	HARALD MARX	GERMANY, KORNTAL-MUNCHINGEN	33	3
81	38.0	N WHITE	U.S.A., FLAGSTAFF LOWELL OBS.	38	0
82	36.7	DAVID BROCK	NEW ZEALAND, AUCKLAND	28	5
83	36.5		U.S.A., MORONGO VALLEY, CALIF.	26	6
84	35.5	W MELLOR	ENGLAND, SHEFFIELD	18	10
85	35.2	MARTIN KNITSCH	GERMANY, HANNOVER	30	3
86	34.2	V PROTIC-BENISEK	YUGOSLAVIA., BELGRADE OBS.	29	3
87	34.0	H. F. COCHRAN	U.S.A., BROWNWOOD, TEXAS	34	0
88	33.2		U.S.A., WISCONSIN, UNIVERSITY	14	11
89	33.0	A SALAZAR	SPAIN, SAN FERNANDO OBS.	26	4
90	33.0	J. POGODA	CZECH., OHOMOUC OBS.	33	0
91	32.7		BRAZIL, BELO HORIZONTE	24	5
92	32.7	E HALBACH	U.S.A., MILWAUKEE, WIS.	24	5
93	32.5	VICTOR J. SLABINSKI	U.S.A., ARLINGTON, VIRGINIA	29	2
94	32.0	V PASCOLI	ITALY, UDINE	18	8
95	32.0	JOHN S. KORINTUS	U.S.A., PALM BAY, FLORIDA	32	0
96	31.7	B. NIKOLAU	NEW ZEALAND, PALMERSTON NO.	30	1
97	31.0		U.S.A., DUBLIN, CALIFORNIA	17	8
98	30.7	O MIDTSKOGEN	NORWAY, TRANBY	29	1
99	30.7		RHODESIA, SALISBURY	29	1
ENG	0.0	ASHAMPSTEAD	4 0		
100	30.3	EDUARDO VALENTIN PRZYBYL	ARGENTINA, RAFAELA	25	3
101	29.7	S INCIONG	PHILIPPINES, MANILA	14	9
102	29.7	T. STO.	JAPAN,	28	1
103	29.5		ENGLAND, SHEERNESS	19	6
104	28.7	MICHAEL C. ASHLEY	AUSTRALIA, CANBERRA	13	9
105	28.7	DAVID STEICKE	AUSTRALIA, MURRAY BRIDGE	20	5
106	28.7		EIRE, NEW ROSS	20	5
107	28.5	MARK TAYLOR	ENGLAND, WAKEFIELD	18	6
108	28.2		ENGLAND, WIMBORNE	16	7

RNK	VALUE	OBSERVER	LOCATION	TOTAL	REAP
109	28.2	T. TAKEMURA	JAPAN, KURASIKI	16	7
110	28.0	ROGER H. GILLER	AUSTRALIA, ENGADINE	28	0
111	28.0	J SMITH	U.S.A., WACO, TEXAS	28	0
112	27.7	MAURICE STOKER	NEW ZEALAND, AUCKLAND	26	1
113	27.5	O KLINTING	DENMARK, RINGSTED	17	6
114	27.5		ITALY, MILAN	24	2
115	26.2	A PIKHARD	AUSTRIA, VIENNA	21	3
116	25.7	D. HALL	NEW ZEALAND, BLACK BIRCH	10	9
117	25.7		ENGLAND, BRACKNELL	17	5
118	25.7	B SOULSBY	AUSTRALIA, CANBERRA	24	1
119	25.5	GEORGE WINGATE	NEW ZEALAND, AUCKLAND	15	6
120	25.5	T. WHELAN	NEW ZEALAND, TKORANGI	22	2
121	25.2	D SCHMIDT	NETHERLANDS, HUIZEN	13	7
122	25.0	H PACHALI	GERMANY, BERLIN NEUKOLLN	25	0
123	24.2		U.S.A., WISCONSIN, UNIVERSITY	12	7
124	24.0		U.S.A., YOUNGSTOWN, OHIO	10	8
125	24.0	G. PATTERSON	NEW ZEALAND, CHRISTCHURCH	24	0
126	23.2		GERMANY, BORKEN - DILLICH	18	3
127	23.0	M THOMAS	NEW ZEALAND, DUNEDIN	23	0
128	22.7		DENMARK, VIBY, JUTLAND	14	5
129	22.7		ENGLAND, LEEDS	14	5
130	22.2	CARL GRUNNET	DENMARK, VIRUM	17	3
131	22.2	RONALD W. CROSS	NEW ZEALAND, CHRISTCHURCH	17	3
132	22.0	I. V. FREITAS	BRAZIL, RECIFE	15	4
133	22.0		ENGLAND, MALVERN	22	0
134	22.0	A. W. DODSON	NEW ZEALAND, OTAKI	22	0
135	21.7	C CANNON JR	U.S.A., SAN FRANCISCO, CALIF.	13	5
136	21.7	WILLIAM J. WESTBROOKE	U.S.A., SAN FRANCISCO, CALIF.	13	5
137	21.5	J MORGAN	ENGLAND, CAMBRIDGE OBS.	18	2
138	21.2		AUSTRIA, WIENER NEUSTADT	16	3
139	21.0	DEMETRIUS P. ELIAS	GREECE, PENTELI	14	4
140	21.0	JOSE OSORIO	PORTUGAL, PORTO UNIV. OBS.	21	0
141	21.0		U.S.A., BEREA	21	0
142	20.2		AUSTRIA, VIENNA	15	3
143	20.0	R MIDDLETON	ENGLAND, COLCHESTER	13	4
144	19.7		U.S.A., GRAND RAPIDS,MICHIGA	11	5
145	19.7	V RASMUSSEN	DENMARK, KOLDING	18	1
146	19.5	G MORSE	ENGLAND, MAIDENHEAD	16	2
147	19.5		ITALY, ANCONA	16	2
148	19.5	D. GOODMAN	NEW ZEALAND, CARTER OBS.	16	2
149	19.2	H. TOMIOKA	JAPAN, HITACHI	14	3
150	19.0		AUSTRIA, GRAZ	12	4
151	19.0		ITALY, PADOVA	12	4
152	19.0	BRUCE RUSNAK	U.S.A., ST. PAUL, MINNESOTA	12	4
153	19.0	F CERCHIO	ITALY, RIVALBA, NR. TURIN	19	0
154	19.0	JOHN A. CHURCH	U.S.A., PRINCETON JUNC., N.J.	19	0
155	18.7		ENGLAND, WOOLHAMPTON	17	1
156	18.5		NORWAY, LANGENESBYGDA	8	6
157	18.5	ROBERT GERMANN	SWITZERLAND, WALD	15	2
158	18.0	C REID	CANADA, SELKIRK, MANITOBA	11	4
159	18.0		ITALY, NAPLES	18	0
160	17.7		DENMARK, HARNDRUP	9	5
161	17.7	W ALBRECHT	U.S.A., MILWAUKEE, WIS.	9	5
162	17.7	A VAN DER DRIFT	NETHERLANDS, SOESTDIJK	16	1
163	17.0	M. KAWADA	JAPAN, TOKYO	10	4
164	17.0	R BOSCHLOO	NETHERLANDS, LAREN	17	0
165	17.0	G MARSHALL	S. AFRICA, JOHANNESBURG	17	0
166	17.0		U.S.A., SOLON, OHIO	17	0
167	16.7	K. HON.	JAPAN,	15	1
168	16.7	J VAN DER MEULEN	NETHERLANDS, WOGNUM	15	1
169	16.5		U.S.A.,	6	6
170	16.5	A WELLS	ENGLAND, BIRMINGHAM	13	2
171	16.5	F DIEGO	MEXICO, MEXICO D.F.	13	2
172	16.5		U.S.A., WISCONSIN, UNIVERSITY	13	2
173	16.2		AUSTRIA, ST LEONHARD(POLTEN)	11	3
174	16.2	MATTI SUHONEN	FINLAND, HELSINKI	11	3
175	16.0	DIETMAR BUTTNER	GERMANY, EILENBURG	9	4
176	16.0	J MEDSKER	U.S.A., BUCHANAN, MICHIGAN	16	0
177	15.0	T. HIRAIWA	JAPAN, KURASIKI	8	4
178	15.0	SOUKUPOVA	CZECH., PRAHA OBS.	15	0
179	15.0	RICHARD SCHMIDT	U.S.A., WASHINGTON, D.C.	15	0
180	14.7	K. KENMOTU	JAPAN, SIMOSATO	6	5
181	14.5		AUSTRIA, VIENNA	11	2
182	14.5		ENGLAND, EASTBOURNE	11	2
183	14.5	H LUFT	U.S.A., OAKLAND GARDENS, N.Y.	11	2
184	14.0	A HILTON	RHODESIA, SALISBURY	7	4
185	14.0	W. H. ROBERTSON	AUSTRALIA, SYDNEY, N.S.W.	14	0
186	13.7	P.C.A. BARRETTO	BRAZIL, RECIFE	12	1
187	13.5	PAUL TEICHER	U.S.A., FARMINGDALE,L.I.,N.Y.	10	2
188	13.5	D SCOTT	U.S.A., PANAMA CITY, FLORIDA	10	2
189	13.2	MICHELLE L. KLEINRICHERT	U.S.A., ST. PAUL, MINNESOTA	8	3
190	12.7	ROLAND BONINSEGNA	BELGIUM, CHARLEROI(MARCINELLE)	11	1
191	12.7		PORTUGAL, LISBON OBSERVATORY	11	1
192	12.7	X WILLI	SWITZERLAND, OBEREHRENDINGEN	11	1
193	12.7	W. OSBORN	U.S.A., MT PLEASANT, MICHIGA	11	1
194	12.5	J PEDLER	ENGLAND, BRISTOL	9	2
195	12.2	V TANGNEY	U.S.A., MILWAUKEE, WIS.	7	3
196	12.0	KLAUS KLEBERT	GERMANY, SCHMIDEN/STUTTGART	12	0
197	12.0		U.S.A., COLUMBUS, OHIO	12	0
198	11.7	GEOFFREY W. AMERY	ENGLAND, READING	10	1
199	11.5	T. KAZ.	JAPAN,	8	2
200	11.5	G. COULING	NEW ZEALAND, TAWA	8	2
201	11.2		NORWAY, BRANDAL	6	3
202	11.0	JEAN SCHWAENEN	BELGIUM, CHARLERO, HAINAUT	4	4
203	11.0		AUSTRALIA, GEELONG	11	0
204	11.0		AUSTRIA, VIENNA	11	0
205	11.0	KYRIL W. FABRIN	DENMARK, AALBORG	11	0
206	11.0	M ABDULAHAD	IRAQ, BASRAH	11	0
207	11.0		NETHERLANDS, GOUTUM	11	0
208	11.0	D. KOLB	U.S.A., MT PLEASANT, MICHIGA	11	0
209	10.7		DENMARK, COPENHAGEN	9	1
210	10.7	C KAPRAL	U.S.A., PARLIN NEW JERSEY	9	1
211	10.5	B. MALECEK	CZECH., VALASSKE MEZIRICI OBS.	7	2
212	10.5	I. COOPER	NEW ZEALAND, PALMERSTON NOR.	7	2
213	10.2	E RAUSCHER	AUSTRIA, VIENNA	5	3
214	10.2		NETHERLANDS, HUIZEN	5	3
215	10.2	R EBERST	SCOTLAND, EDINBURGH	5	3
216	10.0	P DARNELL	DENMARK, COPENHAGEN	10	0
217	10.0	C BRUNT	ENGLAND, CAMBRIDGE OBS.	10	0
218	10.0	D PETTITT	ENGLAND, CARLISLE	10	0
219	10.0	G TAYLOR	ENGLAND, NEAR HERSTMONCEUX	10	0
220	10.0		ITALY, FLORENCE	10	0
221	10.0	JAMES E. BROOKS	U.S.A., CHATHAM, VIGINIA	10	0
222	9.7		AUSTRIA, ST JOHANN (TIROL)	8	1
223	9.7	P GOODWIN	U.S.A., SHREVEPORT, LOUISIANA	8	1
224	9.5	M ALON	ISRAEL, YAVNE	6	2
225	9.5	W. KULLI	SWITZERLAND, KONIZ UND LEYSIN	6	2
226	9.5	WAYNE H. WARREN JR.	U.S.A., GREENBELT, MARYLAND	6	2
227	9.2		U.S.A., MILWAUKEE, WIS.	4	3
228	9.0	ROGER LAUREYS	BELGIUM, DIEPENBEEK	9	0
229	9.0	PALKA	CZECH., PRAHA OBS.	9	0
230	9.0	E OTTO	GERMANY, EILENBURG	9	0
231	9.0		ITALY, ROME	9	0
232	9.0	BARRY MENZIES	NEW ZEALAND, AUCKLAND	9	0
233	9.0		U.S.A., SAN FRANCISCO UNIV.	9	0
234	9.0	C PERKALL	U.S.A., WEST PALM BEACH, FLA	9	0
235	8.7		CANADA, QUEBEC	7	1
236	8.5		AUSTRIA, MISTELBUCH	5	2
237	8.5		ENGLAND, WALES, PRESTATYN	5	2
238	8.2		U.S.A., TAMPA, FLORIDA	3	3
239	8.2	DAVID LIEN	U.S.A., OAKLAND, ILLINOIS	3	3
240	8.0	SOBRA	CZECH., PRAHA OBS.	8	0
241	8.0	W CAUNTER	ENGLAND, TOTNES DEVON	8	0
242	8.0		ITALY, TURIN	8	0
243	8.0		NETHERLANDS, GRONINGEN,KAPTEYN	8	0
244	8.0	J.B. MACKIE	NEW ZEALAND, NELSON, STOKE	8	0
245	8.0	ERNESTO V. CALPO	PHILIPPINES, QUEZON CITY	8	0
246	8.0	B MARTINEZ	PHILIPPINES, MANILA	8	0
247	8.0		U.S.A., EAU CLAIRE, WISCONSI	8	0
248	8.0		U.S.A., EAU CLAIRE, WISCONSI	8	0
249	8.0		U.S.A., EAU CLAIRE, WISCONSI	8	0
250	8.0	N MCKINNON	U.S.A., PANAMA CITY, FLORIDA	8	0
251	7.7	K SILBER	AUSTRIA, GMUNDEN	6	1
252	7.7		AUSTRIA, VIENNA	6	1
253	7.7		ITALY, BOLOGNA	6	1
254	7.7	P. KILBEY	NEW ZEALAND, AUCKLAND	6	1
255	7.7	D HOUGH	U.S.A., SOUTH PLAINFIELD	6	1
256	7.5		AUSTRALIA, CANBERRA	4	2
257	7.5	M. NEZEL	GERMANY, HANNOVER	4	2
258	7.5		ITALY, TURIN	4	2
259	7.0	J. A. BARRATA ARAUJO	BRAZIL, RECIFE	7	0
260	7.0	MANEK	CZECH., PRAHA OBS.	7	0
261	7.0	M. MULLER	GERMANY, EILENBURG	7	0
262	7.0	E AHNERT	GERMANY, SONNEBERG OBS.	7	0
263	7.0	K MALDE	NORWAY, STAVANGER	7	0
264	7.0	J. THIEL	U.S.A., MT PLEASANT, MICHIGA	7	0
265	7.0	NEIL BLACKBURN	U.S.A., KANSAS CITY, MO.	7	0
266	7.0	THOMAS G. MCFAUL	U.S.A., HOPEWELL JCT., N.Y.	7	0
267	6.7	JEAN MEEUS	BELGIUM, ERPS-KWERPS	5	1
268	6.7	A. HOUSKA	CZECH., TURNOV	5	1
269	6.7		ENGLAND, EASTHAM	5	1
270	6.7		NETHERLANDS, UITHOORN	5	1
271	6.7	THOMAS H. CAMPBELL JR.	U.S.A., TEMPLE TERRACE, FLA.	5	1
272	6.5	W. ZIMMERMAN	GERMANY, HANNOVER	3	2
273	6.5		NETHERLANDS, SOESTDIJK	3	2
274	6.5	RICHARD W. LASHER	U.S.A., LAKE PARK, FLA.	3	2
275	6.5	G SAMOLYK	U.S.A., MILWAUKEE, WIS.	3	2
276	6.0		AUSTRIA, VIENNA	6	0
277	6.0	H. J. WIDDOP	CANADA, PIERREFONDS, QUEBEC	6	0
278	6.0	P. NAJSER	CZECH., PRAHA OBS.	6	0
279	6.0	VOLF	CZECH., PRAHA OBS.	6	0
280	6.0		DOMINICAN REP. SANTO DOMIN	6	0
281	6.0		ITALY, MILAN	6	0
282	6.0	A PENNEL	NEW ZEALAND, DUNEDIN	6	0
283	6.0	D. THEIL	U.S.A., MT PLEASANT, MICHIGA	6	0
284	6.0	WAYNE E. CLARK	U.S.A., WEBSTER GROVES, MO.	6	0
285	5.7		AUSTRALIA, CANBERRA	4	1
286	5.7		AUSTRIA, VIENNA	4	1
287	5.7	HANZLIK	CZECH., CHEB	4	1
288	5.7	S PATTINSON	ENGLAND, SOUTH CROYDON	4	1
289	5.7		ENGLAND, EXETER	4	1
290	5.7	L MORRISON	ENGLAND, WESTHAM, SUSSEX	4	1
291	5.7	M. SASAKI	JAPAN, TOKYO	4	1
292	5.5	VAN LOO	BELGIUM, CHARLERO, HAINAUT	2	2
293	5.5	LEYMAN	BELGIUM, CHARLERO, HAINAUT	2	2
294	5.5		ITALY, BOLOGNA	2	2
295	5.5	S. DOZYUM	JAPAN, SIMOSATO	2	2
296	5.0	PETER PAISLEY	AUSTRALIA, MURRAY BRIDGE	5	0
297	5.0		AUSTRIA, VIENNA	5	0
298	5.0		AUSTRIA, VIENNA	5	0
299	5.0		AUSTRIA, VIENNA	5	0
300	5.0		CANADA, VICT. DOMINION OBS	5	0
301	5.0	NETOPIL	CZECH., PRAHA OBS.	5	0
302	5.0	DOLEZALOVA	CZECH., PRAHA OBS.	5	0
303	5.0	A FOSS	NORWAY, ASKER	5	0
304	5.0	OSCAR G. DELAS ALAS	PHILIPPINES, QUEZON CITY	5	0
305	5.0		U.S.A.,	5	0
306	5.0		U.S.A., WISCONSIN, UNIVERSITY	5	0
307	4.7		AUSTRALIA, CANBERRA	3	1
308	4.7		AUSTRALIA, CANBERRA	3	1
309	4.7		AUSTRIA, GMUNDEN	3	1
310	4.7		BERMUDA	3	1
311	4.7		ENGLAND, BIRMINGHAM	3	1
312	4.7	W. BEISKER	GERMANY, HANNOVER	3	1
313	4.7	FLAVIO GAMBINO	ITALY, CHIERI, TORINO	3	1
314	4.7	A. NIS.	JAPAN,	3	1
315	4.7	M. GALLAGHER	NEW ZEALAND, CARTER OBS.	3	1
316	4.0	D. S. KING	AUSTRALIA, SYDNEY, N.S.W.	4	0
317	4.0		AUSTRIA, VIENNA	4	0
318	4.0		AUSTRIA, VIENNA	4	0
319	4.0	KRAJCIR	CZECH., HLOHOVEC OBS.	4	0
320	4.0	M LOOCKS-VASQUEZ	CHILE, VALPARAISO	4	0
321	4.0	J OLESEN	DENMARK, RONNE BORNHOLM	4	0
323	4.0	DIETMAR BOHME	GERMANY, NESSA	4	0
324	4.0	E. NIR.	JAPAN,	4	0
325	4.0	J HEYNIS	NETHERLANDS, AMSTERDAM	4	0
326	4.0	ERIC HANHAM	NEW ZEALAND, AUCKLAND	4	0
327	4.0	N. MASEYK	NEW ZEALAND, WAINUIOMATA	4	0

RNK	VALUE	OBSERVER	LOCATION	TOTAL	REAP
328	4.0	N. REGO	PORTUGAL, PORTO UNIV. OBS.	4	0
329	4.0	H POVENMIRE	U.S.A., COCOA, FLORIDA	4	0
330	4.0	BRAD TIMERSON	U.S.A., NEWARK, NEW YORK	4	0
331	3.7		AUSTRALIA, CANBERRA	2	1
332	3.7	JOHN SOYLAND	AUSTRALIA, MURRAY BRIDGE	2	1
333	3.7		AUSTRIA, VIENNA	2	1
334	3.7	PERESTY	CZECH., UHERSKY BROD	2	1
335	3.7		ENGLAND, SOUTH CROYDON	2	1
336	3.7		ENGLAND, SOUTH CROYDON	2	1
337	3.7		ENGLAND, SOUTH CROYDON	2	1
338	3.7		ENGLAND, HERSTMONCEUX, R.G.OBS	2	1
339	3.7		ENGLAND, PRESTON	2	1
340	3.7	JUHANI KORHONEN	FINLAND, JYVASKYLA	2	1
341	3.7	D. KRAUSS	GERMANY, HANNOVER	2	1
342	3.7		GERMANY, HANNOVER	2	1
343	3.7	T. UTI.	JAPAN,	2	1
344	3.7		NETHERLANDS, LAREN	2	1
345	3.7	J PARKER	U.S.A., MILWAUKEE, WIS.	2	1
346	3.7	R ZIT	U.S.A., MILWAUKEE, WIS.	2	1
347	3.7		U.S.A., SAN FRANCISCO UNIV.	2	1
348	3.0	K. P. SIMS	AUSTRALIA, SYDNEY, N.S.W.	3	0
349	3.0	T. L. MORGAN	AUSTRALIA, SYDNEY, N.S.W.	3	0
350	3.0	SOJKA	CZECH., PRAHA OBS.	3	0
351	3.0	P. HAZUCHA	CZECH., HLOHOVEC OBS.	3	0
352	3.0	KARLOVSKY	CZECH., HLOHOVEC OBS.	3	0
353	3.0	S. KOCHAN	CZECH., ZIAR NAD HROUOM OBS.	3	0
354	3.0	J. BOCEK	CZECH., JINDRICHUV HRADEC	3	0
355	3.0	OCENAS	CZECH., BANSKA BYSTRICA	3	0
356	3.0	M. MATYSEK	CZECH., GOTTWALDOV	3	0
357	3.0	V HEGVAD	DENMARK, COPENHAGEN	3	0
358	3.0	BUSCH	GERMANY, EILENBURG	3	0
359	3.0	H KRUGER	GERMANY, HANNOVER	3	0
360	3.0	W KOHLBACH	GERMANY, HANNOVER	3	0
361	3.0	R SCHNEIDER	GERMANY, STUTTGART SWABIAN	3	0
362	3.0	K. KOYAMA	JAPAN, TOKYO	3	0
363	3.0	A. MARINO	NEW ZEALAND, AUCKLAND	3	0
364	3.0	O. HULL	NEW ZEALAND, AUKLAND	3	0
365	3.0	R GLEDHILL	NEW ZEALAND, DUNEDIN	3	0
366	3.0	C. COLLINS	NEW ZEALAND, PALMERSTON NO.	3	0
367	3.0	N BRYNILDSEN	NORWAY, HORTEN	3	0
368	3.0	BEAT RYKART	SWITZERLAND, AATHAL	3	0
369	3.0	M. BOLEN	U.S.A., MT PLEASANT, MICHIGA	3	0
370	2.7	G KANATSCHNIG	AUSTRIA, GMUNDEN	1	1
371	2.7	M. SEDLACEK	CZECH., UHERSKY BROD	1	1
372	2.7	KEN ST. CLAIR	U.S.A., KANSAS CITY, MO.	1	1
373	2.7	ANDY PRIEBE	U.S.A., ST. PAUL, MINN.	1	1
374	2.0	G READING	AUSTRALIA, GEELONG	2	0
375	2.0	DANIELLE BOURGEOIS	BELGIUM, MONTIGNIES LE TILLEUL	2	0
376	2.0	VALEK	CZECH., PRAHA OBS.	2	0
377	2.0	KAPLANOVA	CZECH., PRAHA OBS.	2	0
378	2.0	KARAS	CZECH., PRAHA OBS.	2	0
379	2.0	VYHLIDKA	CZECH., PRAHA OBS.	2	0
380	2.0	V. SKODOVA	CZECH., VALASSKE MEZIRICI OBS.	2	0
381	2.0	M. VYKUTILOVA	CZECH., VALASSKE MEZIRICI OBS.	2	0
382	2.0	E. BELDA	CZECH., TURNOV	2	0
383	2.0	E PEDERSEN	DENMARK, HORSENS, JUTLAND	2	0
384	2.0	P RIPPINGHAM	ENGLAND, CRAWLEY	2	0
385	2.0	A DRUMMOND	ENGLAND, CRAWLEY	2	0
386	2.0	M. YAM.	JAPAN,	2	0
387	2.0	B. HITCHCOCK	NEW ZEALAND, PALMERSTON NO.	2	0
388	2.0	B SORENSEN	NORWAY, TRONDHEIM	2	0
389	2.0	M. LINKE	U.S.A., MT PLEASANT, MICHIGA	2	0
390	2.0	S. SIBLE	U.S.A., MT PLEASANT, MICHIGA	2	0
391	1.0	FIEDLEROVA	CZECH., PRAHA OBS.	1	0
392	1.0	VACHA	CZECH., PRAHA OBS.	1	0
393	1.0	DOSTAL	CZECH., PRAHA OBS.	1	0
394	1.0	M. NAUBAUER	CZECH., VALASSKE MEZIRICI OBS.	1	0
395	1.0	B. SIEGEL	CZECH., POLICE NAD METUJI	1	0
396	1.0	RAKOVA	CZECH., UHERSKY BROD	1	0
397	1.0	J. VASICEK	CZECH., UHERSKY BROD	1	0
398	1.0	ZIMNIKOVAL	CZECH., BANSKA BYSTRICA	1	0
399	1.0	KRAL	CZECH., GOTTWALDOV	1	0
400	1.0	KOPRIVA	CZECH., GOTTWALDOV	1	0
401	1.0	KOLCAVA	CZECH., GOTTWALDOV	1	0
402	1.0	REHAK	CZECH., GOTTWALDOV	1	0
403	1.0	RAJNOHA	CZECH., GOTTWALDOV	1	0
404	1.0	M. PETRAS	CZECH., GOTTWALDOV	1	0
405	1.0	HRUZA	CZECH., CHEB	1	0
406	1.0	KNECH	CZECH., CHEB	1	0
407	1.0	G APPLEBY	ENGLAND, HERSTMONCEUX, R.G.OBS	1	0
408	1.0	MATTI TURUNEN	FINLAND, LIEKSA	1	0
409	1.0	FRANZE	GERMANY, EILENBURG	1	0
410	1.0	SEIDEL	GERMANY, EILENBURG	1	0
411	1.0	LITSA ELIAS	GREECE, PENTELI	1	0
412	1.0	S. HUTTIMOUE	JAPAN, TOKYO	1	0
413	1.0	Y. KUB.	JAPAN,	1	0
414	1.0	K. MAT.	JAPAN,	1	0
415	1.0	F VAN DER PLUYM	NETHERLANDS, VLAARDINGEN	1	0
416	1.0	FRANCEY MCNAB	NEW ZEALAND, AUCKLAND	1	0
417	1.0	TRIXIE STEWART	NEW ZEALAND, AUCKLAND	1	0
418	1.0	D. WHELAN	NEW ZEALAND, TKORANGI	1	0
419	1.0	F. ANDREWS	NEW ZEALAND, BLACK BIRCH	1	0
420	1.0	D. WILTSHIRE	NEW ZEALAND, PALMERSTON NO.	1	0
421	1.0	D. BUCKLEY	NEW ZEALAND, CHRISTCHURCH	1	0
422	1.0	R. F. HALL	NEW ZEALAND, WHANGAREI	1	0
423	1.0	T. J. HICKEY	NEW ZEALAND, WHANGAREI	1	0
424	1.0	STEIN HOYDALSVIK	NORWAY, TROMSO	1	0
425	1.0	J PFANNETSTILL JR	U.S.A., MILWAUKEE, WIS.	1	0
426	1.0	A. EDGAR	U.S.A., MT PLEASANT, MICHIGA	1	0
427	1.0	W. BISARD	U.S.A., MT PLEASANT, MICHIGA	1	0
428	1.0	K. BURKE	U.S.A., MT PLEASANT, MICHIGA	1	0
429	1.0	R. RUELLE	U.S.A., MT PLEASANT, MICHIGA	1	0
430	1.0	J. KIMBALL	U.S.A., MT PLEASANT, MICHIGA	1	0
431	1.0	E. ANDREZEWSKI	U.S.A., MT PLEASANT, MICHIGA	1	0
432	1.0	D. BRAGG	U.S.A., MT PLEASANT, MICHIGA	1	0
433	1.0	N. DEBLACUM	U.S.A., MT PLEASANT, MICHIGA	1	0
434	1.0	H POSS	U.S.A., PHILADELPHIA, PA.	1	0
435	1.0	M HERBSTRITT	U.S.A., ST. MARYS, PA.	1	0
436	1.0	SHERMAN W. SHULTZ	U.S.A., ST. PAUL, MINN.	1	0

available HMNAO tapes but no names were available. No U.S.S.R. observers are listed because only the totals for that country were available. Also, only 436 individuals are listed; 58 with no names and low scores were dropped in order to simplify the reporting format. Finally, some Japanese names are abbreviated since that's how they were presented on the available listing and I could make only a few complete correlations.

Again reviewing the listings since 1975, we find the only consistent placers among the top ten are: Sirahama Observatory of Japan, Hays of the USA, and Wieth-Knudsen of Denmark. In fact, Wieth-Knudsen and Hays are the most consistent leaders for the years available (see "A Correction to the 1977 Total Occultation Tally," *o.N. 2* (13), 178). Takemura of Japan was in the top ten for recent years, but dropped all the way to 109 for 1978. However, Clyde of the USA and Vincent of Rhodesia [Ed: now Zimbabwe] have placed since '76 and '77 respectively. Fuhr, our leader for 1978 was second in 1976, but absent from the 1977 listing.

In the country listing, the USA leads, as always, because of its large number of observers. If value per observer is computed, however, South Africa leads with 137.1. Namibia is next with 92.5 and Rhodesia (the leader in this category in 1977) is third at 92.0. Africa is certainly an active continent!

Again, I want to express my appreciation to Honeywell Inc. for their computer time support of these tallies and of the asteroid occultation local circumstance predictions. Also, my thanks go to Dave Dunham, Tom Van Flandern, and H. F. DaBoll, for providing data and organizing the publication, respectively.

As to coming tallies, that for 1979 probably will emerge next fall. The 1980 list may follow shortly or be delayed, depending on the degree of completeness desired. (Remember, it takes about four years for a complete tape listing to become available. The coupons for 1981 still are arriving. It's tempting to compile preliminary lists based on data to date.)

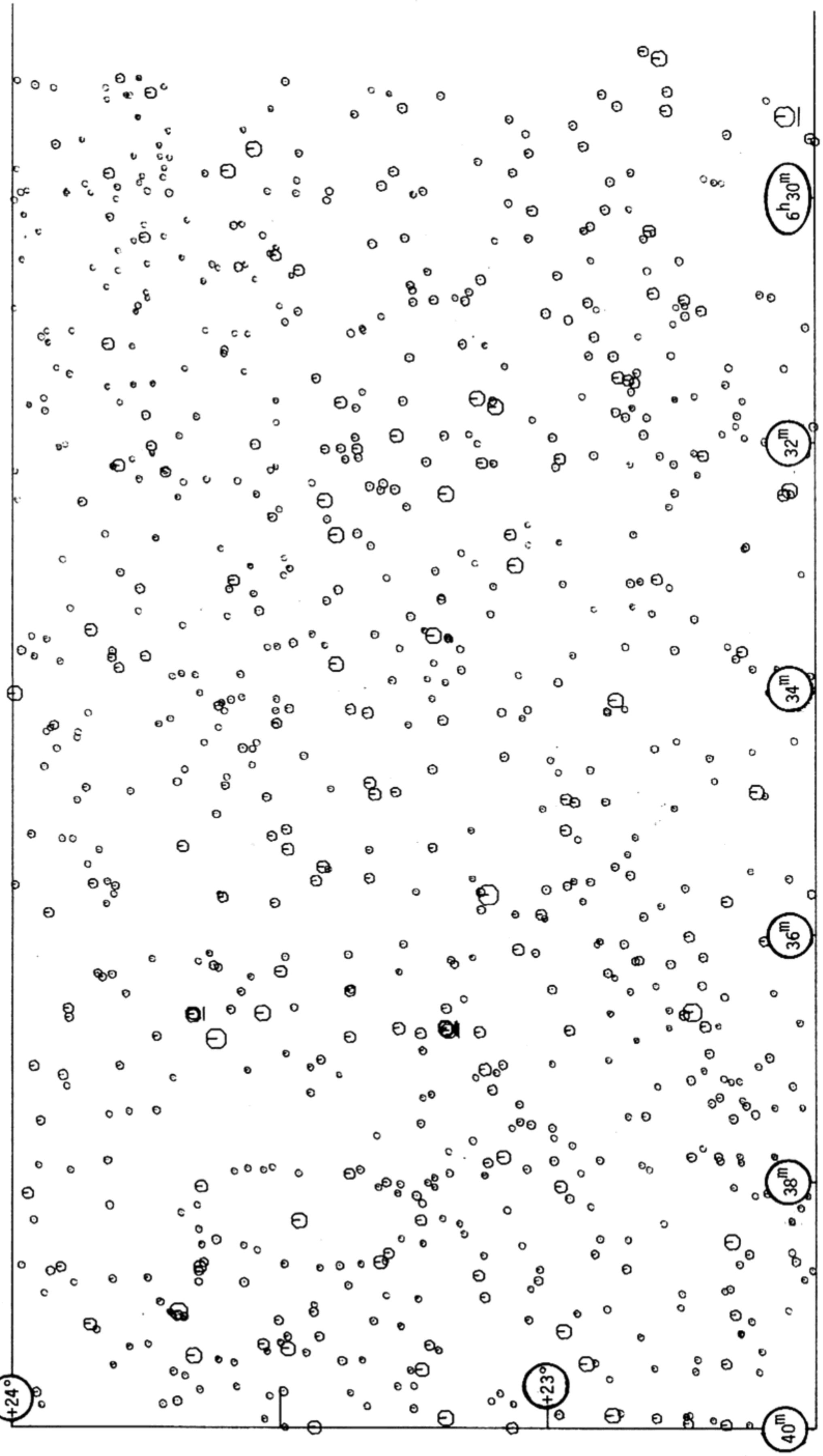
OCCULTATIONS DURING THE LUNAR ECLIPSE OF 1982 DECEMBER 30

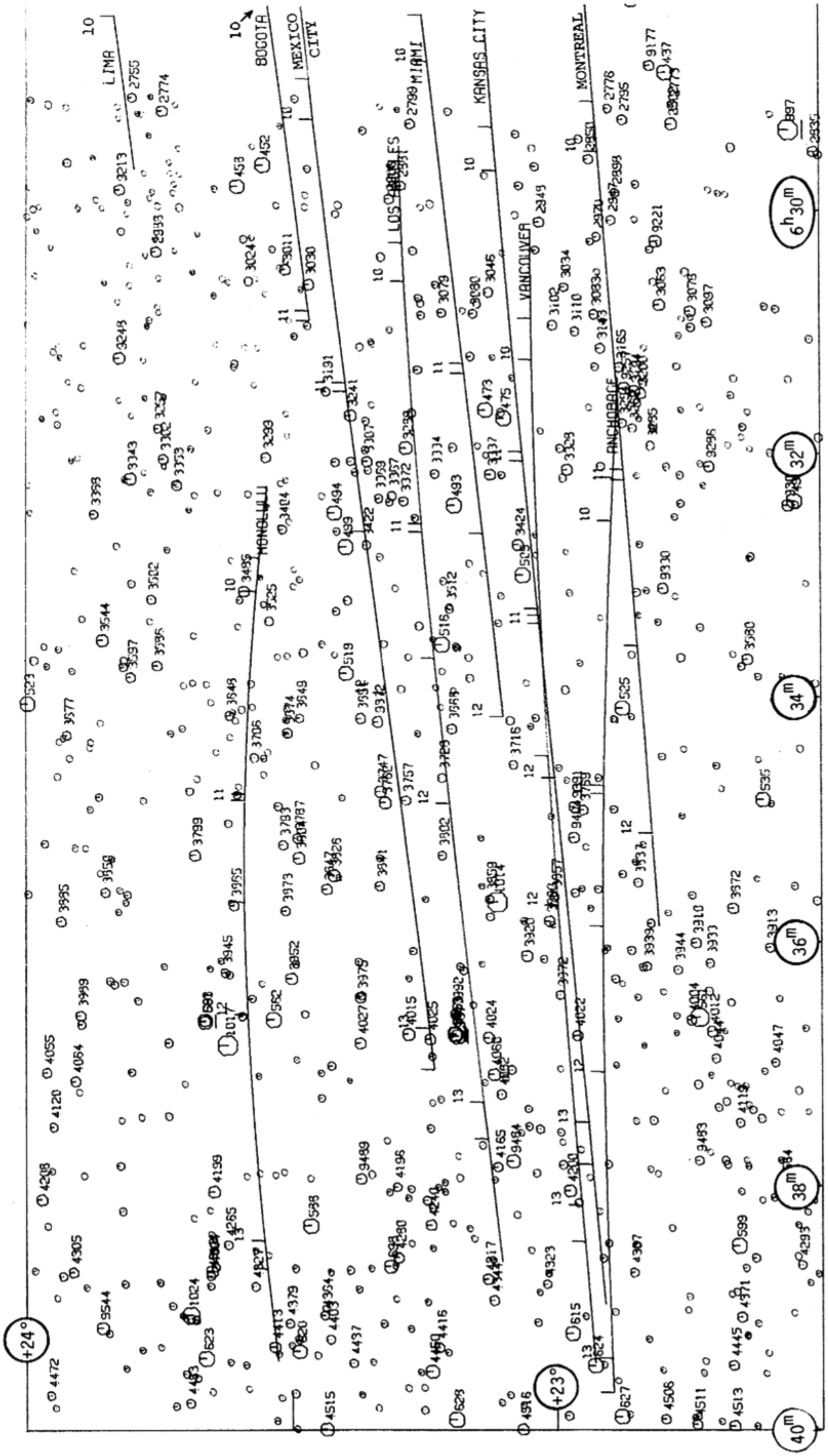
David W. Dunham

Much information about this year's last total lunar eclipse, with emphasis on occultations, is given in my article starting on p. 574 of this month's issue of *Sky and Telescope (S&T)*, and will not be repeated here. Also, considerable information about observing strategies and the value of eclipse occultation timings given in the article about the July 6th eclipse starting on p. 214 of *o.N. 2* (16) will not be repeated here.

Although this month's totality will not last nearly as long as the July eclipse, the fact that the moon will be near perigee gives this eclipse some advantages for occultations. Since the moon is both closer (and hence larger in apparent size) and moves faster at perigee than at apogee, it will sweep out a larger area of the sky, occulting more stars, in a given amount of time; this will help offset the shorter duration. This could be a very dark eclipse, as explained in my *S&T* article. However, the extreme northern limb of the moon may be relatively bright, not only because it will be farthest from the umbra center, but also because material from the El Chichón volcano has diffused little to arctic latitudes. Extensive December cloud cover in the Northern Hemisphere probably will darken the inner parts of the umbra, but not the outermost parts, which are illuminated by sunlight which is refracted through higher layers of the atmosphere above the clouds.

The star field maps I have prepared for this eclipse differ from those published in *O.N.* for previous eclipses, as described in the proposed changes on p. 4 of the last issue. Three versions of the star field plots have been prepared: One set is for North America, northwestern South America, and Hawaii; one set is for Australia and New Zealand; and the third set is for Asia. There are two charts in each set. One shows only the stars, with no identifications. The other shows the tracks for the moon's center for selected locations, as well as the numbers of stars brighter than mag. 11.5. The diameters of the stellar symbols are proportional to their brightness, with the faintest stars being about 13th magnitude and the brightest being mag. 6.8 (6.5 for the Australia-





New Zealand version). The coordinates are apparent of date (equinox 1983.00), so that they can be compared directly with the R.A.'s and Dec.'s given in the U.S. Naval Observatory (USNO) total occultation predictions. My plot on p. 575 of *S&T* uses equinox 1950.0 coordinates and can be used to crossreference to other sources using 1950 coordinates, if that is needed. Since the *S&T* map does not include the star field eclipsed from Australia and New Zealand, *O.N.* subscribers there are being sent an equinox 1950 map showing stars to 10th mag. which includes the field covered by the eclipsed moon for all parts of the world.

There is an obvious lack of faint stars on the right side of the chart for the Americas showing only the stars, for R.A.'s less than $6^h\ 29^m$. The faint *Astrographic Catalog* data for the C-catalog, from which the plot was produced, started at that R.A., since no part of the moon actually immersed in the umbra would cross that area for any terrestrial location during the eclipse. There is a representation of the moon's disk, shown in the proper size for use in conjunction with the chart, printed as a detachable portion of the "Count of Lunar Occultation Timings Made During 1982" coupon which is included in this issue. Watts angles are marked and labeled at 30° intervals around the disk, with smaller marks at 10° intervals between 180° and 360°, to help in locating stars emerging at the western limb. The representation is based on a photograph of an earthshine-lit thin waning crescent taken by Thomas Campbell in Temple Terrace, FL, several years ago. The photograph shows well the muted appearance that the moon will have when it is deep within the umbra. I have drawn in some rays and features near the overexposed (sunlit) eastern limb, which is not as critical since disappearing stars are easier to locate. The disk should be cut out and moved, using the Watts angle markings to provide orientation (the Watts angle of the northernmost point of the moon's limb will be 5°), so that a reappearing star is at the predicted Watts angle on the disk; then, it should give a good simulation of the moon and star field at the predicted time. If you want to use a more detailed lunar map to try to locate reappearing stars, subtract 275° from the predicted position angle or 270° from the Watts angle to obtain the selenographic latitude of emersion. But few features other than shown here likely will be visible in the umbra, especially in its darker parts in the southwestern quadrant of the moon, where there are few prominent features near the limb. In general, it probably will be easier to locate reappearing stars using the patterns of the star field.

For the topographic tracks showing the moon's center on the second chart, dots plotted at 15-minute intervals are connected by line segments. The dots (which individually can not be seen since they are just the ends of joined line segments), are plotted only when the moon is above the local horizon. Vertical marks are given every U.T. hour, which is labeled above the mark. Vertical marks also are given at 9:50.4 U.T. (first umbral contact), 10:58.2 (start of totality), 11:28.7 (mid-eclipse), and 13:07.0 (last umbral contact). The end of totality will occur very close to 12:00 U.T. The name of the city for which the track is plotted is given at the right (low R.A.) end of the track; The label for Los Angeles, the track between Miami and Mexico City, is nearly illegible due to interfering star numbers. Coordinates for the cities shown on all three versions of the charts are given in Table 1 below.

Table 1. Stations for Topocentric Paths

Location	Longitude	Latitude
Dunedin, New Zealand	170°.500 E	-45°.873
Brisbane, Australia	153.070 E	-27.516
Melbourne, Australia	145.000 E	-37.750
Tokyo, Japan	139.770 E	+35.660
Manila, Philippines	121.062 E	+14.651
Nanking, China	118.821 E	+32.067
Perth, Australia	115.830 E	-31.950
Naini Tal, India	79.457 E	+29.361
Montreal, Canada	73.600 W	+45.500
Bogota, Colombia	74.081 W	+4.599
Miami, U.S.A.	80.250 W	+25.750
Kansas City, U.S.A.	94.497 W	+38.964
Mexico City, Mexico	99.100 W	+19.250
Los Angeles, U.S.A.	118.302 W	+34.113
Vancouver, Canada	123.100 W	+49.500
Anchorage, U.S.A.	149.870 W	+61.210
Honolulu, U.S.A.	157.850 W	+21.300

The star numbers on the second chart are from different catalogs, depending on their values. Numbers in the 400's and 500's are the last three digits of SAO numbers, the first two digits always being 78. Hence, the star marked 493 is SAO 78493. Numbers in the 900's and 1000's are Zodiacal Catalog (Z.C.) numbers; 6.8-mag. Z.C. 1014 is the brightest star occulted for most North American observers. Numbers from the 2000's to the 5000's are USNO C-catalog numbers. Numbers in the 9000's are USNO X-catalog numbers, indicating AGK3 stars not in the SAO catalog. The star number always begins at a fixed distance to the right, and slightly below, the center of the symbol marking the star. This can help to untangle some cases where star numbers overlap. In a few cases, as for close doubles where both components are cataloged, the numbers are so crowded together that they can't be read. In these cases, as for the stars fainter than mag. 11.5, the USNO predictions need to be consulted to determine the actual star number. Known double stars are underlined on the charts. If you time the occultation of any star not plotted on the chart, mark its location on the chart. Arnold Klemola plans to take plates of this eclipse star field at Lick Observatory, as he did for the July 6th eclipse field. Several months after the eclipse, after we have received most reports of occultations timed during the eclipse, he will measure accurate positions for all stars whose occultations have been timed, whether or not they are on my charts. He also plans to measure the positions for some of the stars before the eclipse, so that we can update the predictions for grazes which are likely to be observed, as we did for the July 6th eclipse.

Every effort should be made to time reappearances, which are more valuable because they are timed less frequently during eclipses. If you have ready access to a copying machine, you might follow Richard Nolthenius' successful example for the July 6th eclipse. Using the USNO predictions to position the cut-out lunar disk at the appropriate Watts angle, make a copy of the chart for each predicted reappearance to show how the moon will look relative to the star field. This could be done at one or two-minute intervals if a few stars reappear during these intervals; mark the star number(s) and predicted U.T.(s) and uncertainties on each chart.

The brightest star to be occulted anywhere during the eclipse will be the 6.5-mag. spectroscopic binary Z.C. 1023 (SAO 78596). The occultation will be visible during totality from New Zealand and southeastern Australia. From 11:15 to 11:20 U.T., a graze will occur along the northern limit, which passes just northwest of Melbourne and Canberra, and over the northwestern suburbs of Sydney. David Herald plans to observe the eclipse from the Melbourne area, so he may be able to coordinate plans to observe the graze there. His address is given below, but during the holidays, he will be staying with his parents at 12 Elm St., Surrey Hills, Melbourne, Vic. 3127. Information near Sydney might be obtained from Roger Giller, 20 Gwydir St., Engadine, N.S.W. 2233. Although he plans to be at Hat Head during the holidays, he might return to the vicinity of Engadine for the eclipse, since the northern limit of the occultation of Z.C. 1023 passes only 21 miles northwest of Engadine.

For North America, 6.8-mag. Z.C. 1014 (SAO 78545) will be the brightest star to be occulted during the eclipse. The northern limit crosses northern Alaska and northwestern Canada. Northeast of a line extending from the Carolinas to Wisconsin, the total occultation of this star can not be accurately timed since it will occur in the penumbra, just outside the edge of the umbra.

Grazes which might be observed at both the northern and southern limits during the eclipse are described on p. 575 of the *S&T* article. The stars marked "A" and "B" on the *S&T* chart are 10.2-mag. C03747 and 10.0-mag. C03762, respectively. I erred in the *S&T* article; it is the northern limit for C03747 ("A") which crosses the southern limit of the occultation of SAO 78561 at North Powder, OR, not star "B." Paul Maley, 15807 Brookvilla, Houston, TX 77059, phone 713, 488-6871, is organizing an expedition on the island of Hawaii to observe the southern-limit graze of C03747, while Richard Linkletter, 1108 Lafayette Ave. North, Bremerton, WA 98310, phone 206, 479-1191, is organizing an effort to record the star's northern-limit graze, as well as the graze of SAO 78561, at North Powder, OR. Maley notes that the northern limit of C03747 also crosses Pocatello, ID and Denver, CO. At Denver, the graze probably will be very difficult to see, since it will occur at an umbral distance of 95% on what likely will be a relatively bright northern limb of the moon.

The forms of the International Lunar Occultation Centre (ILOC), or the equivalent IOTA/ILOC grazing occultation report forms, should be used for reporting observations of occultations timed during the eclipse. Besides sending your report to the ILOC, you also should send a copy to me at P.O. Box 7488, Silver Spring, MD 20907, U.S.A., or to David Herald, P.O. Box 254, Woden, A.C.T. 2606, Australia, if you live in Australia or New Zealand.

CORRECTION

Joseph Carroll notes a transposition of numerals in his address as given in *O.N. 3* (1), 17, col. 1, line 6. The correct name and address are: Joseph E. Carroll; 4261 Queen's Way; Minnetonka, MN 55343; U.S.A.

ERRONEOUS STAR POSITIONS FROM OCCULTATIONS, by David Herald

ZC	SAO	DATE	Ph	Ac	O-C	Observer	Comments
1051	78852	81 Nov 15	R	2	-4	Hays	SAO/ZC proper motion in declination too small
	93756	81 Jan 16	D	7	+11	Hays	Slight difference in declination between SAO/Yale and AGK3
	93886	82 Feb 3	D	3	-5	Baldridge	
798	94478	82 Feb 4	D	3	-6	Van Nuland	SAO/GC and AGK3 essentially agree
	94883	80 Mar 23	D	2	+3	Hays	AGK3 slightly better than SAO/Yale
	94920	80 Mar 23	D	2	+5	Hays	SAO declination position and proper motion in error
	95265	80 Aug 7	R	6	+9	Hays	SAO/Yale and AGK3 essentially agree
	95594	80 Sep 23	D	2	+5	Hays	SAO/Yale and AGK3 essentially agree
	96343	80 Feb 26	D	2	+4	Hays	SAO/Yale better than AGK3
	98249	80 Oct 31	R			Wieth-Knudsen	SAO/Yale in error. AGK3 position is used in USNO predictions, but not in HMNAO reductions.
	118325	80 May 22	D	4	-8	Hays	SAO/Yale proper motion in right ascension in error
	140094	81 Jul 21	G			Stott	Graze path one mile south. SAO/GC/ZC declination and Yale declination are inconsistent.
	158927	81 Jun 6	D	6	-8	Hays	No comparison
	159601	81 Aug 9	D	4	-11	Hays	SAO dec. 1″3 north of Perth 70, but SAO better than Perth 70.
	160995	81 Feb	G			Herald	Graze prediction; SAO/GC and Yale differ by three seconds.
	161066	80 Feb 12	R	4	+6	Hays	No comparison
	163965	81 Sep 11	D	7	-8	Hays	SAO/GC position and proper motion in declination in error
	165337	80 Dec 14	D	4	+5	Baldridge	No comparison
	187233	80 Oct 16	D	5	+13	Van Nuland	No comparison
	188091	80 Nov 13	D	?	-4	Baldridge	No comparison
	188357	81 Oct 7	D	4	-5	Hays	No comparison
	X00853	80 Dec 16	D	3	+8	Baldridge	AGK3 star. No comparison. = BD -01° 85
	X02485	80 Jan 24	D	3	+5	Hays	AGK3 star. No comparison. = BD +04° 308
	X16083	80 Nov 6	R	8	-10	Baldridge	AGK3 star. No comparison. = BD +10°2195

This list does not include several reports of occultations falling outside the accuracy range that occurred in the period 1981 Jan 1 to Jun 30. As noted in *O.N. 2* (11), 124, the USNO predictions for this period required the addition of one second, and for those events reported that came within the accuracy range after the inclusion of this correction, no further investigation was made.

From the events which have been reported to me over the last several years, it has become evident that a significant number of these occurrences are caused not so much by error in the star position (at least not a significant error, anyway) as by the quoted accuracy being too small, particularly for occultations that are 'near grazing', i.e., those with cusp angles less than about twenty degrees (except near full moon). As a general guide, it would appear that an occultation occurring outside the accuracy range is only worth investigating if the event occurs more than fifty percent of the accuracy range, or five seconds, outside the accuracy range, whichever is the lesser. For example: If the accuracy is two seconds, report only if the error is three seconds or more; if the accuracy is fifteen seconds, report only if the error is twenty seconds or more.

SOME HINTS FOR TIMING OCCULTATIONS

Dietmar Büttner

In addition to the time of the event, the report of each occultation observation should contain information on the accuracy of the measurement. This is needed to give your observation a weight when it is combined with other data in an analysis being made at ILOC. The accuracy is an expression of the quality of your measurement, or in other words, it is a measure of accidental error in your observation. It is a value preceded by ±, and tells by what amount the true occultation may have occurred earlier or later than the reported time. Example: You observed an occultation to occur at $21^{h}\,18^{m}\,36^{s}.5$ UT, and estimated the accuracy to be $\pm 0^{s}.2$. Thus, the occultation could have taken place between $21^{h}\,18^{m}\,36^{s}.3$ and $21^{h}\,18^{m}\,36^{s}.7$ UT.

I prefer to use the term 'uncertainty' rather than 'accuracy' because in the case of the latter, a small value means a high accuracy and vice versa, while the uncertainty is low when its value is small. By using the 'uncertainty' term, misunderstandings are much less probable. The uncertainty should not be confused with the personal equation (PE) or with the time corresponding to the distance between two adjacent marks on your stop watch.

How can the observer get a reliable value for the uncertainty? The correct way to resolve this task is to analyse the timing method being used to find out where there are sources of uncertainties. Thus, the timing is considered as a whole process which consists of several parts. Each of the parts brings an uncertainty, and the uncertainty of your measurement is the sum of all these components. I will try to show it with the stop watch method, which probably is the method in most common use:

A timing using this method consists of three parts:
1. starting the watch as quickly as possible after the occultation; it provides the systematic error PE. Here, an uncertainty depends on how well you are able to estimate your PE for this particular occultation event;
2. the period during which your watch continues to run; since your watch is too slow or too fast, a systematic watch error must be considered. The uncertainty resulting from this part is the uncertainty with which you determined the systematic error of your watch. Here, as an adequate approximation of the uncertainty, you can use the standard deviation computed from a series of tests to find the watch's error;
3. stopping the watch at any defined moment, e.g., 6 s after a whole minute at the standard time signal; here, you probably are late by a few tenths of a second ($0^{s}.1$ or $0^{s}.2$ or so). Although this systematic error is smaller than the PE in most cases, it is large enough to require consideration. The uncertainty of this part again depends on your ability to estimate the delay in relating the stop watch to the time signal. It is also present when you use the Taylor method! [Ed: As we had been led to believe that the Gordon Taylor method eliminated this source of error, we invite further comment from Herr Büttner, to explain that statement.]

Clearly, the described method seems to be rather complicated, but it is the only way to get reliable values for the uncertainty. Estimating the uncertainty of the process as a whole probably would lead to too large an estimate. As a rule, I recommend that systematic errors should be determined and the observing result should be corrected for them. Uncertainties from all parts also should be determined where possible, or at least estimated, and then added to get the uncertainty of the whole timing process. [Ed: While taking care not to fall on your face, you should avoid leaning so far the other way that you fall on your back. Adding all possible errors, without respect to sign, could lead to too large an estimated uncertainty, resulting in your observation being given less weight than it deserves by the ILOC. Remember that you are not supposed to be stating the extreme limits of possible error; rather, you should be stating that there is a 67% chance that your timing is within the stated uncertainty.] An analysis of the method used, such as shown above, is also very useful in improving the precision of the observation by eliminating such parts as may have large uncertainties. This can lead to a change in the timing method, e.g., to eye-and-ear instead of the stop watch method.

Another important point regarding timing results is the number of digits given after the decimal point in the seconds part of the reported time. The only digits which should be given are those which are valid with respect to the uncertainty of the timing. Example: If you suspect the uncertainty to be $\pm 0^{s}.2$, enter only one digit after the decimal point, not two or more digits. This rule also should be considered in the PE or in any watch error for which the result is corrected. Often these quantities are determined from a test series, and the mean values are computed to three or more digits after the decimal point. In such cases, the standard deviation of the series should be calculated. This is a measure for the accidental errors. It then will be seen that the second or third digits are quite useless because the standard deviation lies higher by one or two orders. I believe that the cause for giving more digits than are valid often is the use of electronic pocket calculators or electronic stop watches. Clearly, they give many digits, but they don't know the practical importance of them. This can be determined only by the observer. If you give the uncertainty of the timing to $0^{s}.01$ or $0^{s}.001$, please recall that the uncertainty is partly or totally the result of estimates, and that nobody can estimate $0^{s}.01$ or $0^{s}.001$. Always, it feigns a higher precision than really exists if more digits are given than are valid!

As a third hint, please note that values for PE and watch error estimates should be determined for the *actual observing situation*. Remember that these values depend on such influences as disposition of the observer, temperature, etc. This may seem trivial, but is rather important for reliable timings. Generally, the use of standard values for the mentioned quantities will lead to larger uncertainties and errors, thereby reducing the value of the often excellent efforts of amateur astronomers to get data which are useful to professional astronomers.

Finally, a more general aspect of timing occultations: Each occultation is an unique event, in that it does not occur again under exactly the same circumstances, e.g., position angle, libration, distance and speed of the moon, etc. Thus, a measurement can not be repeated, as is possible, for instance, with dimensional measurements in the manufacturing process. For that reason, the greatest possible care should be given to each occultation timing in order to get an uncertainty as small as achievable. Finally, it should be noted that the attainable precision of any observation may not be as fully utilised in a current analysis as it can be a few years from now, when more accurate limb corrections and star positions become available

---

WEATHER AND OCCULTATIONS DURING THE LUNAR ECLIPSE OF 1982 JULY 6

David W. Dunham

An infrared NOAA satellite photo taken during the eclipse shows the complex weather pattern which hindered many observers during the July 6th eclipse. The photo, taken at 7 hours U.T., enhances cold high-level cirrus, while some opaque low-level stratus clouds, being nearly as warm as the land which they cover, are barely visible. The weather was capricious, with few substantial areas of clear sky, whose location was hard to predict in advance. Clear skies prevailed over normally humid Louisiana and eastern Texas, while clouds covered the desert regions farther west.

About 15 hours before the eclipse, I asked the National Weather Service where the best possibility for clear skies would be in the eastern $^2/_3$rds of the country, where the most favorable occultations would be visible. They recommended Georgia, which we could reach by automobile from the Washington, DC, area. Skies were mostly cloudy during the drive south, until we reached South Carolina, where the sky was very clear. We drove to Columbia, where we met local observers who were kept busy with an open house at their observatory. It was a classic example of what I warned against in the article about the July 6th eclipse in last June's *O.N.* Later, we learned that no occultations were timed there because the astronomers had their hands full showing visitors the eclipsed moon through the observatory telescopes, when small portable scopes set up on the front lawn could have served the same purpose, freeing the large telescope for research. Skies remained good, so we decided to observe from a site near St. Matthews, on the southern limit of the occultation of AR Sagittarii about 30 miles to the south. We called the weather service 4 hours before the eclipse to see if it might be better to continue on to Georgia. Clouds then covered most of Georgia, and they recommended going northwest. We decided not to travel farther, since we did not have occultation predictions ready for more northern sites and would miss the graze of AR Sgr if we moved. Using a 14-inch Schmidt-Cass loaned to us by Robert McCracken, I timed 9 occultations of stars as faint as 12th magnitude on the moon's northeastern limb before low stratus clouds covered our site at 7 hours U.T. The clouds thinned enough to see AR Sgr briefly a few minutes before the graze, but not during it. We learned later that clouds also moved in during the eclipse at Columbia and for observers in North Carolina, especially the western part, where it rained. Back in the DC area, the whole eclipse was seen, but observers there (Victor Slabinski, Arlington; and Paul Hueper, Bethesda) were able to time only one occultation due to cirrus and haze. Fred Espenak, Bowie, MD, contacted the weather service a few hours before the eclipse and traveled, at their suggestion, to southeastern Maryland, where he had a clear view until the last partial phases. Although the altitude was lower, Mark Allman (near Pittsburgh, PA), Robert Young (Harrisburg, PA), Don Trombino (Sparta, NJ), and Philip Dombrowski (Glastonbury, CT) were each able to time about a half dozen occultations.

Paul Maley was the most successful occultation observer during the eclipse who has sent me a report. Using a 17-inch Dobsonian in his back yard in Houston, TX, he timed 48 disappearances and 25 reappearances (as noted briefly on p. 392 of the October issue of *Sky and Telescope*), including nearly 20 stars which are not in the *Astrographic Catalog*, which I had used to compute predictions for stars as faint as photographic magnitude 13. As far as I know, his total of 73 occultation timings is a record for one observer in one night. This remarkable achievement was made by an amateur astronomer with his own equipment, not by a professional astronomer, and not at a public observatory.

My map in the January issue of *Sky and Telescope* shows that the northern limits of the occultations of 8.4-mag. SAO 187543 and 7.7-mag. SAO 187581 intersected in eastern Oklahoma during the eclipse. Carl Schweers (Ardmore, OK) and Tom Williams (Houston, TX) led a 4-station expedition to Stigler, OK, at the intersection. About a week before the eclipse, Arnold Klemola obtained a plate of the eclipse field with the 20-inch twin astrograph at Lick Observatory. He relayed to me his measurements of several of the stars, including the two in question, to update the predictions of all grazes to be attempted during the eclipse. This enabled the observers at Stigler to select optimum locations, from which they timed 80 contacts during the two grazes. Biff Bigbie was most successful, getting 18 events for SAO 187543 and 13 for SAO 187581. The observations will define the profile of the northern limb of the moon very accurately for an extended range of position angles, which in turn will be of particular value for our analysis of total solar eclipse Bailey bead timings for determining the solar radius. The observers were quite lucky, since the sky was very clear during the eclipse, but quite cloudy shortly before it began and soon after it ended. Tom Williams' plot of their results for SAO 187543 was published on p. 576 of this month's *Sky and Telescope*.

Richard Nolthenius (Los Angeles, CA) observed the eclipse with his 6-inch reflector from Kennedy Meadows at an elevation of 6480 ft. in the Sierras. He timed 28 occultation events, including a few of a graze of an 11.8-mag. star. He had selected the site partly because it was at the northern limit of the occultation of an 11.8-mag. star. Don Stockbauer (Houston, TX) timed 4 events during the graze of AR Sgr using an 8-inch Schmidt-Cass near Damon, TX. Although Klemola's plate showed that the star was mag. 8.7, brighter than usual, Stockbauer had some trouble seeing it against the moon's southern limb, which was much brighter than the northern limb. At Damon, the graze occurred shortly after totality began when the southern edge of the moon was still close to the edge of the umbra. In the June issue of *O.N.*, distributed a week before the eclipse, I stated that "the northern part of the moon may be slightly darker than the southern part during the eclipse," since the eclipse was nearly central and dust from the Mexican El Chichón volcanic eruption of April 4 was mainly confined to the earth's Northern Hemisphere. This turned out to be an understatement; Richard Nolthenius first had suggested the idea to me. Comparison of Patrick Thomas' photograph of the eclipse and star field on p. 393 of the October issue of *Sky and Telescope* with Sherman Schultz's photo of the 1963 December eclipse on p. 602 of that journal's June issue shows that the latter eclipse was considerably darker than last July's eclipse. Measurements of the brightness of the totally eclipsed moon in July were nearly two magnitudes brighter than those for the 1963 December eclipse.

Thomas Langhans (San Bruno, CA) timed 24 occultations using a 14-inch Schmidt-Cass during the eclipse. Bob Melvin (Fayetteville, NC) used the University of North Carolina's 24-inch telescope at Chapel Hill to time occultations during the eclipse. He clearly saw about 25 occultations before clouds moved in at mid-eclipse, but recovered only 3 timings due to tape recorder problems.

The NOAA photo shows extensive cloud cover over Mexico, Central America, and northern South America. Observers in Recife and Porto Alegre, Brazil; Buenos Aires, Argentina; and Valparaiso, Chile did not see any of the eclipse, due to clouds. Astronomers at Santiago, Chile, were able to time some occultations during breaks in the clouds. Graham Blow timed about 25 occultations using the 9-inch refractor at Carter Observatory in Wellington, New Zealand. At last report, he had received 51 occultation timings from 7 other observers around the country, and estimated that over 100 timings during the eclipse eventually would be sent from New Zealand.

Some potential observers said that commitments to news media and public viewing prevented any serious observing of the eclipse, and hoped to make better arrangements for obtaining data at the December 30th eclipse. Cold weather, the late hour of a weekday, and a duration far short of a record for the century likely will discourage public viewing, permitting more concentration on projects like timing occultations. Since the moon will be in Gemini, it will be farther above the horizon during most of the eclipse for most of the U.S.A. (especially the western half). More information about the December 30th eclipse appears in a separate article in this issue. A tally of occultation timing totals for all three lunar eclipses during 1982 will appear in future issues of *Occultation Newsletter*.

EXPERIENCES WITH THE EYE-AND-EAR METHOD

Dietmar Büttner

Since early 1982, I have used this method routinely for timing lunar occultations, whereas during the previous four years I used the stop watch method. Knowing both methods from a considerable number of observations, I will compare certain aspects of them and report my current experiences with the eye-and-ear method here.

The eye-and-ear method provides an absolute measurement of the occultation event time. That is, the event is related directly to the UTC time scale, whereas in the stop watch method, the primary measurement is of the difference between the event time and a time signal, using the stop watch calibrated against the time signal as a secondary standard. As the nomenclature implies, the eye-and-ear method does not use any watch but the observer's eye, ear, and mind. Thus, in this method, no systematic errors or uncertainties from the watch itself, respective to starting or stopping it, can have any influence on the precision of the timing. Most important is the elimination of the personal equation, which is the biggest source of error in the stop watch method. Instead, another effect becomes central, namely the question of how precisely you can estimate the tenths of a second between the two second markers bracketing the occultation. Even after my first few observations using this method, I realized that this ability is solely a matter of some practice.

Regarding the uncertainty, two aspects should be mentioned:

a) I feel that smaller uncertainties are achievable with eye-and-ear than with the stop watch. This is possible because fewer error sources are inherent than in the stop watch method. Whereas with the stop watch I expect to attain averages not less than ±0ˢ3 or so, it is easy to obtain ±0ˢ1 when working with eye-and-ear.
b) Due to the direct method of measurement, it seems to be much easier to estimate the uncertainty of the timing with eye-and-ear than with the stop watch. I do this in the following way: After estimating the time of the occultation, I ask myself whether the event could have occurred by an arbitrary amount (usually 0ˢ3) earlier or later than was recorded. Depending on the answer (yes or no) I reduce or increase the amount by 0ˢ1 and ask again. This is continued until I believe it to be as close as possible to the probable uncertainty.

In the case of gradual occultation events, I feel that I am able to estimate the duration of the gradual stage rather precisely. Using the eye-and-ear method, I hear the time signal, which is practically a one-second scale. Most gradual events, however, have durations shorter than one second, so they can be estimated conveniently with respect to the time signal.

A disadvantage of the eye-and-ear method is the necessity of having a time signal available at the telescope. When using the method, be sure that you continuously can hear the time signal satisfactorily. In the case of short-wave time signals, the reception may fade suddenly. Therefore, you always should have a stop watch in your hand to ensure getting the timing, even when you can hear no time signal at the moment of the event.

I believe that the above justifies my conclusion that the eye-and-ear method is more favorable than the stop watch method for timing lunar occultations in most cases. In the final analysis, it may be too peremptory to state that the eye-and-ear method is the more precise method, but it certainly achieves an accuracy at least equal to that of the stop watch method while requiring much less expenditure of effort to determine and correct any errors. To those observers who have not worked with this method, I offer my recommendation that they familiarize themselves with it.

ASTEROIDAL OCCULTATION FINDER CHARTS AND REGIONAL MAPS FOR SOUTHERN HEMISPHERE OBSERVERS

David W. Dunham

In the last issue, I noted that finder charts and regional maps usually were published in *O.N.* only for asteroidal occultations potentially visible from North America and Europe. There are few subscribers in other parts of the Northern Hemisphere, so I usually send them copies of the computer-produced charts and maps directly. Sometimes, an event will be visible from both Europe and Asia, for example. In such a case, the Asian observers usually will not be sent a finder chart, since it will be published in *O.N.* I send these materials for Southern Hemisphere events to regional and national coordinators, who distribute them to IOTA members and other *O.N.* subscribers in their region or country, as specified below. If you live in these regions, you should inform the appropriate coordinator of your current address and telephone number(s) which might be useful for distributing the results of last-minute astrometric prediction improvement. Also, you should send the coordinator some self-addressed (and stamped, if you live in the same country) long envelopes to decrease his costs and expedite the distribution. The addresses and telephone numbers of the regional coordinators are given below:

Australia. David Herald, P.O. Box 254, Woden, A.C.T. 2606. Telephones area 62, 319214 (home) and 832111 (work). Observers in Australia, especially the eastern part, may wish to subscribe to the quarterly circulars of the Occultation Section of the Royal Astronomical Society of New Zealand (see New Zealand below), since it contains charts, maps, and news which are often applicable for Australia.

New Zealand. Graham Blow, Director, Occultation Section of the Royal Astronomical Society of New Zealand, P.O. Box 2241, Wellington, New Zealand. Telephones 861882 and 728167.

Northern South America. Jorge Polman, Clube Estudantil de Astronomia, Colegio Sao Joao, Rua Francisco Lacerda, 455-Varzea, 50.000 Recife - PE- Brazil. Telephones area 0812, 271864 or 270094.

Southern Africa. M. D. Overbeek; Box 212; Edenvale, Transvaal 1610; Republic of South Africa. Telephone 11-53-5447.

Southern South America. Eduardo V. Przybyl, Observatorio Astronomico, Colegio Nacional Luisa R. de Barriero, 9 de Julio 387, 2300 Rafaela (Santa Fe), Argentina. Telephone 22163

DECEMBER LUNAR ECLIPSE DARKNESS AND CONTACTS

Geoffrey W. Amery

If the observations do not interfere with occultation timings, I would appreciate estimates of the intensity (preferably using the Danjon scale) and colors of the December 30th total lunar eclipse. Estimated times of penumbral and umbral contacts also would be helpful. Please send reports to me at 183 Church Road, Earley, Reading, Berks. RG6 1HN, England. Results will be published in the *Circulars* of the Lunar Section of the British Astronomical Association.

PLANETARY OCCULTATIONS DURING 1983

David W. Dunham

[Ed: This is a continuation of the article which began on page 9 of the last issue. The first paragraph below was inadvertently omitted last time; it should have been the second paragraph under its heading, on page 17.]

Local Circumstances. Since the computer program producing these predictions was originally written by me, and since Mr. Carroll uses input data supplied by me, his calculations are consistent with mine. For each input event, the local circumstances printed include the U.T. and distance (in arc seconds, kilometers, and diameters of the occulting object) of closest approach, and 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 proportional to an estimate of the occulting object's along-track (time) error, or if the star is fainter than 6th mag. in daylight.

Notes about Individual Events (Continued)

Oct. 1: The star is A.D.S. 10893, with equally bright components separated by about 0".2. Hence, the Δm that observers actually will see will be about 0.7, since only one component will be occulted at a time, except in the unlikely case that the orbit is very eccentric and the stars are near periastron. Unfortunately, the orbit can not be determined with the four available observations, all of which range from 0".17 to 0".23 in separation. The observations were made in 1926.58, 1927.37, 1928.61, and 1960.57, when the p.a. was measured at 12.8°, 23.3°, 27.4°, and 30.2°, respectively. Since the components are equally bright (only the last observation indicates a 0.1-mag. difference), the actual p.a. in the late 1920's could be 180° from the reported values. So it is possible that, from the late 1920's to 1960, the stars completed one, a half, or no revolutions, resulting in periods of 32, 63, and 4110 years, respectively. The last value seems much too long for such a close pair. Of the others, the 63-year period (half-revolution from 1920's to 1960) gives a smaller error in the p.a. in 1960 if the approximate angular motion is computed from the differences in p.a. in 1928 and 1926. This would imply that the p.a. in 1983 Oct. would be 163° with a sep. of perhaps 0".19. These parameters imply that the paths for the occultations of the two stars will be separated by only 0".03 (less than Lachesis' radius), so that observers fortunate enough to be in the occultation path probably will see occultations of both components, the disappearance of the second star following the reappearance of the first star by about 11 seconds. But these are only rough estimates from the available meager observations, so recent observations of the sep. and p.a. by Southern-Hemisphere observers are needed to predict the circumstances more accurately.

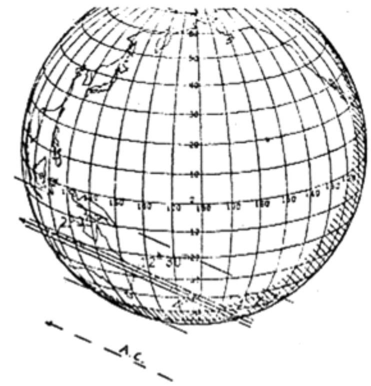
Oct. 5 and 14: The diameters of (55) Pandora (occulted Oct. 14) and Palma (Aug. 21 and Oct. 5) are very uncertain due to their ambiguous type. Since a low albedo typical of C-type asteroids has been assumed, the actual diameters for these objects may be considerably smaller, possibly by even more than 50%. The angular diameters and central occultation durations consequently also may be smaller.

Nov. 20: (6) Hebe may have a 20-km satellite, based on Maley's 1977 March 5 observation.

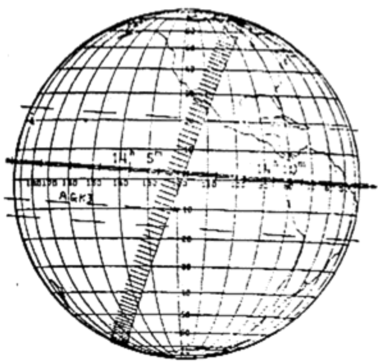
Dec. 30, (4) Vesta: The Δm will be difficult to detect even photoelectrically.

SAO 118599 by Elpis 1983 Jan 19

SAO 80228 by Dione 1983 Jan 19



L 679853 by Europa 1983 Jan 19



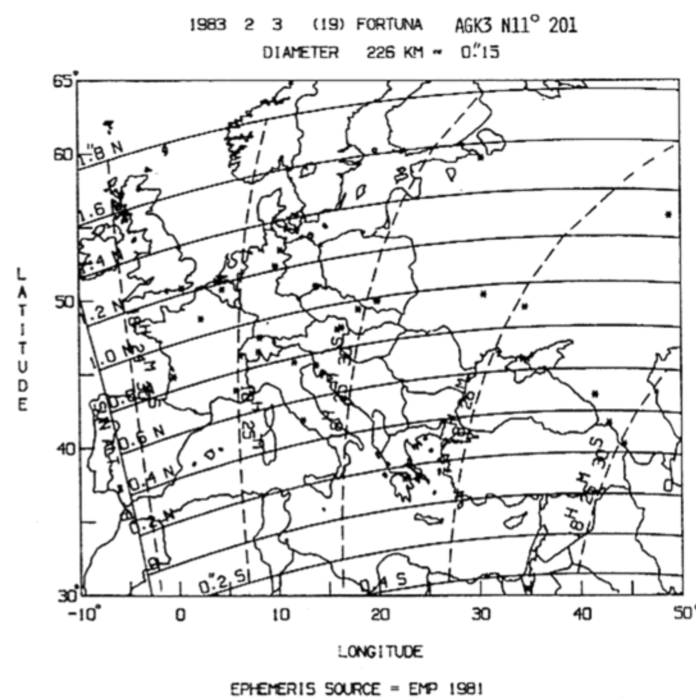
SAO 140011 by Aeria 1983 Jan 24

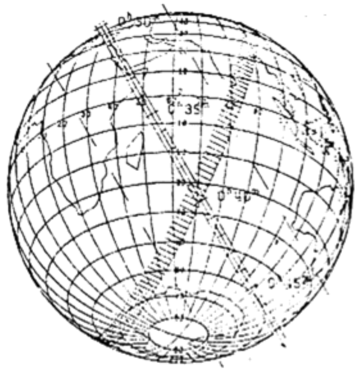
SAO 80157 by Dione 1983 Jan 27

L 679733 by Europa 1983 Feb 2

N11° 201 by Fortuna 1983 Feb 3

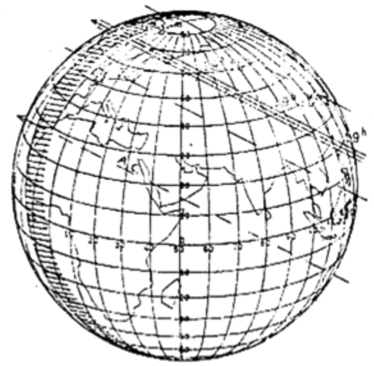
SAO 160906 by Eugenia 1983 Feb 5



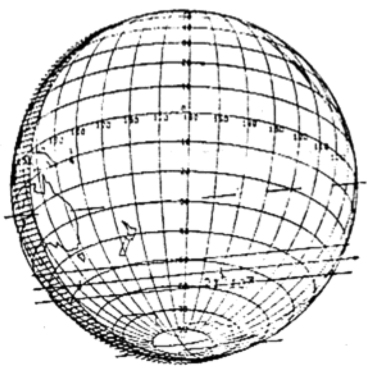


L 692822 by Interamnia 1983 Feb 6

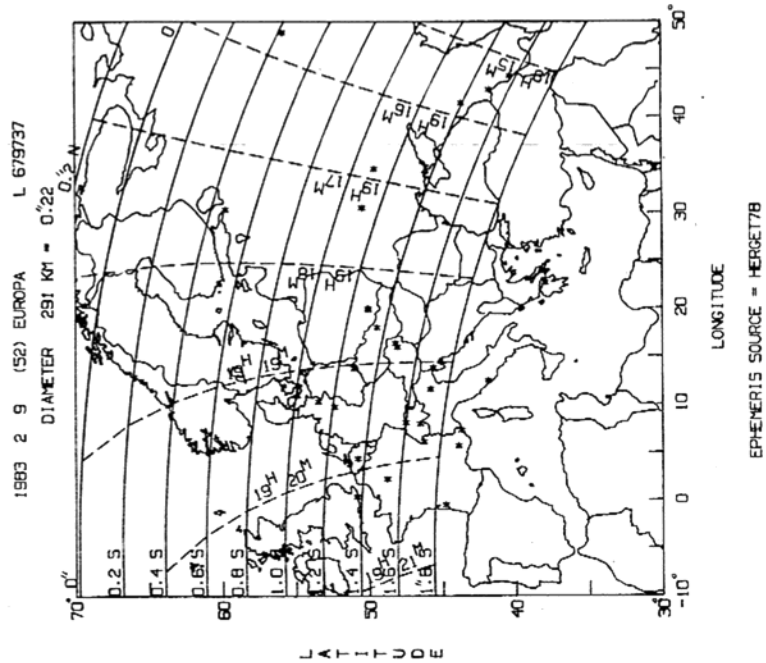
L 679736 by Europa 1983 Feb 8



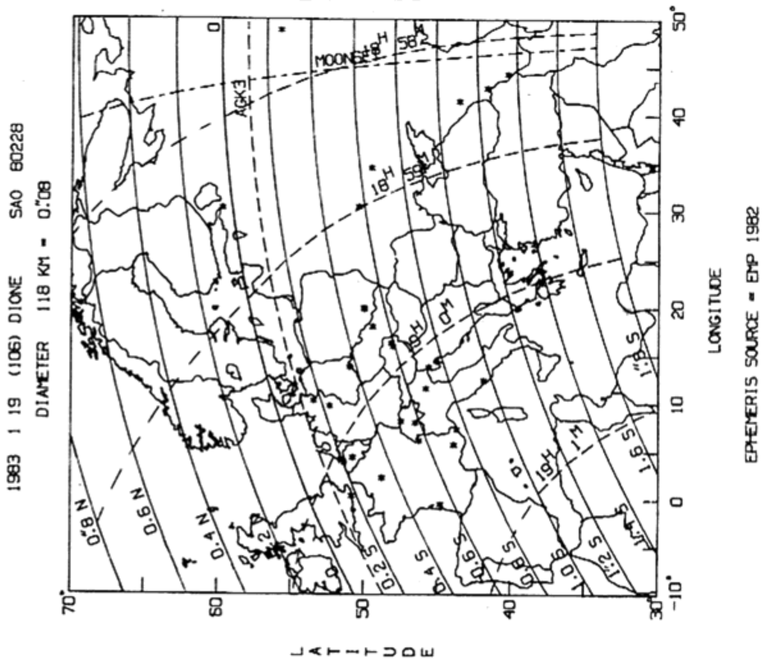
L 679737 by Europa 1983 Feb 9

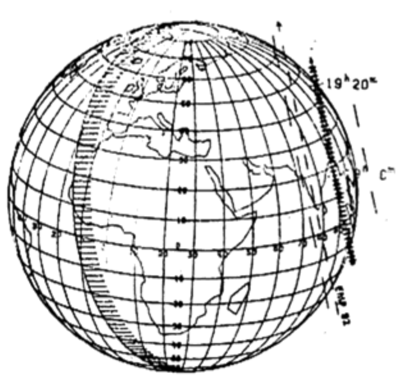


SAO 188703 by Ceres 1983 Feb 12

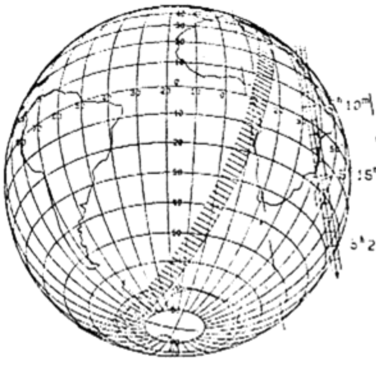


L 679740 by Europa 1983 Feb 13

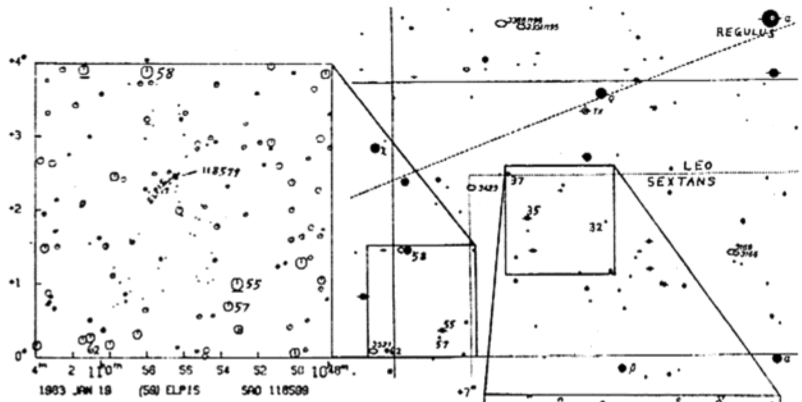


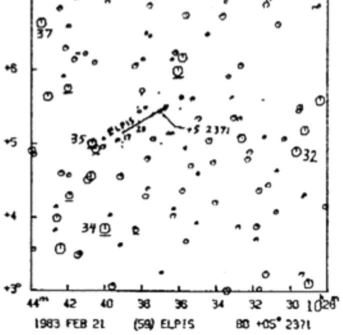


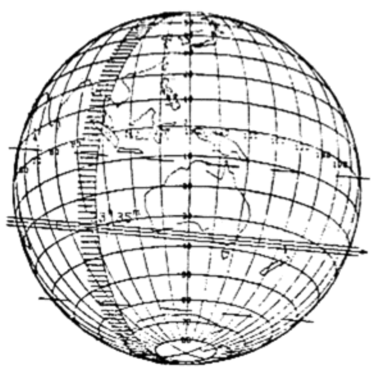
SAO 95572 by Kassandra 1983 Feb 14



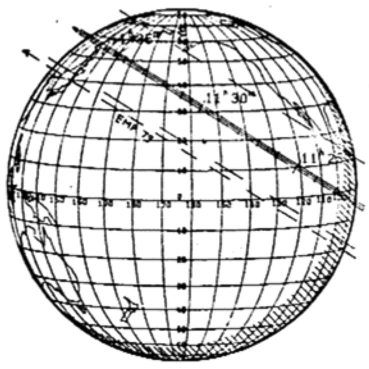
L 692831 by Interamnia 1983 Feb 17



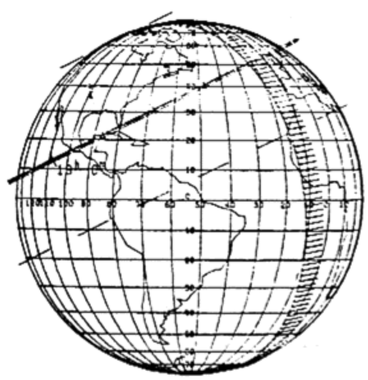




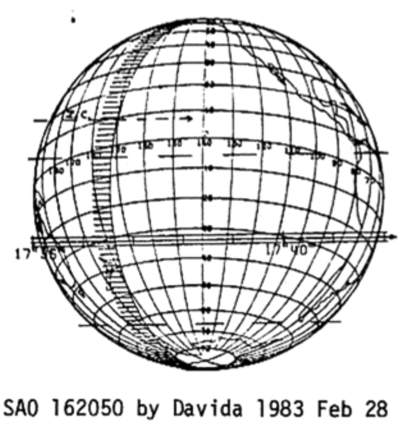
SAO 186447 by Patientia '83 Feb 19



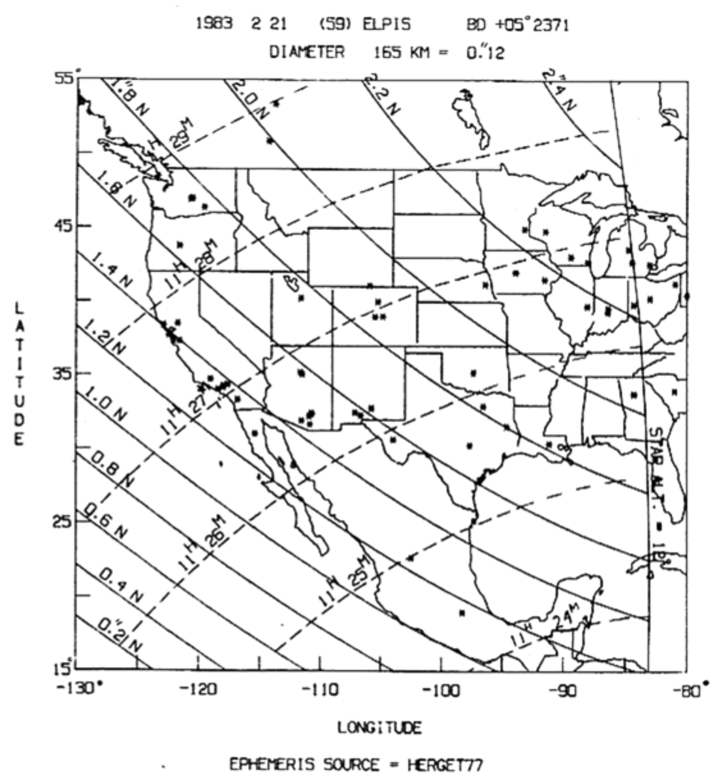
+05°2371 by Elpis 1983 Feb 21

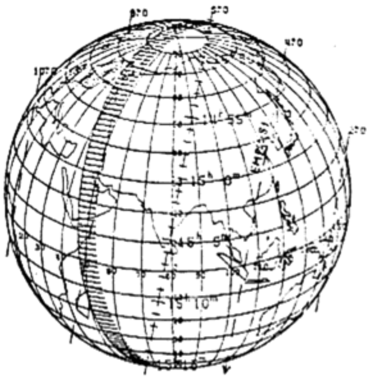


+00° 311 by Antigone 1983 Feb 27

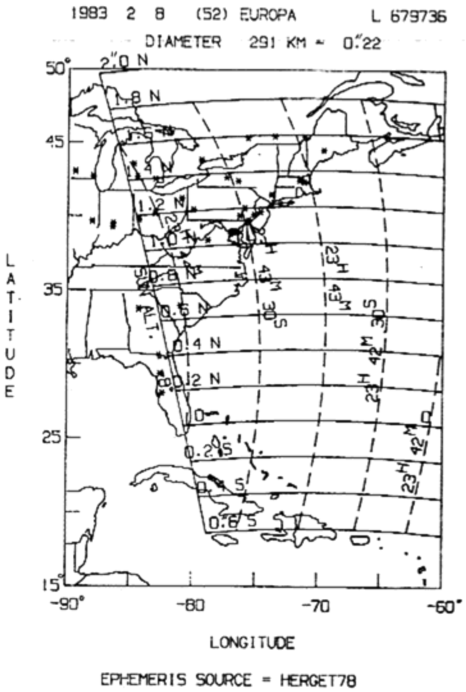


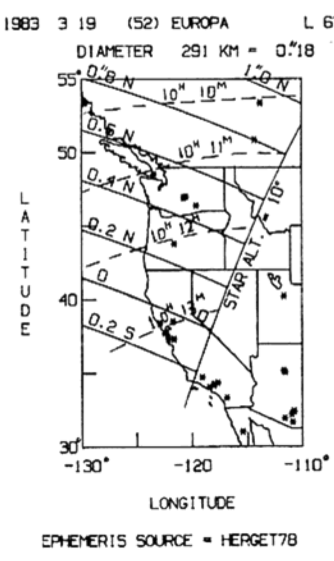
SAO 162050 by Davida 1983 Feb 28

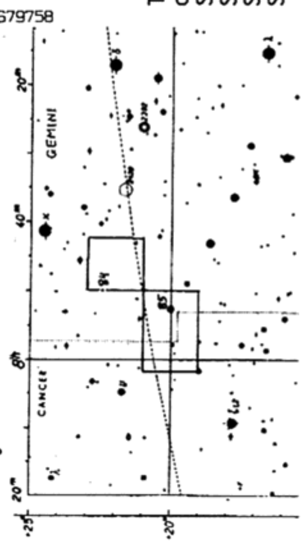




SAO 79122 by Hippo 1983 Mar 2

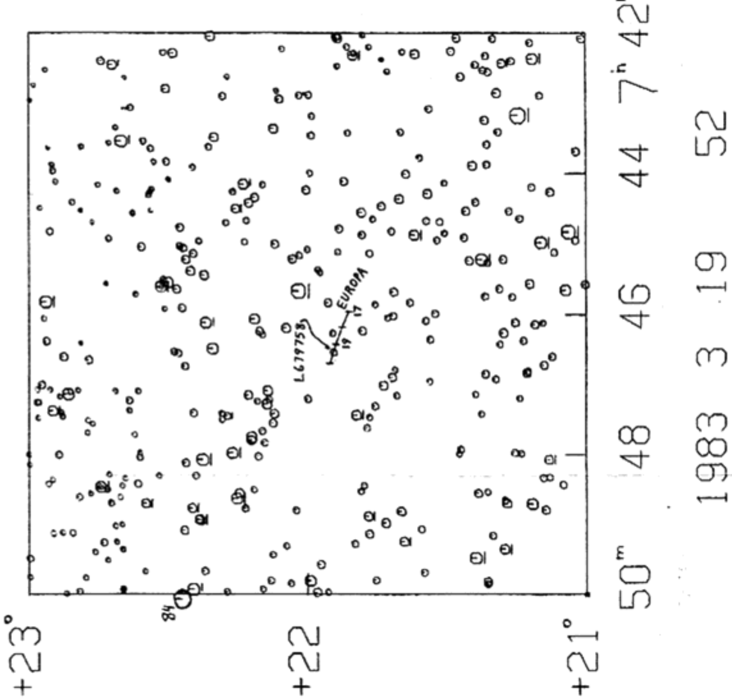


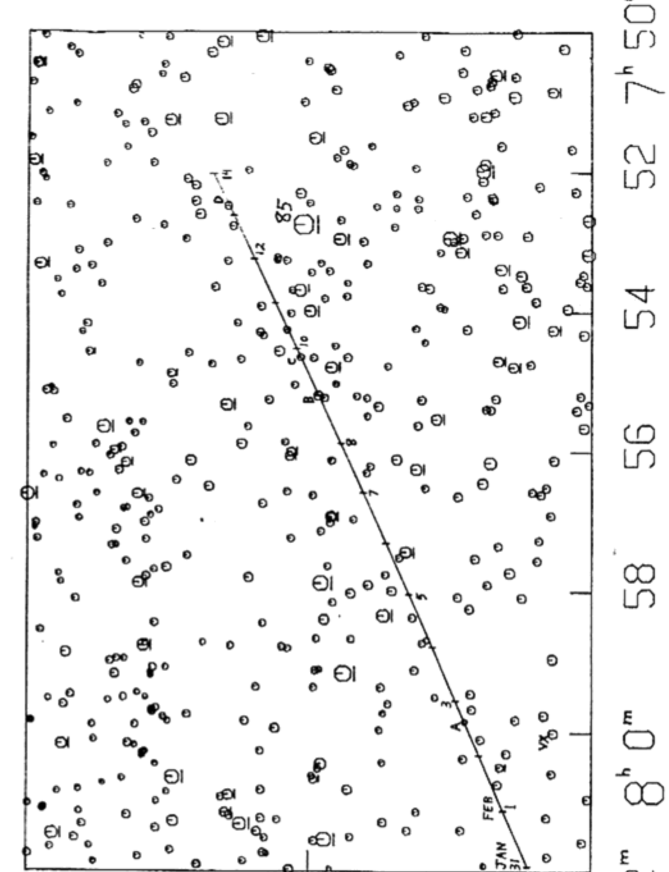


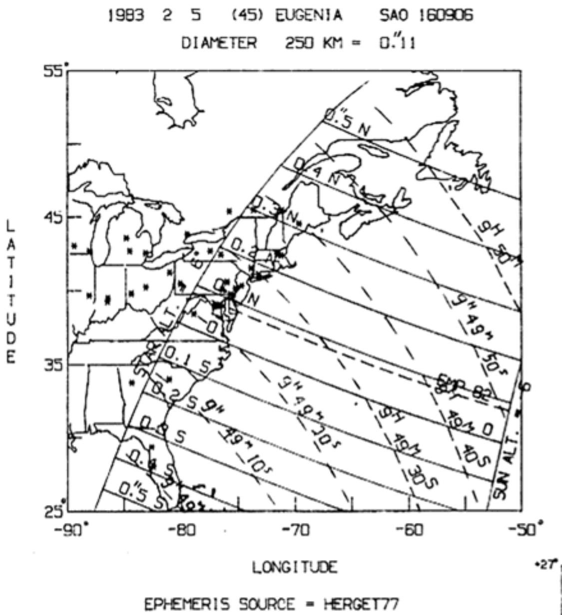


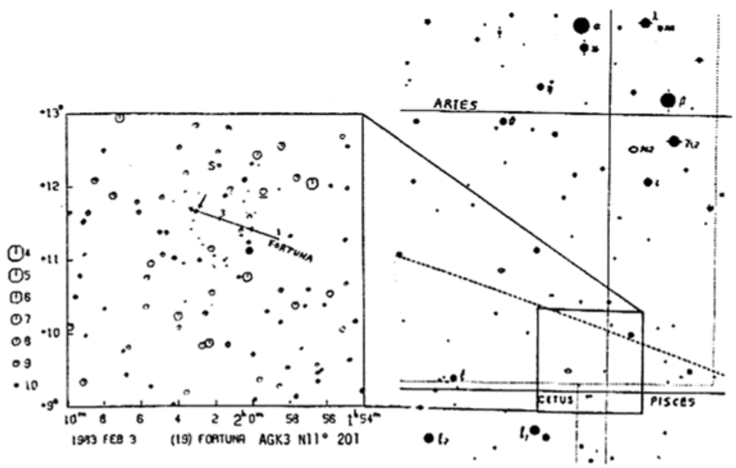
The small-scale Gemini - Cancer chart gives the outlines of the large-scale (52) Europa finder charts covering the period 1983 Jan 31 through Feb 14 on one, and Mar 17 through 20 on the other.
Star A = L 679733 1983 Feb 2
Star B = L 679736 1983 Feb 8
Star C = L 679737 1983 Feb 9
Star D = L 679740 1983 Feb 13

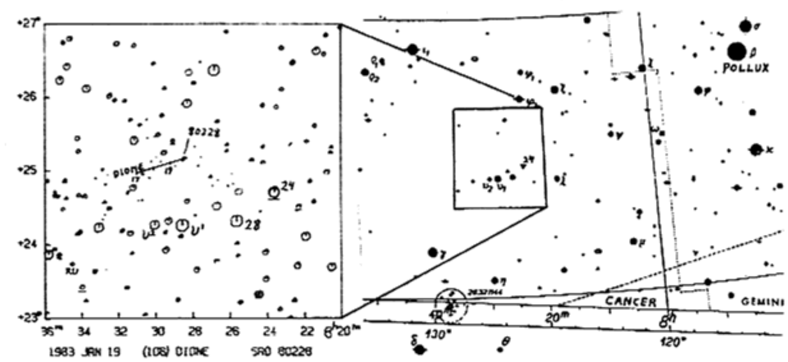
(52) EUROPA — L 679758

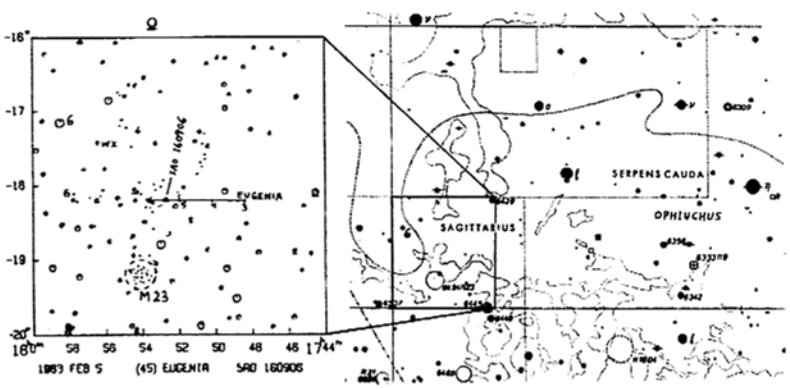


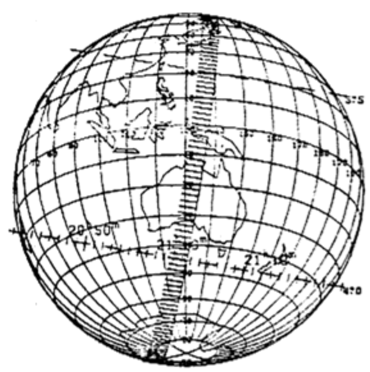






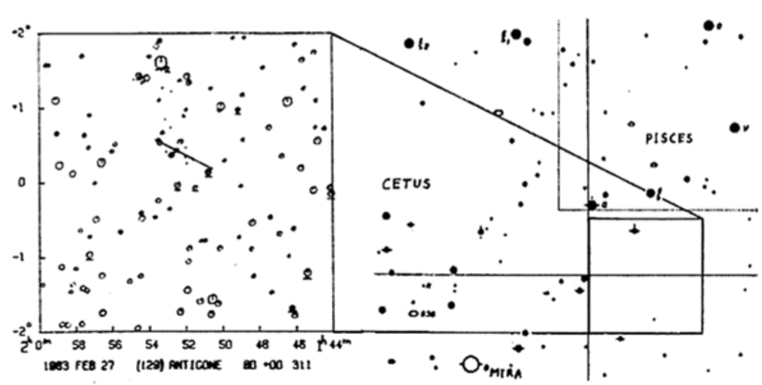




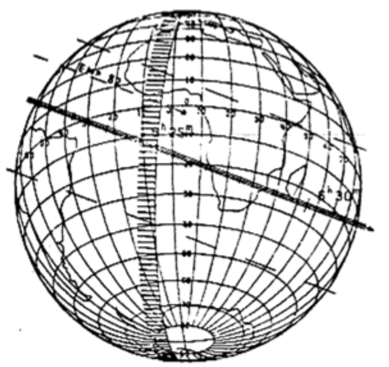


-2164352 by Uranus-R 1983 Mar 3

SAO 110445 by Undina 1983 Mar 6

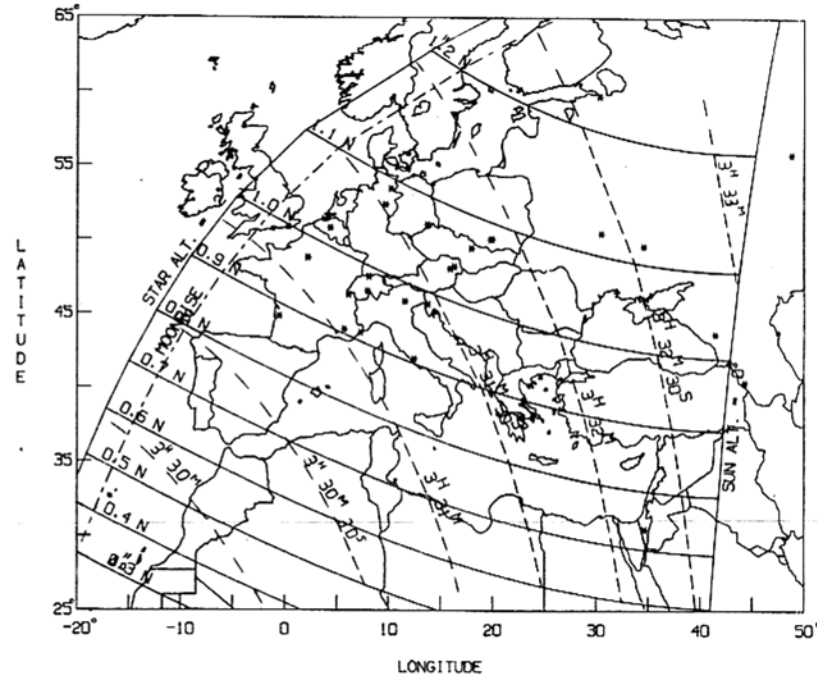


+03°2001 by Meliboea 1983 Mar 6



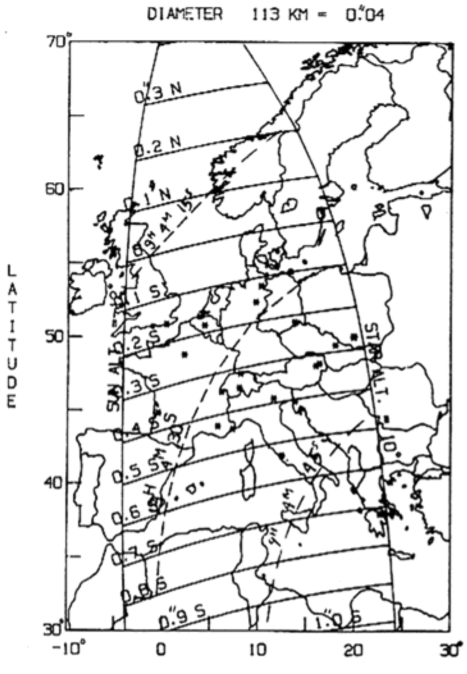
SAO 185773 by Merapi 1983 Mar 7

1983 3 8 (334) CHICAGO SAO 161056
DIAMETER 199 KM = 0."07



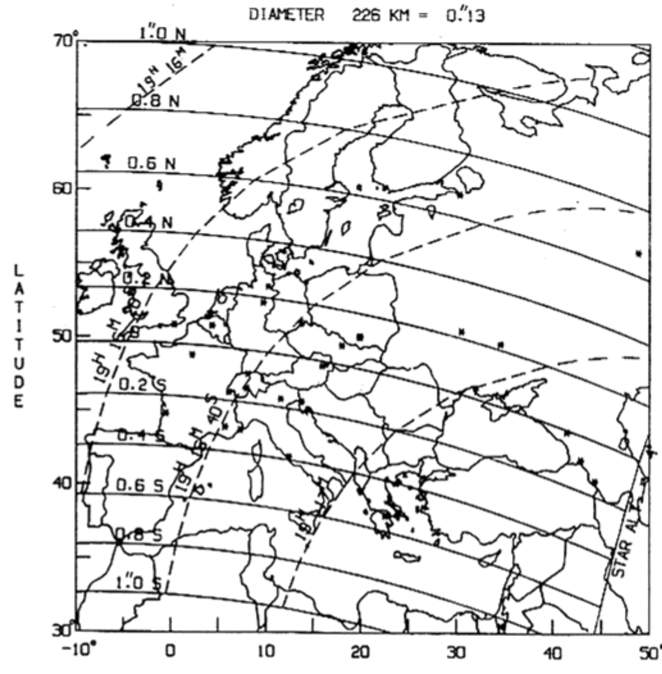
EPHEMERIS SOURCE = EMP 1983

1983 2 27 (129) ANTIGONE BD +00° 311
DIAMETER 113 KM = 0."04



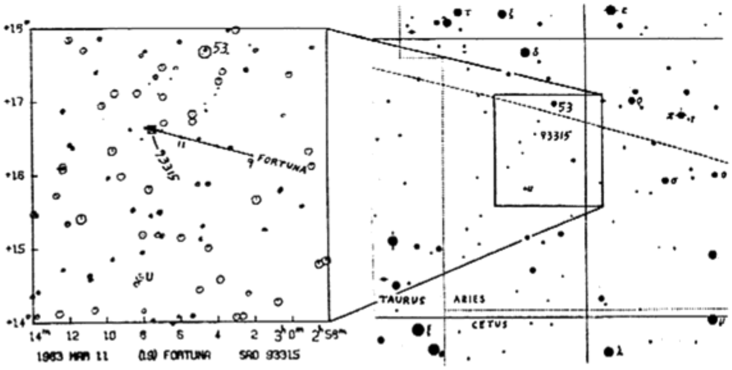
· EPHEMERIS SOURCE = EMP 1980

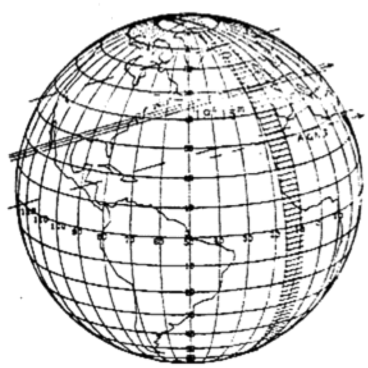
1983 3 11 (19) FORTUNA SAO 93315
DIAMETER 226 KM = 0."13



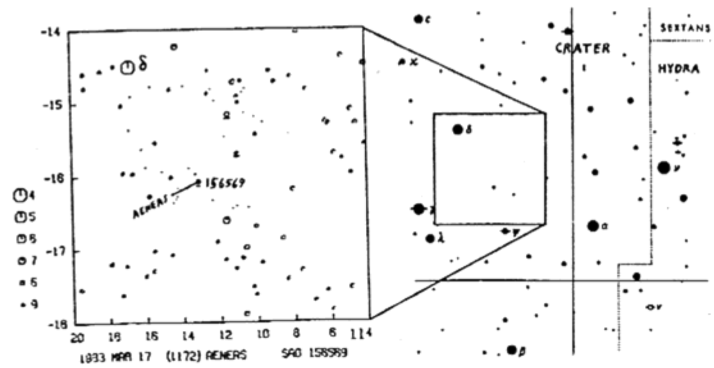
EPHEMERIS SOURCE = EMP 1981

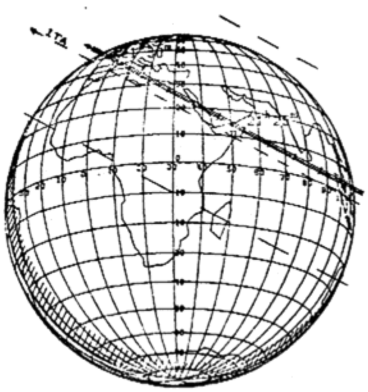
SAO 161056 by Chicago 1983 Mar 8



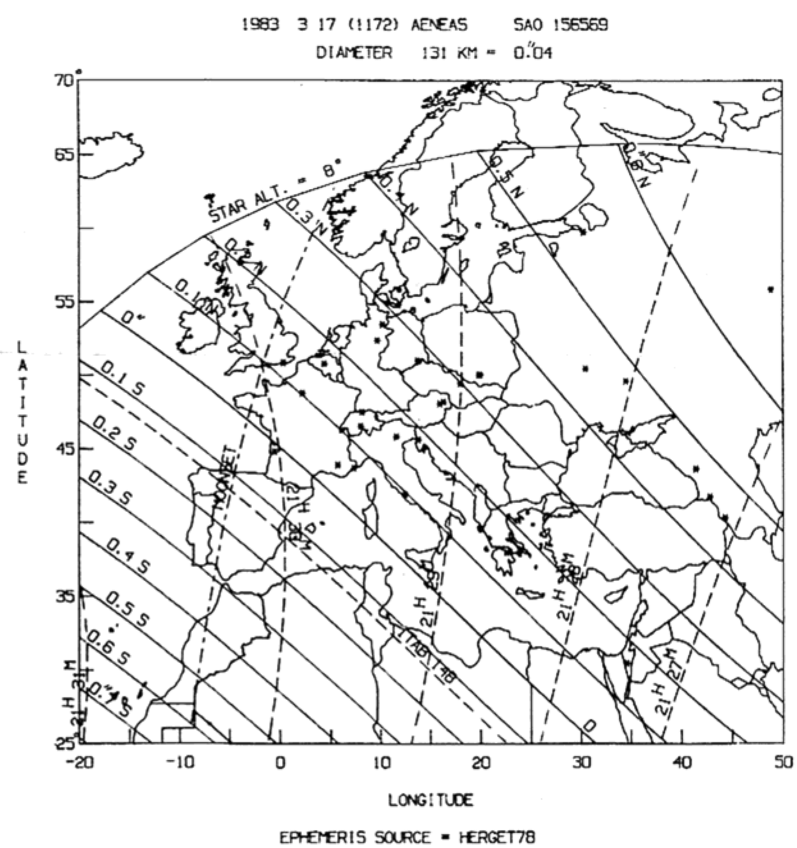


SAO 93315 by Fortuna 1983 Mar 11





SAO 156569 by Aeneas 1983 Mar 17



L 679758 by Europa 1983 Mar 19