Occultation Newsletter

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FROM THE PUBLISHER

For subscription purposes, this is the fourth issue of 1987.

Please note our zip code change to 60175.

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There are 16 issues per volume, all still available.

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

Local circumstance (asteroidal appulse) predictions (entire current list for your location)	1.00
Graze limit and profile prediction (each graze)	1.50
Papers explaining the use of the predictions	2.50

Supplements for South America will be available at extra cost through Ignacio Ferrin (Apartado 700; Merida 5101-A; Venezuela), for Europe through Roland Boninsegna (Rue de Mariembourg, 33; B-6381 DOURBES; Belgium), for southern Africa, through M. D. Overbeek (Box 212; Edenvale 1610; Republic of South Africa), for Australia and New Zealand, through Graham Blow (P.O. Box 2241; Wellington; New Zealand), and for Japan, through Toshio Hirose (1-13 Shimomaruko 1-chome; Ota-ku, Tokyo 146, Japan). Supplements for all other areas will be available from Jim Stamm (Route 13, Box 109; London, KY 40741; U.S.A.) by surface mail at the low price of 1.18 or by air (AO) mail at 1.96

Observers from Europe and the British Isles should join IOTA/ES, sending DM 40.-- to the account IOTA/ES Bartold-Knaust Strasse 8, 3000 Hannover 91, Postgiro Hannover 555 829 - 303, bank-code-number (Bankleitzahl) 250 100 30. Full membership in IOTA/ES includes the supplement for European Observers (total and grazing occultations).

[1] Single issue at ¼ of price shown
[2] Price includes any supplements for N. A. observers
[3] Not available for U.S.A., Canada, and Mexico
[4] Area "A" = Central America, St. Pierre and Miquelon, Caribbean Islands, Bahamas, Bermuda, Colombia, and Venezuela. If desired, area "A" observers may order the North American supplement by surface mail at $1.18, or by air (AO) mail at $1.50.
[5] Area "B" includes the rest of South America, Mediterranean Africa, and Europe (except Estonia, Latvia, Lithuania, and U.S.S.R.).

IOTA NEWS

David W. Dunham

During 1987, IOTA produced new and bigger *O.N.* issues and supplements, accelerating our expenditures so that they are significantly exceeding our income. As noted by C. Herold in the minutes of IOTA's meeting, held on October 10th (see p. 136), there has been a dangerous drop in IOTA's balance during the year, in spite of last year's $1 dues and subscription increase. So, reluctantly, we find it necessary to once again raise our dues and rates, to the values given in "From the Publisher" on this page. At the meeting, a larger raise was decided upon, in order to postpone the need for another raise. The rates are still quite reasonable compared with those of organizations providing similar services. Unfortunately, like last year, the old rates were published in the R.A.S.C. *Observer's Handbook for 1988*, but the new rates will appear in my articles in the January issue of *Sky and Telescope*. Also at the meeting, we decided to abandon the two-tier cost structure for credit card payments, which causes some confusion.

In the meantime, Hans-Joachim Bode reports that the European Section (IOTA/ES) has decided to lower their main membership rate from DM 50.-- to DM 40.-- for annual dues, as noted in "From the Publisher." This brings their dues more in line with our parent IOTA dues for overseas members.

If anyone has, or knows where we can get, a database of coordinates of Canadian provincial boundaries, please let me know; see p. 141. Databases of boundaries of Australian states and Soviet republics also would be useful, although not as urgently needed as the Canadian data.

A form, "1987 Survey of NBS Time and Frequency Service Users," and an associated letter, are enclosed for North American readers. Copies will be supplied to others upon request. Please complete and mail this form to the National Bureau of Standards, especially those in the U.S.A., who do not need to affix any postage. Don Oliver sent me these forms after responding to a request broadcast on WWV. We don't want WWV to go the way of VNG. The Time and Frequency Division has worked with us in the past, broadcasting last-minute asteroid occultation updates on a couple of occasions.

On December 19th, my company, Computer Sciences Corp., moved my office to a new building called Greentec II, in Lanham-Seabrook, Maryland, about 15 miles east of Silver Spring. The full address is Computer Sciences Corp.; Greentec II; 10110 Aerospace Road; Lanham-Seabrook, MD 20706. My new office telephone number is 301,794-1392 (direct); the switchboard number is 301,794-4460. In a few months, we plan to buy a house near Greentec II and close our Silver Spring post office box; new addresses and telephones will be announced in *O.N.* as soon as they are available.

Unfortunately, this issue has been delayed by various projects that took more time than expected, so that it will be received by most North Americans after the first one or two asteroid occultations in the North American Asteroidal Occultation Supplement. Our successful trip to China for the September 23rd eclipse; work on asteroidal occultations; my recent office move; and various software problems described in other articles in this issue, contributed to the delays. Especially unfortunate has been my inability to produce the grazing occultation supplements for distribution with this issue; see page 141. We plan to distribute the next issue, Number 7, either late in January or early in February, along with the grazing occultation supplements. That issue will contain Jim Stamm's report on asteroidal occultations and appulses during the first half of 1987, and an article about the February 24th Pleiades passage that is very favorable for North America.

MINUTES OF 1987 IOTA MEETING

Charles H. Herold, Jr.
Executive Secretary, IOTA

Date: 1987 October 10
Time: 9:05 am, CDT
Place: Lunar and Planetary Institute; Houston, TX

The regular yearly IOTA meeting was held on Saturday, 1987 Oct 12, in the conference room of the LPI Building. There were fifteen members present, including three of IOTA's directors: Dr. David Dunham, President; Paul Maley, Executive Vice President; and Charles Herold, Executive Secretary. The Secretary-Treasurer, Homer DaBoll, was not present.

At 9:05 am, Dr. Dunham opened the meeting and introduced everyone in attendance. Members from the Johnson Space Center Astronomy Society, the Houston Astronomical Society, the Brazos Bend Astronomy Society, and the Saguaro Astronomy Club of Phoenix, AZ, were present. The meeting was held in two parts, business and scientific. First to be conducted was the business session.

Business Session.

1) Dr. Dunham presented the Treasurer's report:

Bank balance as of 1986 Sept. 22	$1,481.50
Receipts	5,002.82
Expenditures	5,557.22
Bank balance as of 1987 Sept. 22	$927.10

2) Dr. Dunham mentioned the problem of rising cost of paper, postage, and sundry items, with the idea of possibly raising rates in the future. C. Herold made a motion to increase domestic subscription and dues rates to $10.00 and $15.00, respectively, now, with appropriate foreign rates to be set by the Secretary-Treasurer, to avoid financial problems in the near future. Joan Dunham seconded the motion. During the discussion, Gene Lucas noted that there is a lot of good data, needed by the member, for an extremely low price, and consequently, he thought the motion was reasonable. A vote was taken, and all 15 of the members present voted yes, to increase rates, starting with the next [Ed: this] issue of *O.N.*

Scientific Session.

1) A preview of asteroid and comet occultations for 1988 was given by Dr. Dunham. Many were discussed. See *Occultation Newsletter* and *Sky and Telescope* for more details.

2) A preview of grazing occultations for 1988 was next. See *O.N.* for more information.

3) Past expeditions, with some results.
A) Video of Antares graze in Arizona on 1987 Jan 25 was presented by P. Manly, C. Herold, and G. Lucas.
B) Video of Spica graze in New Mexico on 1987 Feb 20 was presented by D. Dunham, C. Herold, P. Maley, and G. Nealis.
C) Video of Alcyone graze in Corpus Christi, TX, on 1987 Mar 20 was presented by C. Herold, P. Maley, and G. Nealis.
D) Many videorecordings of past occultations and eclipses were also shown. Reductions of these events will appear in future issues of *O.N.*
E) Video of the total-annular eclipse in Gabon on 1987 Mar 26 was presented by P. Maley and G. Nealis. They had some problems with 30-knot winds and clouds. But they did get some good data which supported the new simulation program at the U.S.N.O.
F) Videos of the annular solar eclipse in China on 1987 Sep 23 were presented by D. Dunham, J. Dunham, P. Maley, C. Herold, and G. Nealis; they also showed videotapes by members not present, Denise and Derald Nye, and Robert and Sallie Coke. Photographs and other recorded data were shown by the IOTA members, and by G. Dommerman. D. Dunham, J. Dunham, and G. Nealis drove to Pei-Cheng Chen, a small town about 15 km south of Chang Zhi, to record data at the southern limb. All others were positioned along a line at Taiyuan, the northern limb.

4) Plans for future eclipses.
A) Plans for the eclipse in Mar 1988 are still not finalized, due to the turmoil in the Philippines. It may be necessary to go to Indonesia, perhaps eastern Borneo.

B) Plans for the eclipse trip in Jul 1990 to Russia may not be feasible because fixing our position to the desired accuracy may not be possible. Therefore, Finland may be the only choice, but there is a problem there, in that the Sun will be at only 3°5 altitude at eclipse time.

5) Other topics.

A) P. Maley described efforts by A. Saulietis and himself, using a 24-inch reflector at the Santa Fe Observatory, to record the ISEE-2 spacecraft. This satellite entered the atmosphere over Brazil on 1987 Sep 26. The two were successful in recording the satellite before burn-up, using the same methods as for recording satellite occultations. They also recorded the companion satellite ISEE-1 at a slant range of 20,000 km. The magnitude of the satellite was approximately +12, with a rotation rate 20 rpm.

B) P. Maley and C. Herold talked about the 100th anniversary of the Societe Astronomique de France, which was celebrated in June 1987. IOTA was an invited co-sponsor of the week-long event. P. Maley chaired one of the technical sessions, and presented two papers on IOTA-related topics.

C) Don Stockbauer reminded everyone that it is important to send graze reports to him and to ILOC, and that all total occultation reports should be sent to ILOC.

D) The deadline for submission of projects for HST (Hubble Space Telescope) has been extended to the date of the next shuttle launch.

E) It was suggested that someone should investigate the possibility of IOTA members and other groups, to communicate on SPAN or BIT-NET network systems. This could reduce the cost of transmitting large amounts of data.

Formal Talks.

1) P. Manly, of IOTA and Litton Industries, gave an in-depth talk on the use of image intensification for astronomical work. According to him, an eight-inch telescope with an intensifier can give the same results as a forty-inch without one! (Imagine recording 13th-mag. stars in real-time video with an eight-inch) It may be possible to get a copy of his talk by writing him or me.

2) G. Nealis talked about reducing videotapes of grazes and other astronomical events. Careful consideration needs to be given when calculating disappearances and reappearances. Video equipment records at different rates, and it is important to record at the SP rate of the recorder. Disappearances and reappearances always occur in three steps with the Ultricon; never full on or off. It seems to be intrinsic in the hardware.

3) G. Lucas, IOTA and Saguaro Astronomy Club, talked about limiting the amount of light reflected into the eyepiece. A way to place a cardboard baffle to reduce the glare in a Schmidt-Cass was discussed, and more information will be published in *Astronomy* magazine and in a future issue of *O.N.*

Post-Adjournment Proceedings.

Our reserved time at the LPI ran out, and we adjourned to a restaurant to continue our discussions. We had some programs to evaluate and exchange, and some unfinished business, so we continued the meeting at my home, where we wore each other out, and finally broke up at 11:45 pm CDT. Next year, we may need two days to conduct business.

ECLIPSE NEWS

Paul D. Maley

This is a brief status summary on solar eclipse efforts by IOTA. More details will follow in the next issue of *O.N.*

1987 September 23 Annular Solar Eclipse. IOTA teams led by me entered China on September 19 and returned on October 3, completing a very productive eclipse expedition. Three stations at the northern limit of this annular eclipse had clear skies at Taiyuan (southwest of Beijing) while David Dunham and Gary Nealis (Houston, TX) observed at Pei-Cheng Chen at the south edge and had the same good fortune. Video records were obtained on VHS tape by Chuck Herold (Houston, TX), Derald and Denise Nye (Tucson, AZ), and me, and by Robert and Sallie Coke (Macon, GA) who used 8mm and afocal projection. Chinese astronomers at Shanghai Observatory mounted an independent effort and sent cinematography stations to both limits north and west of coastal Shanghai. IOTA teams recorded Baily's beads at every site. *Sky and Telescope* is expected to publish our account in February 1988.

1988 March 18 Total Solar Eclipse. Plans for a U.S.-based expedition remained stalled due to several factors. Political conditions continue to deteriorate in the Philippines. At Bangka Island, Indonesia hotel space remains a problem, as are flights, but we continue to work the situation. Persons interested in a tax-deductible effort at the northern limit should contact me at 713,488-6871.

Hans Bode (IOTA/ES) is preparing to go to the southern limit in Kalimantan, while Australians David Herald and Brian Soulsby plan to observe at the southern edge also, on Belitung Island,

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1979 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 1979. In the individual list, B. F. Sincheskul of the USSR is the leader, followed by N. P. Wieth-Knudsen of Denmark and R. Hays of the USA. Evans, et al, and Japan Photoelectric, represent multiple observers.

The values were again 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 1979, 394 plus observers (when multiple observers are counted) from 27 countries reported 7478 observations, of which 2015 were reappearances. That makes C = 1.7111662, or reappearances are weighted over disappearances by the factor 2.7111662.

In the table of individual observers, station and observer numbers occur for names in those cases where observations were listed on the available HMNAO tapes but no names were available. In addition, 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.

B. F. Sincheskul, the leading observer for 1979, was also eighth in 1975, and might have placed in the top 10 in 1978, were it not for the fact that only the total USSR occultation observations were available. Wieth-Knudsen and Hays continue their consistent observing since 1975. They have been in the top four each of those years. It is also interesting to note that, for the first time since these tallies have been published (1975), there are an equal number of top 10 observers south of the equator as north of it.

The listing by country shows that 27 countries had active observers, with the USA leading in the value column. The USSR is next, and also has the largest number of observers. New Zealand is then third in the value column, but has the second largest number of occultations observed. On a per-observer basis, however, Denmark and Argentina are certainly the most productive of all reporting countries, and this is due primarily to their two dominant observers.

From a personal standpoint, I wish to express my apologies for the long lapse between publication of the 1978 and 1979 tallies: 5 years!! This was due to a number of events, principal among them a double change of computers (rapid technology advances). The current (and future?) tallies are being done on my Macintosh Plus whereas the 1977 and 1978 tallies were accomplished on a large main-frame. I hope to catch up rapidly for the years 1980 through about 1985. Then we can proceed once a year, with about a 2-year lag. Please keep the coupons coming; they will probably constitute the only data source for the future tallies. Tapes are too hard to deal with, need to be hand-correlated with the coupons, and are most often incomplete.

Country Listing of 1979 Occultation Tally

Rank	Value	Total	R's	Country	Obsrv's	Value/Obs
1	2888.2	1983	529	USA	55	52.5
2	1503.7	862	375	USSR	76	19.8
3	1464.0	1156	180	New Zealand	42	34.9
4	1439.2	931	297	Japan	27	53.3
5	586.8	491	56	Italy	20	29.3
6	557.7	260	174	Denmark	3	185.9
7	486.4	370	68	Australia	13	37.4
8	408.2	285	72	Czechoslovakia	56	7.3
9	258.9	223	21	England	19	13.6
10	229.9	158	42	Brazil	10	23.0
11	178.8	83	56	Argentina	1	178.8
12	167.7	89	46	Poland	12	14.0
13	165.5	121	26	Philippines	3	55.2
14	125.9	90	21	Finland	11	11.4
15	104.7	91	8	South Africa	4	26.2
16	103.7	90	8	Netherlands	9	11.5
17	58.8	28	18	Yugoslavia	5	11.8
18	52.8	34	11	Greece	1	52.8
20	36.4	33	2	German Fed. Rep.	2	18.2
19	32.4	29	2	German Dem. Rep.	8	4.1
21	24.4	21	2	Portugal	5	4.9
22	18.0	18	0	Zimbabwe	1	18.0
23	11.7	10	1	Canada	3	3.9
24	7.0	7	0	Belgium	1	7.0
25	7.0	7	0	Malta	5	1.4
26	5.0	5	0	Dominican Republic	1	5.0
27	3.0	3	0	Scotland	1	3.0
Totals:		7478	2015		394	

1979 Occultation Observations Summary
(ordered by value)

		Name	Location	T	R
1	744.2	B.F. SINCHESKUL	USSR, POLTAVA	390	207
2	555.8	DAVID EVANS, ET AL	USA, MCDONALD OBS., TX	395	94
3	517.1	PHOTOELECTRIC	JAPAN,	334	107
4	497.5	N.P. WEITH-KNUDSEN	DENMARK, TISVILDELEJE, SEALAND	210	168
5	337.7	ROBERT H. HAYS, JR.	USA, WORTH, IL	194	84
6	277.2	DAVID STEICKE	AUSTRALIA, MURRAY BRIDGE	178	58
7	232.6	G. HERDMAN	NEW ZEALAND, AUCKLAND	159	43
8	208.6	NOEL MUNFORD	NEW ZEALAND, PALMERSTON NORTH	123	50
9	196.9	T. ZYO	JAPAN,	125	42
10	194.8	JAMES L. FERREIRA	USA, LIVERMORE CA.	152	25
11	185.8	GRAHAM L. BLOW	NEW ZEALAND, BLACK BIRCH	179	4
12	178.8	AMBROSIO J. CAMPONOVO	ARGENTINA, BUENOS ARIES	83	56
13	158.6	ROBERT CLYDE	USA, STREETSBORO, OH	73	50
14	146.5	A. SUZUKI	JAPAN, SIRAHAMA	90	33
15	137.1	RICHARD NOLTHENIUS	USA, MOUNTAIN VIEW, CA	108	17
16	122.9	LIONEL E. HUSSEY	NEW ZEALAND, CHRISTCHURCH	87	21
17	117.4	Y. KIMOTO	JAPAN, SIMAGAWA	90	16
18	113.6	ROBERT L. SANDY	USA, KANSAS CITY, MO	76	22
19	111.8	PAUL L. MCBRIDE	USA, GREEN FOREST, AK (Ed AR)	93	11
20	108.6	V.I. MAZUR	USSR, KIEV	59	29
21	107.4	ROBERT N. BOLSTER	USA, ALEXANDRIA, VA	68	23
22	97.1	M.D. OVERBEEK	USA, GARDEN CITY, N.Y.	68	17
23	96.8	PAUL J. NEWMAN	USA, GARLAND, TX	54	25
24	90.4	CLAUDIO COSTA	ITALY, ROME	75	9
25	90.0	HARRY O. WILLIAMS	NEW ZEALAND, AUCKLAND	78	7
26	89.1	CESARIO E. TAGANAS	PHILIPPINES, QUEZON CITY	48	24
27	86.7	ADRIANO FILIPPONI	ITALY, ROME	73	8
28	85.9	Y. KOM	JAPAN,	50	21
29	85.7	A.A.B.	ITALY, BOLOGNA	72	8
30	84.5	K. BLACKWELL	ENGLAND, WESTHAM, SUSSEX	64	12
31	83.4	JAMES H. VAN NULAND	USA, SAN JOSE, CA	80	2
32	82.8	ALFRED C. WEBBER	USA, CHADDS FORD, PA	52	18
33	81.1	P. KILBEY	NEW ZEALAND, AUCKLAND	64	10
34	80.0	SPESSATO-VETTORI	ITALY, FONTANIVA, PADOVA	68	7
35	75.9	T. MIY	JAPAN,	40	21
36	75.1	JOSEPH ZODA	USA, MAPLE PARK, IL	34	24
37	72.4	JORGE POLMAN	BRAZIL, RECIFE, PERNAMBUCO	69	2
38	71.9	CLIFFORD J. BADER	USA, WEST CHESTER, PA.	36	21
39	69.4	M. OKU	JAPAN,	42	16
40	67.7	JUAN D. SILVESTRE	PHILIPPINES, QUEZON CITY	66	1
41	64.0	GERRY D. ALLCOTT	NEW ZEALAND, AUCKLAND	52	7
42	63.4	B. NIKOLAU	NEW ZEALAND, PALMERSTON NORTH	48	9
43	62.4	I.V. FREITAS	BRAZIL, RECIFE, PERNAMBUCO	23	23
44	60.3	P MAEGRAITH	AUSTRALIA, ADELAIDE, S. AUSTR.	50	6
45	59.0	BEN HUDGENS	USA, CLINTON, MS	59	0
46	56.8	STEVE J. ZVARA	USA, WHITTIER, CA	50	4
47	52.8	DEMETRIUS P. ELIAS	GREECE, PENTELI	34	11
48	51.7	JOSEPH E. CARROLL	USA, MINNETONKA, MN	38	8
49	50.1	RICHARD W. LASHER	USA, CHINA LAKE, CA	33	10
50	49.6	SAUDRO BARONI	ITALY, MILANO	41	5
51	49.1	JAN HERS	SOUTH AFRICA, SEDGEFIELD, CAPE PROV	44	3
52	47.1	JAMES H. FOX	USA, AFTON, MN	30	10
53	46.0	ROBERT LASCH	USA, GREEN VALLEY, AZ	46	0
54	45.1	G. PATTERSON	NEW ZEALAND, CHRISTCHURCH	40	3
55	44.0	B. BRIDGE	AUSTRALIA, BRISBANE	44	0
56	44.0	T.J. HICKEY	NEW ZEALAND, WHANGAREI	44	0
57	43.1	MATTI TURUNEN	FINLAND, LIEKSA	26	10
58	42.1	ASTRON. GRP. CMU	USA, MT PLEASANT, MICHIGA	37	3
59	38.7	A.W. DODSON	NEW ZEALAND, OTAKI	37	1
60	38.5	A.K. OSIPOV	USSR, KIEV	18	12
61	37.8	MANEK	CZECHOSLOVAKIA, PRAHA	31	4
62	37.6	N.P. KALINICHENKO	USSR, SHTOMPELEVKA	29	5
63	37.1	MAURICE STOKER	NEW ZEALAND, AUCKLAND	32	3
64	36.4	DON M. STOCKBAUER	USA, HOUSTON, TX	33	2
65	36.0	H. TOMIOKA	JAPAN, HITACHI	24	7
66	35.4	M. MATTHEWS	NEW ZEALAND, AUCKLAND	32	2
67	35.1	M. BECH	DENMARK, COPENHAGEN	30	3
68	34.7	BARRY MENZIES	NEW ZEALAND, AUCKLAND	33	1
69	34.5	V.N. MAZHOROVSKI	USSR, POLTAVA	14	12
70	33.8	A. HOUSKA	CZECHOSLOVAKIA, TURNOV	15	11
71	33.8	STATION 331 OBS. 51	NETHERLANDS, ZOETERMEER	27	4
72	33.8	TOM MARTINEZ	USA, KANSAS CITY, MO	15	11
73	33.1	FRANCESCO CERCHIO	ITALY, RIVALBA, TORINO	28	3
74	31.8	D. GOODMAN	NEW ZEALAND, WELLINGTON	25	4
75	31.4	S. KAN	JAPAN,	28	2
76	31.0	BRAD TIMERSON	USA, NEWARK, NY	19	7
77	30.4	ROGER H GILLER	AUSTRALIA, ENGADINE, NSW	27	2
78	30.1	A.I. ZAPOROZHETS	USSR, KIEV	13	10
79	29.4	V.O. VASH	USSR, UZHGOROD	14	9
80	29.0	A.M. MOROZOV	USSR, TOMSK	17	7
81	28.8	JUHANI SALMI	FINLAND,	22	4
82	28.7	T. YAT	JAPAN,	15	8
83	27.3	K. KENMOTU	JAPAN, SIMOSATO	17	6
84	27.1	LUCA PIETRANERA	ITALY, ROME	22	3
85	27.1	A.I. ZAPOROZHETS	USSR, LESNIKI	10	10
86	26.7	DOUGLAS HALL	ENGLAND, LEICESTER	25	1
87	26.3	V.M. MOZHAROVSKII	USSR, NABLUODEI	16	6
88	26.0	M.R. ZSHMATOV	USSR, TASHKENT	14	7
89	25.8	SOUKUPOVA	CZECHOSLOVAKIA, PRAHA	19	4
90	25.4	HARALD MARX	FRG, KORNTAL-MUNCHINGEN	22	2
91	25.1	CARL GRUNNET	DENMARK, VIRUM	20	3
92	25.0	LUIZ AUGUSTO DA SILVA	BRAZIL, PORTO ALEGRE, RS	13	7
93	24.7	E. BELDA	CZECHOSLOVAKIA, TURNOV	11	8
94	24.4	Y. GENEKO	JAPAN, TOKYO	21	2
95	24.0	H. KRUMM	SOUTH AFRICA, LANGEBAAN	24	0
96	23.7	J. VASICEK	CZECHOSLOVAKIA, UHERSKY BROD	10	8
97	23.4	PAOLO EMILIO DI NUNZIO	ITALY, ROME	20	2
98	23.3	JOHN A. CHURCH	USA, PRINCETON JCT., NJ	13	6
99	23.0	P.E. ANDERSON	AUSTRALIA, BRISBANE	23	0
100	23.0	ROMAN FANGOR	POLAND, WARSAW	11	7
101	22.7	STATION 293 OBS. 28	NETHERLANDS, GOUTUM	21	1
102	22.3	V.V. SOTNIKOV	USSR, NOVOSIBIRSK	12	6
103	22.0	JERZY LUKASZEWICZ	POLAND, WARSAW	10	7
104	21.8	P. NAJSER	CZECHOSLOVAKIA, PRAHA	15	4
105	21.4	LOUI PAGANO	AUSTRALIA, SYDNEY, N.S.W.	18	2
106	21.1	STATION 177 OBS. 76	ENGLAND, WOOLHAMPTON	16	3
107	21.0	F. SAMPAIO	BRAZIL, RECIFE, PERNAMBUCO	21	0
108	21.0	JAMES E. BROOKS	USA, CHATHAM, VA	9	7

		Name	Location	T	R
109	20.8	HAROLD POVENMIRE	USA, BRADENTON, FL	14	4
110	20.6	V.A. ZIVA	USSR, GORNOTAEZHNOE	12	5
111	20.0	KRAJCIR	CZECHOSLOVAKIA, HLOHOVEC	8	7
112	19.7	STATION 148 OBS. 76	ENGLAND, LEEDS	18	1
113	19.6	JANUSZ WILAND	POLAND, WARSAW	11	5
114	19.0	PIERSON C.A. BARRETTO	BRAZIL, RECIFE	7	7
115	18.8	PRIBYL	CZECHOSLOVAKIA, PRAHA	12	4
116	18.6	WOJCIECH JABLONSKI	POLAND, WARSAW	10	5
117	18.0	J. VINCENT	ZIMBABWE, SALISBURY	18	0
118	17.8	V.G. FEDOSENKO	USSR, KOMSOMOLSK	11	4
119	17.7	G. MORSE	ENGLAND, MAIDENHEAD	16	1
120	17.6	MAREK ZAWILSKI	POLAND, LODZ	9	5
121	17.4	BRAGAGNOLO	ITALY, CAMPOSAMPIERO, PADO'	14	2
122	16.8	MATTI SUHONEN	FINLAND, HELSINKI	10	4
123	16.8	RONALD W. CROSS	NEW ZEALAND, CHRISTCHURCH	10	4
124	16.8	G.N. WALKER	SOUTH AFRICA, BLOEMFONTEIN, ORANG:	10	4
125	16.4	MAGA	ITALY, TORINO	13	2
126	16.4	D.G. ZVOLEIKO	USSR, KAMEKETS-PODOLSK	13	2
127	16.3	RYSZARD SZUJECKI	POLAND, WARSAW	6	6
128	16.3	L.V. MARTOVITSKAYA	USSR, KIEV	6	6
129	15.6	RICK BINZEL	USA, ST. PAUL, MN	7	5
130	15.1	G. COULING	NEW ZEALAND, TAWA	10	3
131	15.0	A.P. POROSHIN	USSR, GORKY	15	0
132	14.8	T. YAG	JAPAN,	8	4
133	14.7	L.E. ST. GEORGE	NEW ZEALAND, AUCKLAND	13	1
134	14.7	STATION 409 OBS. 36	SOUTH AFRICA, JOHANNESBURG	13	1
135	14.7	A.A. ZHITETSKII	USSR, KIEV	13	1
136	14.6	M. VYKUTILOVA	CZECHOSLOVAKIA, VALASSKE MEZIRIC	6	5
137	14.6	TOMAZ STUKELJ	YUGOSLAVIA, JAVORNIK	6	5
138	13.8	B. MALECEK	CZECHOSLOVAKIA, VALASSKE MEZIRIC	7	4
139	13.8	D.G. ZVOLEIKO	USSR, KIEV	7	4
140	13.8	ROBERT ROBEK	YUGOSLAVIA, JAVORNIK	7	4
141	13.7	A.V. KUKLIN	USSR, GORNOTAEZHNOE	12	1
142	13.6	DAMIJAN SPEGEL	YUGOSLAVIA, JAVORNIK	5	5
143	13.4	BIZZOTTO	ITALY, GALLIERA V., PADOVA	10	2
144	13.4	PAUL TEICHER	USA, FARMINGDALE, L.I., N.Y.	10	2
145	13.0	R.M. SHUTEVA	USSR, KHARKOV	13	0
146	12.8	D. WHELAN	NEW ZEALAND, TIKORANGI	6	4
147	12.8	MIECZYSLAW SZULC	POLAND, TUCHELA	6	4
148	12.8	GARY PITTMAN	USA, KANSAS CITY, MO	6	4
149	12.4	RAINER VASTAMAKI	FINLAND,	9	2
150	12.4	WILLIAM J. WESTBROOKE	USA, SAN FRANSCISCO, CA	9	2
151	12.0	B. BRUNDLE	ENGLAND, HAYWARDS HEATH	12	0
152	11.8	SANIGA	CZECHOSLOVAKIA, BANSKA BYSTRICA	5	4
153	11.7	W. MELLOR	ENGLAND, SHEFFIELD	10	1
154	11.7	MARK TAYLOR	ENGLAND, WAKEFIELD	10	1
155	11.7	SERGIO BUONAIUTO	ITALY, NAPLES	10	1
156	11.7	STATION 322 OBS. 52	NETHERLANDS, UITHOORN	10	1
157	11.7	A.V. EFIMOV	USSR, RIAZAN	10	1
158	11.1	MARKO PETEK	BRAZIL, PORTO ALEGRE, RS	6	3
159	11.1	M.R. FEDIANIN	USSR, TOMSK	6	3
160	11.0	VYHLIDKA	CZECHOSLOVAKIA, PRAHA	11	0
161	11.0	STATION 137 OBS. 78	ENGLAND, EASTBOURNE	11	0
162	11.0	H. PACHALI	GERMANY, BERLIN NEUKOLLN	11	0
163	11.0	T. ROUNTHWAITE	NEW ZEALAND, AUCKLAND	11	0
164	11.0	A.I. TARASOV	USSR, GORKY	11	0
165	10.8	BLAZEJ FERET	POLAND, LODZ	4	4
166	10.8	P.Y. DROZDOV	USSR, ENISEISK	4	4
167	10.8	A.G. KIRICHENKO	USSR, UZHGOROD	4	4
168	10.7	J. PEDLER	ENGLAND, BRISTOL	9	1
169	10.7	T. TAKEMURA	JAPAN, KURASIKI	9	1
170	10.7	A. VAN DER DRIFT	NETHERLANDS, SOESTDIJK	9	1
171	10.7	WAYNE E. CLARK	USA, WEBSTER GROVES, MO	9	1
172	10.7	STATION 528 OBS. 76	USA, SOLON, OH	9	1
173	10.1	KEN ST. CLAIR	USA, KANSAS CITY, MO	5	3
174	10.0	W.H. ROBERTSON	AUSTRALIA, SYDNEY, N.S.W.	10	0
175	10.0	W.H. ALLEN	NEW ZEALAND, DUNEDIN	10	0
176	10.0	GLEN ROWE	NEW ZEALAND, GISBORNE	10	0
177	10.0	P.P. PAVLENKO	USSR, KHARKOV	10	0
178	9.7	GUARNIERI	ITALY, FIRENZE	8	1
179	9.7	LUSSO	ITALY, TORINO	8	1
180	9.7	ROMERO-COSTA	ITALY, MAGLIE, LECE	8	1
181	9.4	DIETMAR BUTTNER	GDR, EILENBURG	6	2
182	9.4	JURIJ DOLANEK	YUGOSLAVIA, JAVORNIK	6	2
183	9.1	B. SIEGEL	CZECHOSLOVAKIA, POLICE N. METUJI	4	3
184	9.0	DANIHELKA	CZECHOSLOVAKIA, PRAHA	9	0
185	9.0	D. SCHMIDT	NETHERLANDS, HUIZEN	9	0
186	8.7	MARCO CAVAGNA	ITALY, MILANO	7	1
187	8.7	RODRIGO N. NIEVA	PHILIPPINES, QUEZON CITY	7	1
188	8.7	J. CARNEIRO	PORTUGAL, PORTO	7	1
189	8.7	V.M. KIRPATOVSKII	USSR, KHARKOV	7	1
190	8.4	E. HANHAM	NEW ZEALAND, AUCKLAND	5	2
191	8.4	D.I. GALYCH	USSR, LVOV	5	2
192	8.1	OCENAS	CZECHOSLOVAKIA, BANSKA BYSTRICA	3	3
193	8.1	E. NIR	JAPAN,	3	3
194	8.0	J. VACEK	CZECHOSLOVAKIA, SLANY	8	0
195	8.0	R. BOSCHLOO	NETHERLANDS, LAREN	8	0
196	8.0	M. ADAMS	NEW ZEALAND, BLACK BIRCH	8	0
197	8.0	MACIEJ BIELICKI	POLAND, WARSAW	8	0
198	7.7	F. PAVLAS	CZECHOSLOVAKIA, HOLESOV	6	1
199	7.7	C. CANNON, JR	USA, SAN FRANSCISCO, CA	6	1
200	7.7	A.P. ZHELEZNIAK	USSR, KHARKOV	6	1
201	7.7	NAZARETH REGO	PORTUGAL, PORTO UNIV. OBS.	6	1
202	7.4	LARRY MCGILL	USA, KANSAS CITY, MO	4	2
203	7.4	O.G. BOGDANOV	USSR, RIAZAN	4	2
204	7.4	UROS CERAR	YUGOSLAVIA, JAVORNIK	4	2
205	7.0	JEAN MEEUS	BELGIUM, ERPS-KWERPS	7	0
206	7.0	CL. DE PAULA	BRAZIL, RECIFE, PERNAMBUCO	7	0
207	7.0	CEJKA	CZECHOSLOVAKIA, PRAHA	7	0
208	7.0	VALEK	CZECHOSLOVAKIA, PRAHA	7	0
209	7.0	VOLF	CZECHOSLOVAKIA, PRAHA	7	0
210	7.0	STATION 137 OBS. 77	ENGLAND, EASTBOURNE	7	0
211	7.0	D. HICKEY	NEW ZEALAND, WHANGAREI	7	0
212	6.7	M. KAWADA	JAPAN, TOKYO	5	1
213	6.7	ARKADIUSZ KRAJEWSKI	POLAND, WARSAW	5	1
214	6.7	S.V. PLIATSKO	USSR, KAMEKETS-PODOLSK	5	1
215	6.4	F. ONO	JAPAN,	3	2
216	6.4	ZBIGNIEW SZALKIEWICZ	POLAND, OLSZTYN	3	2
217	6.0	K.P. SIMS	AUSTRALIA, SYDNEY, N.S.W.	6	0
218	6.0	M. MATYSEK	CZECHOSLOVAKIA, GOTTWALDOV	6	0
219	6.0	P. SPURNY	CZECHOSLOVAKIA, KUNZAK	6	0
220	6.0	JARI HOFFREN	FINLAND,	6	0
221	6.0	STATION 203 OBS. 33	GDR, EILENBURG	6	0
222	6.0	TOMASZ PESZKE	POLAND, OTWOCK	6	0
223	6.0	H.F. DABOLL	USA, ST CHARLES, IL	6	0
224	6.0	VICTOR J. SLABINSKI	USA, ARLINGTON, VA	6	0
225	6.0	M.N. PYSHNENKO	USSR, KHABAROVSK	6	0
226	6.0	R. RAKHIMOV	USSR, TASHKENT	6	0
227	5.7	STATION 65 OBSERVER 51	CANADA, VANCOUVER	4	1
228	5.7	J. PAGODA	CZECHOSLOVAKIA, OLOMOUC OBSERVATOR'	4	1
229	5.7	T. HUS	JAPAN,	4	1
230	5.7	S. HUTTIMOUE	JAPAN, TOKYO	4	1
231	5.7	STATION 322 OBS. 53	NETHERLANDS, UITHOORN	4	1
232	5.4	A. NIS	JAPAN,	2	2
233	5.0	JAN BACON	AUSTRALIA, TRIGG ISLAND, PERTH	5	0
234	5.0	STATION 39 OBSERVER 6	BRAZIL, RECIFE	5	0
235	5.0	S. KOCHAN	CZECHOSLOVAKIA, ZIAR N. HRONOM	5	0
236	5.0	SOBRA	CZECHOSLOVAKIA, PRAHA	5	0
237	5.0	STATION 115 OBS. 1	DOMINICAN REP., SANTO DOMINGO	5	0
238	5.0	G. APPLEBY	ENGLAND, HERSTMONCEUX R.G.O.	5	0
239	5.0	STATION 132 OBS. 76	ENGLAND,	5	0
240	5.0	STATION 137 OBS. 76	ENGLAND, EASTBOURNE	5	0
241	5.0	A. WELLS	ENGLAND, BIRMINGHAM	5	0
242	5.0	PAULI HEISKANEN	FINLAND,	5	0
243	5.0	DIETMAR BOHME	GDR, NESSA	5	0
244	5.0	M. SAS	JAPAN,	5	0
245	5.0	P. MACQUEEN	NEW ZEALAND, BLACK BIRCH	5	0
246	5.0	N. MASEYK	NEW ZEALAND, WAINUIOMATA	5	0
247	5.0	I.F. PUSTOSHILO	USSR, NOVOSIBIRSK	5	0
248	4.7	ZIMNIKOVAL	CZECHOSLOVAKIA, BANSKA BYSTRICA	3	1
249	4.7	K.A. KUDAK	USSR, UZHGOROD	3	1
250	4.0	STATION 39 OBSERVER 7	BRAZIL, RECIFE	4	0
251	4.0	H.J. WIDDOP	CANADA, PIERREFONDS, QUEBEC	4	0
252	4.0	KARLOVSKY	CZECHOSLOVAKIA, HLOHOVEC	4	0
253	4.0	LETVAK	CZECHOSLOVAKIA, PRAHA	4	0
254	4.0	M. PETRAS	CZECHOSLOVAKIA, GOTTWALDOV	4	0
255	4.0	ESKO JAMSA	FINLAND,	4	0
256	4.0	E. OTTO	GDR, EILENBURG	4	0
257	4.0	BERGANO	ITALY, TORINO	4	0
258	4.0	HAVER	ITALY, ROME	4	0
259	4.0	STATION 508 OBS. 32	USA, EAU CLAIRE, WI	4	0
260	4.0	JOSE OSORIO	PORTUGAL, PORTO UNIV. OBS.	4	0
261	3.7	PEKKA PARVIAINEN	FINLAND,	2	1
262	3.7	CRAIG R. PATTERSON	USA, RANDALLSTOWN, PA	2	1
263	3.7	L.I. MAROVA	USSR, ULYANOVSK	2	1
264	3.7	A.K. MURTAZOV	USSR, RIAZAN	2	1
265	3.7	R.M. RAZNIK	USSR, ULYANOVSK	2	1
266	3.7	A.N. SHAPOVALOV	USSR, KHERSON	2	1
267	3.7	V.N. SINCHESKUL	USSR, POLTAVA	2	1
268	3.7	O.I. SLASTILOVA	USSR, ULYANOVSK	2	1
269	3.0	D.S. KING	AUSTRALIA, SYDNEY, N.S.W.	3	0
270	3.0	N.R. LOMB	AUSTRALIA, SYDNEY, N.S.W.	3	0
271	3.0	STATION 39 OBSERVER 5	BRAZIL, RECIFE	3	0
272	3.0	FIEDLEROVA	CZECHOSLOVAKIA, PRAHA	3	0
273	3.0	KARAS	CZECHOSLOVAKIA, PRAHA	3	0
274	3.0	RAJNOHA	CZECHOSLOVAKIA, GOTTWALDOV	3	0
275	3.0	HEIMO NYROOS	FINLAND,	3	0
276	3.0	M. MULLER	GDR, EILENBURG	3	0
277	3.0	DE BENEDETTO	ITALY, REGGIO CALABRIA	3	0
278	3.0	SERAFINO GARGANO	ITALY, CORSICA, MILANO	3	0
279	3.0	T. KAZ	JAPAN,	3	0
280	3.0	Y. KUB	JAPAN,	3	0
281	3.0	C. JONES	NEW ZEALAND, PALMERSTON NORTH	3	0
282	3.0	J.B. MACKIE	NEW ZEALAND, NELSON, STOKE	3	0
283	3.0	G. WINGATE	NEW ZEALAND, AUCKLAND	3	0
284	3.0	R. EBERST	SCOTLAND, EDINBURGH	3	0
285	3.0	STATION 508 OBS. 28	USA, EAU CLAIRE, WI	3	0
286	3.0	STATION 508 OBS. 30	USA, EAU CLAIRE, WI	3	0
287	3.0	A.U. BELIAKOV	USSR, KALININ	3	0
288	3.0	E.G. DEMIDOVICH	USSR, GORKY	3	0
289	3.0	V.A. GOLUBEV	USSR, VITEBSK	3	0
290	3.0	V.M. KOORNOCOV	USSR, GORKY	3	0
291	3.0	B. STRIUCHKOV	USSR, KALININ	3	0
292	3.0	V.A. VOROTNIKOV	USSR, ENISEISK	3	0
293	3.0	LUISA BASTOS	PORTUGAL, PORTO UNIV. OBS.	3	0
294	2.7	H. MAT	JAPAN,	1	1
295	2.7	I. COOPER	NEW ZEALAND, PALMERSTON NORTH	1	1
296	2.7	MICHELLE L. KLEINRICHERT	USA, ST. PAUL, MN	1	1
297	2.7	RONALD S PRICE	USA, GARLAND, TX	1	1
298	2.7	A.A. BROVKO	USSR, ODESSA	1	1
299	2.7	S. IGNATOVICH	USSR, UZHGOROD	1	1
300	2.7	V.I. KHAREVICH	USSR, ENISEISK	1	1
301	2.7	A.A. KRYSKOV	USSR, KAMEKETS-PODOLSK	1	1
302	2.7	I.L. LEDOVSKAYA	USSR, KIEV	1	1
303	2.7	S.S. RODIN	USSR, ODESSA	1	1
304	2.0	PETER PAISLEY	AUSTRALIA, MURRAY BRIDGE	2	0
305	2.0	BRIAN BURKE	CANADA, OTTAWA, ONTARIO	2	0
306	2.0	J. BOCAK	CZECHOSLOVAKIA, JINDRICHUV HRADE	2	0
307	2.0	P. HAZUCHA	CZECHOSLOVAKIA, HLOHOVEC	2	0
308	2.0	HELD	CZECHOSLOVAKIA, HLOHOVEC	2	0
309	2.0	HERNA	CZECHOSLOVAKIA, PRAHA	2	0
310	2.0	KRAL	CZECHOSLOVAKIA, GOTTWALDOV	2	0
311	2.0	MAJOR	CZECHOSLOVAKIA, PRAHA	2	0
312	2.0	NETOPIL	CZECHOSLOVAKIA, PRAHA	2	0
313	2.0	PALKA	CZECHOSLOVAKIA, PRAHA	2	0
314	2.0	SOJKA	CZECHOSLOVAKIA, PRAHA	2	0
315	2.0	M. STOVICEK	CZECHOSLOVAKIA, SLANY	2	0
316	2.0	STATION 131 OBS. 81	ENGLAND, BIRMINGHAM	2	0
317	2.0	RAUNO HARTIKAINEN	FINLAND,	2	0
318	2.0	STATION 203 OBS. 35	GDR, EILENBURG	2	0
319	2.0	STATION 203 OBS. 36	GDR, EILENBURG	2	0
320	2.0	K. KOYAMA	JAPAN, TOKYO	2	0
321	2.0	Y. TAN	JAPAN,	2	0
322	2.0	SIMON GATT	MALTA, PAOLA	2	0
323	2.0	HADRIAN SAMMUT	MALTA, PAOLA	2	0
324	2.0	P. AITKEN	NEW ZEALAND, WELLINGTON	2	0
325	2.0	M. GALLAGHER	NEW ZEALAND, TAWA	2	0
326	2.0	STATION 508 OBS. 26	USA, EAU CLAIRE, WI	2	0
327	2.0	JOE WACHS	USA, KANSAS CITY, MO	2	0
328	2.0	I.M. DOMRACHEV	USSR, GORKY	2	0
329	2.0	E.I. KOVIAZIN	USSR, KIROV	2	0
330	2.0	M.A. STARINKEVICH	USSR, KIEV	2	0
331	2.0	I.P. TIMOKHIM	USSR, RIAZAN	2	0
332	1.0	IAN JAMIESON	AUSTRALIA, ADELAIDE, S. AUSTRALI/	1	0
333	1.0	DOLEZALOVA	CZECHOSLOVAKIA, PRAHA	1	0
334	1.0	J. DRAPAL	CZECHOSLOVAKIA, JINDRICHUV HRADE	1	0
335	1.0	HANZLIK	CZECHOSLOVAKIA, CHEB	1	0
336	1.0	JURCIK	CZECHOSLOVAKIA, PRAHA	1	0
337	1.0	J. KABRT	CZECHOSLOVAKIA, JINDRICHUV HRADE	1	0
338	1.0	K. KONATA	CZECHOSLOVAKIA, JINDRICHUV HRADE	1	0
339	1.0	KOPRIVA	CZECHOSLOVAKIA, GOTTWALDOV	1	0
340	1.0	KRENEK	CZECHOSLOVAKIA, PRAHA	1	0
341	1.0	MUDRA	CZECHOSLOVAKIA, PRAHA	1	0
342	1.0	PERESTY	CZECHOSLOVAKIA, UHERSKY BROD	1	0
343	1.0	STARECKY	CZECHOSLOVAKIA, PRAHA	1	0
344	1.0	P. VALACH	CZECHOSLOVAKIA, KUNZAK	1	0
345	1.0	ZAHALKA	CZECHOSLOVAKIA, PRAHA	1	0
346	1.0	M. ZAKOPCANOVA	CZECHOSLOVAKIA, VALASSKE MEZIRIC	1	0
347	1.0	STATION 140 OBS. 40	ENGLAND, HERSTMONCEUX R.G.O.	1	0
348	1.0	STATION 140 OBS. 41	ENGLAND, HERSTMONCEUX R.G.O.	1	0
349	1.0	STATION 137 OBS. 79	ENGLAND, EASTBOURNE	1	0
350	1.0	JANNE IGNATIUS	FINLAND,	1	0
351	1.0	STATION 203 OBS. 34	GDR, EILENBURG	1	0
352	1.0	T. HIRAIWA	JAPAN, KURASIKI	1	0
353	1.0	GODFREY BALDACCHINO	MALTA, PAOLA	1	0
354	1.0	MARIO CASSAR	MALTA, PAOLA	1	0

		Name	Location	T	R
355	1.0	DAVID PACE	MALTA, PAOLA	1	0
356	1.0	STATION 321 OBS. 52	NETHERLANDS, SOESTDIJK	1	0
357	1.0	STATION 322 OBS. 54	NETHERLANDS, UITHOORN	1	0
358	1.0	R. DUNCAN	NEW ZEALAND, WELLINGTON	1	0
359	1.0	N. HERDMAN	NEW ZEALAND, AUCKLAND	1	0
360	1.0	J. HICKEY	NEW ZEALAND, WHANGAREI	1	0
361	1.0	B. HITCHCOCK	NEW ZEALAND, PALMERSTON NORTH	1	0
362	1.0	G. HUDSON	NEW ZEALAND, PALMERSTON NORTH	1	0
363	1.0	W. KISSLING	NEW ZEALAND, BLACK BIRCH	1	0
364	1.0	BRIAN LOADER	NEW ZEALAND, BLENHEIM	1	0
365	1.0	N. SHEPHERD	NEW ZEALAND, PALMERSTON NORTH	1	0
366	1.0	S. WARDLE	NEW ZEALAND, WELLINGTON	1	0
367	1.0	A. CUNHA	PORTUGAL, PORTO	1	0
368	1.0	FRANKLIN JORDAN	USA, MEMPHIS, TN	1	0
369	1.0	STATION 508 OBS. 27	USA, EAU CLAIRE, WI	1	0
370	1.0	STATION 508 OBS. 29	USA, EAU CLAIRE, WI	1	0
371	1.0	STATION 508 OBS. 31	USA, EAU CLAIRE, WI	1	0
372	1.0	STATION 508 OBS. 33	USA, EAU CLAIRE, WI	1	0
373	1.0	STATION 508 OBS. 34	USA, EAU CLAIRE, WI	1	0
374	1.0	H. POSS	USA, PHILADELPHIA, PA	1	0
375	1.0	BRUCE S. RUSNAK	USA, ST. PAUL, MN	1	0
376	1.0	KEVIN RYAN	USA, MEMPHIS, TN	1	0
377	1.0	G.A. AKIFEVA	USSR, ULYANOVSK	1	0
378	1.0	I.M. AKSENENKO	USSR, UKNO-SAKHALINSK	1	0
379	1.0	V.V. BELIAKOV	USSR, GORKY	1	0
380	1.0	M.B. BOGDANOV	USSR, SARATOV	1	0
381	1.0	V.E. DEMIDOVICH	USSR, GORKY	1	0
382	1.0	K.N. DERKACH	USSR, KHARKOV	1	0
383	1.0	A.V. FADEEV	USSR, ULYANOVSK	1	0
384	1.0	G.V. GVOZDIKOVA	USSR, UKNO-SAKHALINSK	1	0
385	1.0	A.F. KANTOROV	USSR, TOMSK	1	0
386	1.0	V.V. KONDRASHIN	USSR, VOLOGDA	1	0
387	1.0	T.A. KRYSKOV	USSR, KAMEKETS-PODOLSK	1	0
388	1.0	A.I. LEVOSHOV	USSR, GORKY	1	0
389	1.0	G.V. PICHUGINA	USSR, KHARKOV	1	0
390	1.0	A.V. SEMIN	USSR, GORKY	1	0
391	1.0	M.P. SMIRKOVA	USSR, UKNO-SAKHALINSK	1	0
392	1.0	M. VASH	USSR, UZHGOROD	1	0
393	1.0	E.V. VORONOV	USSR, GORKY	1	0
394	1.0	E.A. ZIVA	USSR, GORNOTAEZHNOE	1	0

1979 World-Wide Occultation Statistics:

Number of Observers:	394
Total Observed Occultations:	7,478
Total Observed Reappearances:	2,015

ANOTHER RECEIVER FOR TIME SIGNALS

Homer F. DaBoll

Anyone seeking a new, replacement, or backup time signal source might want to investigate the Emerson model PSW4010 10-band AM FM-stereo SW band-spread radio receiver. About 3½×7×1¼ inches when the antenna is retracted, it weighs less than 15 ounces with the 3 AA batteries in place. I have received time signals on 2.5, 3.33, 5, 7.335, and 10 MHz with it. I have not been able to raise WWV on 15 MHz, to date, although that seems to be such a short distance from the calibrated portion of dial segment 6, that I will keep trying occasionally. 14.67 and 20 MHz are well beyond the ends of any of the segments.

If you can't find it elsewhere for less than $49.90 + $3 P&H (+ tax for CA residents), take your VISA or MasterCard in hand and phone DAK at 800,325-0800.

GRAZING OCCULTATION PREDICTIONS

David W. Dunham

Northern-Limit North Shifts. As noted in the "Grazing Occultations" article, most northern-limit waning-phase grazing occultations have been systematically shifting north during the past several months. It is probably due to a discontinuity in Watts' lunar profile data near the lunar north pole, since it was hard for Watts to link the lunar Eastern and Western hemispheres, since the two are rarely both sunlit (and both photographable). So for 1988, you should apply a 0".3 northward correction (that is, the shadow should be shifted north on the ground, measured perpendicularly to the limit) to all northern-limit waning-phase grazes that occur with central graze at Watts angles between 320° and 358°. Divide 0.3 by the vertical profile scale (VPS) given in the central bottom part of the profile to determine the number of miles or kilometers of shift on the ground. Do not apply any other empirical corrections to the 80H version graze predictions, which along with the 86 December and 87 November versions of the ACLPPP, were IOTA's prediction basis throughout 1987 and will remain so also for 1988. This correction will be incorporated into ACLPPP in the future, perhaps in time for the predictions for the second half of 1988. You will know about this from the version date of ACLPPP; if it is 1988, then the correction probably has been incorporated. The 87 November version of ACLPPP only corrected a minor bug in the printing of the worst terminator, found by Donald Oliver, and includes exactly the same empirical corrections as are in the 1986 December version, used for all 1987 predictions. I will announce any change in *O.N.*

Zodiacal Zone Catalog. Under the direction of Robert Harrington, the USNO took astrographic plates covering the zodiacal zones to produce a catalog in support of the Galileo mission, to be used in reducing observations made with the spacecraft cameras for navigation. The plan was to obtain improved positions and proper motions of all SAO stars within 16° of the ecliptic. Both the new plates (exposed at Washington during the early 1980s) and the original plates taken for the Yale catalogs in the 1930s were measured with USNO's automatic STARSCAN measuring engine. The measurements for the Northern Hemisphere were reduced with AGK3R data, while those for the south were reduced with the preliminary SRS (Southern Reference Star) data, of which the Perth 70 catalog is a part. The new catalog, called the zodiacal zone (ZZ) catalog, was completed a few months ago. It is not ready for release, since Harrington and his co-workers plan to re-reduce all of the southern data as soon as the SRS is completed, which should happen during the middle or latter part of 1988. In the meantime, I can access the catalog, which resides in a USNO computer disk file, and have used it to check some graze predictions and observations. For example, H. Povenmire led a large expedition for the 1987 October 29th graze of 60 Sagittarii (= ZC 2914) in Florida. He had obtained Yale catalog shifts for this graze, as well as for a graze of a 7th-magnitude star that occurred earlier that evening. The Yale shift for the first event was about 1".0 north, while that for 60 Sgr was 1".0 south. Povenmire reported that the first shift occurred close to the prediction, but the shift for 60 Sgr did not occur, the actual shadow being very close to the nominal prediction (near zero shift). Unfortunately, he positioned most of his observers south of the southern limit to catch the Yale-shifted profile, but instead nearly all of them had no occultation. Data from the zodiacal zone catalog predicted a shift of about 0".2 south, much closer to the actual case. Analysis of other recent southern-limit grazes (these are not affected by the limb data for northern-limit grazes discussed above) have confirmed the accuracy of the ZZ to around the 0".2 to 0".3 level. The measurements seem to smooth out individual star position errors in even the AGK3R and Perth 70 catalogs. No improvement is possible only for the FK4 stars. For future grazes of non-FK4 stars that will be attempted by three or more observers, Wayne Warren or I will compute the expected ZZ shift, if you inform me of your request a month or more in advance, and specify the date, star number (ZC or X number preferred), limit, and position angle of graze. Send requests to me at P.O. Box 7488; Silver Spring, MD 20907; U.S.A., or give them by telephone to 301,585-0989 or 301,495-9062 (IOTA occultation line). Shortly after April, I will update the XZ catalog with the ZZ data so that the ACLPPP profiles can be produced using these improved stellar data. I will then answer several requests for the XZ, and perhaps it can be used for the ACLPPP runs for the second half of 1988.

Graze Supplements Late. Data for the 1987 grazing occultation supplements were generated with the MEEUSMAP program and plotted with the GRAZEMAP, as explained in the supplements and in previous issues. I started working on the data for 1988 in August, and even produced a magnetic tape with the data for the supplement. I also changed the program so that it produces data needed by ACLPPP to generate predicted profiles. I used the system to produce regional maps of brighter grazes in the U.S.A. (for my January *Sky and Telescope* article) and for the western U.S.S.R., which I sent to Prof. Osipov, in Kiev. But that was as far as I got before leaving for China for the September 23rd eclipse, and I was not able to pick up the work again until late November. At that time, I changed MEEUSMAP to avoid problems with repeated sequence numbers and times messed up for graze paths containing 0^h U.T., problems which necessitated manual editing of the large graze path data sets. I also added a code to optionally reject faint star grazes at highly gibbous phases, following the code of another program that was used to select events for the 1987 supplement. Although the program's changes seem to have accomplished their objectives, they somehow introduced a bug that causes numerous spurious bad points in the data for some events. I have not had time to correct this problem before this issue had to go to press. Also, I have either misplaced or written over the data that I had generated in August, which I did not want to use in any case due to the editing that would be required. I will fix the MEEUSMAP to produce 1988 graze supplements to be distributed with the next issue.

IOTA members in the "A" region (northeastern U.S.A., Ontario, and southern Quebec) will also receive their graze predictions for the first half of 1988 late, shortly after the beginning of the year. I apologize for the delay; the members should receive their data before the first A-region graze, which occurs on January 12th.

Canadian Boundary Data Needed. The graze maps for 1988 published in the R.A.S.C. *Observer's Handbook* contain no country, state, or province boundaries, making them hard to use for observers not living near the coasts or near one of the plotted standard stations. Roy Bishop made a suggestion for measuring coordinates of the lines, but I would suggest using the latitude and longitude scales to plot your position on one of the maps. Then, use a piece of paper to mark the distance of your station north of the map's south edge and west of its east edge (or use the north or west edges as reference), and transfer your position to each of the maps.

But it would be much better to have maps showing the boundaries, and I can produce them with MEEUSMAP and GRAZEMAP. However, the world database that I use includes the state boundaries but not the boundaries of the Canadian provinces, which Roy Bishop very much wants to have included for their national handbook. If anyone could supply me with a dataset of Canadian provincial boundary latitudes and longitudes, I would greatly appreciate it. Perhaps one of our Canadian readers could make inquiries to those using computer graphics, who might have such data.

Double Star Data. Don Stockbauer worked with me to re-format IOTA's double star information, and wrote a program to automatically insert these data into the basic data that are used by our graze program to generate limit predictions. Although it took some effort to get this system operational, and delayed the start of the 1988 graze prediction process, it eliminates the major part of the work that had to be done manually in the past to generate predictions. The long-term savings in labor will be enormous. Now that the double star data are in a unified database, it will be easier to update and maintain. In the future, it might be used with USNO's EVANS total occultation program to include step durations, and ILOC is interested in the data for their reductions and analyses.

Improved Graze Program Documentation Produced. Donald Oliver and Pat Trueblood typed all information, that was not obviously out of date, from all of the old computer bulletins, to produce a comprehensive ASCII PC file documenting use of IOTA's GRAZE and ACLPPP programs. I added final touches to this work in August. The program documentation is now much more manageable and comprehensible than the previous series of papers that contained much old misinformation. Oliver has recently written additional documentation specifically for those using the PC versions of the programs.

GRAZING OCCULTATIONS

Don Stockbauer and David W. Dunham

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

At the moment, Stockbauer does not have access to a PC, and does not have any use, himself, for graze data in soft form. We encourage you to report grazes on floppies to ILOC, if you have the Capability, but if you do so, please just send Don a listing of your data file.

The graze of El Nath (= Beta Tauri = ZC 810), visible across the southeastern U.S. on the morning of 1987 October 12, now holds the record as the most successfully observed; 343 timings were obtained from four expeditions. The previous record holder was Merope on 1973 February 10, with 310 timings (total of three separate expeditions). The shift observed during the Alcyone graze on 1987 September 13 was a key factor in placing El Nath participants in the most advantageous positions. Grazes of stars with well-determined positions are shifting $0''.35$ north of their 80H predictions for Watts angles near 350° and large negative latitude librations. This was confirmed also by the graze of the FK4 star Upsilon Geminorum observed in Florida in September, and by grazes of ZC stars observed in Maryland and Florida in July and August. David Dunham will determine the general empirical correction. El Nath's

Date V/P	Star #	Mag	% Snl	CA	Location	# Sta	# Tm	S S	Ap Cm	Organizer	C St	WA	b
1985													
0515	128695	7.2	19-	9N	Hammanskraal, RSA	2	6	2	15	B. Fraser	5N	35	48
0812	077563	8.0	19-	20N	Pretoria, RSA	1	2	2	20	J. Smit	2S	34	-51
0918	159004	8.3	20+	4N	Kyalam, RSA	4	17	1	11	B. Fraser	3S	7	10
0921	2621	7.4	53+	1S	Benoni, RSA	2	10	1	11	B. Fraser	3S	180	53
1986													
0303	2336	6.6	55-	17S	Stilfontein, RSA	1	8	2	20	D. Overbeek	0	199	35
0320	1093	6.4	64+	8N	Cedarburg, WI	5	22	2	15	G. Samolyk		9	-61
0401	2784	3.4	48-	12S	Silverton, RSA	3	16	2	8	J. Smit	2N	192	63
0401	2784	3.4	48-	12S	Bronkhorst, RSA					B. Fraser	2N	192	63
0801	0756	6.5	19-	21N	Bloemfontein, RSA	2	2			M. Senay			
0826	0559	6.6	53-	18N	Skandinawia, RSA	3	16	3	20	J. De Klerk	9N	340	-45
0826	0559	6.6	53-	18N	Daleside, RSA	1	3	1	20	B. Fraser		340	-45
0910	2364	6.9	43+	4N	Hammanskraal, RSA	2	3	1	8	B. Fraser	6N	6	50
1007	184198	7.8	19+	5S	Gottenburg, RSA	2	12	2	15	T. Cooper	3N	179	47
1007	184198	7.8	19+	5S	Villiers, RSA	4	30	2	15	D. Overbeek	5N	179	47
1108	3116	6.7	49+	12S	Potchefstroom, RSA	3	12	2	20	J. De Klerk	6S	168	55
1108	3116	6.7	49+	12S	Roodepoort, RSA	4	23	2	8	B. Fraser	3S	168	55
1108	3116	6.7	49+	12S	Lyttelton, RSA	1	8	2	20	D. Overbeek	4S	168	55
1108	3116	6.7	49+	12S	Silverton, RSA	3	9	2	8	J. Smit	4S	168	55
1987													
0110	076119	8.1	82+	11N	Kumeu, New Zealand	1	3	1	20	Barbara Ives		14	-54
0112	0890	4.5	95+	13S	Bertrix, Belgium	2	6	1	20	Jean Schwaenen		176	-59
0220	183232	7.7	60-	10S	Auckland,New Z'lnd	1	5	1	10	Barbara Ives		192	33
0326	3271	7.1	9-	6S	Brisbane,Australia	1	8		41	Peter Anderson	5N	179	37
0406	079295	7.6	51+		Brisbane,Australia	1	4		41	Peter Anderson			
0501	076770	7.6	9+	13N	Elliston, IN	1	2	1	13	Robert H. Hays, Jr	3N	6	-57
0522	0035	6.4	22-	13N	Brisbane,Australia	1	8	1	25	Steve Hutcheon	8N	346	6
0530	0979	7.7	6+	17N	Grove, KS	1	2	2	15	Richard P. Wilds	1S	9	-61
0605	1712	3.8	61+	18N	Aranjuez, Spain	1	2	1	9	N. P. Wieth-Knudsen		20	-8
0610	2270	5.4	97+	16N	Engadine,Australia	2	6	1	20	Roger Giller	0	5	51
0702	1609	4.7	29+	10N	El Dorado, KS	3	6	1	6	Richard P. Wilds	0	11	-17
0704	1795	7.1	47+	14N	Pocahontas, MS	1	6	1	15	Benny Roberts		22	9
0708	2349	3.0	89+	18N	Boggabilla, Austrl	2	18	1	20	Steve Hutcheon	0		60
0708	2366	1.2	90+	S	Bombala, Australia	6	32			David Herald	0	178	56
0708	2366	1.2	90+	S	Geelong, Australia	3	10		10	Frank C. Baker	0	178	56
0708	2366	1.2	90+	S	Lyndhurst, Austrl	68	14	1	6	Kruijshoop & Nelson	0	178	56
0720	0521	6.7	25-	17N	Myersville, MD	2	20	1	20	David W. Dunham	4N	344	-47
0910	0146	4.4	93-	13N	Lauterbach, D.D.R.	3	4	2	6	Dietmar Büttner	2N	344	-13
0913	0552	3.0	67-	9N	Whaley Corner, TX	4	13	1	10	Don Stockbauer	3N	349	-51
0913	0552	3.0	67-	11N	London, KY	1	6	3	20	Jim Stamm		347	-51
0929	185400	7.3	39+	S	Kambah, Australia	3	20			David Herald	2S	172	-64
1012	0810	1.8	72-	8N	Tilden, TX	17	126			Paul Maley		349	-67
1012V	0810	1.8	72-	6N	Genoa, TX	23	201	1	6	Don Stockbauer	4N	351	-67
1012	0810	1.8	72-	4N	McLaurin, MS	3	14	2	15	Benny Roberts	0	354	-67
1012	0810	1.8	72-	N	Georgetown, GA	1	2	1	11	Tony Murray		356	-67
1019	118736	8.1	11-	3S	Wheaton, MD	1	7	2	20	David W. Dunham	5S	189	-16
1124	2688	6.9	10+	20S	Jackson, MS	2	2	2	33	Benny Roberts	8N	168	72
1129	3461	6.4	63+	13S	Kingsville, TX	1	4	1	20	Don Stockbauer	5S	166	11

suspected duplicity was confirmed by the large number of stepwise phenomena recorded. The system probably consists of a close pair with Δm about 1.0, plus one or more fainter stars of 7th to 9th magnitude. Also see Ron Dawes' article on p. 143 about his graze. Not listed in the table are the 14 timings, from two stations, obtained by H. Povenmire's expedition near Garland, AL, reported on obsolete forms.

Dietmar Büttner has brought our attention to several subjects which deserve comment:

1. The uncertainty code of the limb profile points (*, 1, 2, etc.) refers to their absolute probable error, not error relative to other points in the profile. This is why isolated lower-accuracy points will often be discontinuous with those of higher accuracy. A string of identically coded lower-accuracy points may represent the true shape of the profile (although possibly shifted), assuming that they were measured as a group.

2. Grazes are not routinely reduced by IOTA or ILOC as unified group observations. However, ILOC does treat each graze timing as a total occultation, and sends residuals to the person submitting the report. This will detect only gross error, such as an incorrect star number, etc. David occasionally reduces certain past grazes, usually to improve the prediction of an upcoming event. The current method is to hand-plot tabular data produced by the OCC program, and visually inspect the results. Robert Sandy's plots, which appear in *O.N.*, are examples of reduction profiles. He uses the same basic processes as those in Don's graze shift paper, although straightening out the mean limb makes the combination of separate expedition results much easier. Robert Bolster's reduction profile program for the Apple II is a step toward automating the process (see *O.N.* *4* (5), p. 109).

3. The Watts data are currently being updated only when serious errors are found. The ideal situation would be to have all certain observations update the Watts limb corrections, but without their automated analysis, this is not possible.

4. The software version of the predicted profile should be reported along with a graze shadow shift. However, this has not been done before, and there have been thousands of past expeditions. At this point, we have to assume the USNO version in effect at the time was used, although this is certainly not always the case.

5. Clarifications to Don's graze shift calculation paper:

a. The elevation correction, as calculated by the formulae should always be applied perpendicularly to the sea-level limit, not in any fixed compass direction.

b. The calculations given for time of central graze are valid only for small elevations. The intersection points of the map edges with the sea-level-limit line should be shifted in the direction of the Moon's azimuth to the corrected limit before using them to interpolate for the time of central graze. This is important for an automated calculation of the shift of a high-altitude (above sea level) graze. However, for a manual solution, we find that it is better to adjust the timings, as a group, right or left, to obtain the best fit, in which case, a precise central graze time is not as important. There are "horizontal" errors in the Watts data which are best compensated for by ignoring, to some extent, the profile's dictate of the time at which a lunar feature should be seen. The paper describing how to calculate a graze shadow shift (i.e., your graze's overall residual) is available from Don upon request.

The 1988 IOTA meeting will probably be held in conjunction with one of two very favorable grazes potentially visible near Houston next November. Depending on the appearance of the predicted profiles, preliminary plans are to observe either 3.4-mag. Tau Sagittarii on Sunday evening, Nov. 13, or 1.3-mag. Regulus on Wednesday morning, Nov. 30. Paul Maley will provide overall coordination; the meetings should attract more attendees if a good observing opportunity is provided.

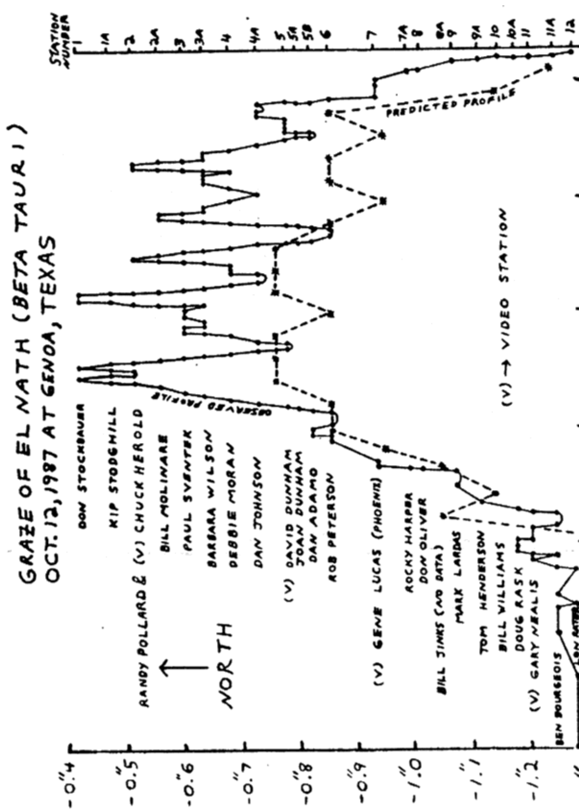
Corrections: In the graze table of *O.N. 4* (5), 103, ZC 184 on 1986 July 27 had an observed shift of 0".2 north. For the same table, David states that for ZC 2298 on 1987 March 20, Toshio Hirose was the expedition leader, rather than David, himself. This graze and the one for ZC 2366 on 1987 January 25 should also be coded "V," for videotape.

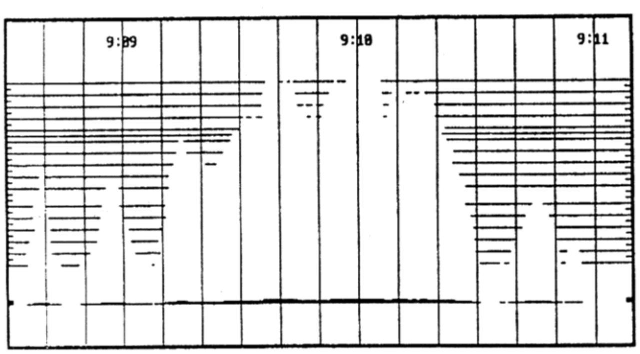
Harold Povenmire had much difficulty trying to observe a graze of X10832 = SAO 79256. The star's catalog magnitude is 7.5, but Povenmire believes that it is more like 8.6.

Shifts are available for a few grazes, listed below, which can not be included in the main list either because they were reported on non-standard forms, or all of the information has not been determined. They are included here to help in planning for future grazes of these stars.

1987 Date	Star	Limit	Shift	Organizer
May 01	076764	N	0".7 S	D. Dunham
Aug 18	0771	N	0".3 N	H. Povenmire
Sep 17	1149	N	0".4 N	H. Povenmire
Oct 29	2914	S	0".0	H. Povenmire
Nov 01	3347	S	0".2 S	D. Dunham
Nov 30	0035	S	0".2 S	G. Rattley

Thanks for the reports received; Don is looking forward to reporting on many more in the future.





This is a profile of the El Nath graze as drawn by computer. Each tick along the left and right sides represents 100 feet. The vertical lines are at 10-second intervals beginning at 9:08:30 U.T. The upper graph is expanded 50:1 vertically and covers a range, on the ground, of 3100 feet. Below it is a 1:1 representation of the lunar profile. The graph spans roughly 100 miles of lunar surface.

REDUCING OCCULTATION DATA USING BASIC AND A HOME COMPUTER

Ron Dawes

The traditional means by which occultation timing data are reduced is with a stopwatch, pencil, paper, and maybe a hand-held calculator. This, according to Paul Maley, is the tried-and-true method. I recently had the opportunity not only to witness my first grazing occultation, but to reduce the data of some 18 observers. I did it on a home computer, and the results, according to a few who have trudged through the traditional method, are worth noting.

The cassette tapes gathered from the graze of El Nath on 1987 October 12 were to be turned over to Paul immediately after the occultation and he would, at some time in the near future, analyze them and inform us of the results. He was already overcommitted, though, and asked us to do the data reduction ourselves. Robert Reeves, who headed our expedition, got this bad news shortly after the occultation ended, and called me the following morning with a "brainstorm" (read that "plea"). Knowing I had a home computer and that I was interested in astronomical computing, he proposed a method by which we might reduce this data, and asked whether this was something I could do. I was as anxious as anyone to see what we had accomplished, so I jumped on it. The next day I had a BASIC program which solved the problem.

Having a built-in clock in my PC, things fell together in short order. The idea behind the program is simply to record the computer's clock whenever a key is pressed. From what I understand of the traditional method, this reduces significantly the drudgery of listening to the tapes. Using a stopwatch, a tape would, typically, be played at least twice for every event (12 events = 24 tape plays . . . times the number of tapes). I only needed to play each tape two or three times.

The process of reducing the data on a computer is fairly straightforward. The first task that the program performs is to synchronize the computer's clock with the recorded WWV time signal. The user is prompted to enter the WWV time and press [ENTER] at the time hack. This resets the computer's clock to WWV. From that point until the final time hack, the tape runs continuously. Whenever a "disappear" is announced, the user presses a "D"; a "reappear" is a "K" (for ease and speed of entry – it is the same finger of the opposite hand on the keyboard). The program records the computer's clock for each D and K pressed. The letter which was pressed (D or K) is also recorded for display later. When all timings have been entered, an "X" is pressed to terminate entry. Then a final WWV time signal is marked just as before. Since there may be a difference between *recorded* elapsed time and the *true* (computer's) elapsed time, an adjustment is made to the timings to compensate for slow or fast recorders. The program takes the ratio of the two elapsed times and applies it to each of the event timings. These corrected data are then stored permanently on disk in a file which identifies the observer, his location, and the instrument used. The next tape is then processed in a similar fashion.

Once all the data are entered and stored, the fun begins. In a separate routine, all these data are retrieved and mapped onto a grid. The X axis represents time, and the Y axis the observer's position. Each observer's timings are displayed on the screen in such a way as to show when the star was visible and when it was hidden by the lunar limb. A horizontal line indicates periods of visibility. Blank sections indicate the star was hidden. In a matter of seconds, the lunar profile is readily apparent, and the display is capable of resolving the timings to better than half a second.

I don't know the time savings realized using this procedure, but in only a few cases did I have to listen to a tape more than two or three times. I found it best to do a dry run first and get a "feel" for the observer's style. Then I ran the program. I started entering data on Friday evening and finished early Saturday afternoon. This included a full night's sleep and the delays encountered in just having to look at the results of each tape as it was entered. In less than 12 working hours I was looking at a finished lunar profile.

Paul Maley is one who has trod the weary path of the stopwatch and was duly impressed. His concern, naturally, was with the accuracy of the method, so he took several of the tapes to run a comparison. He reports that the computer method compares very favorably with the "tried-and-true" stopwatch method. Since this is a new area for me, I would be interested in hearing from anyone who has done similar reductions, for possible improvements to the program.

For computing astronomers, here are a few facts about the program. It is written in Microsoft QuickBASIC under MS-DOS 3.1 on an IBM PC/XT clone with an internal clock. Timing was done using the "elapse-timer" as opposed to the "clock timer." This timer provides elapsed time since midnight and is measured in hundredths of a second on my machine. It saves having to perform time-consuming conversions while the program is executing. The data are stored in this same format, but can be readily converted if so desired. The program is about 200 lines long, many of which are either comments or "whistles and bells." I tried using a more generic basic, but couldn't get the color and resolution I wanted. I think it is straightforward enough that it can be translated to whatever machine or version of basic you may have. Write for more information.

4438 Bikini Dr.; San Antonio, TX 78218

Comments by referees:

The plot is a fine pictorial representation; if augmented by a scale to represent graze height in seconds, and a means of anchoring it to the predicted limit, it would be useful for determining the shift.

The drudgery of reading out a tape with a stopwatch seems exaggerated, in that it does not consider playing the entire tape just once, and then re-playing only those minutes which contain event signals. It may be that Dawes assumes that the stopwatch is actually stopped for each event; this certainly would not be the ideal way; the time should be read while the watch continues to run, so that there is no additional personal equation involved.

The article assumes ideal conditions, which apparently obtained for all observers during the El Nath graze. It is often necessary to deal with clouds and other interruptions. Dawes has not indicated a system for dealing with these, and his technique may be only borderline for handling flashes and blinks.

Although inaccuracies of a second or so do not keep a graze observation from being useful, one should try to be as accurate as possible. Dawes method assumes a uniform reaction time when hitting the key, plus a uniformly recorded and played-back tape. Merely applying a ratio to compensate for a tape playing back at a rate which differs from real time seems too simplistic (and optimistic). Since he has the minute hacks as data, he could see if they are linear; if not, he could use least squares fitting to establish the maximum error, or perhaps fit a higher-order polynomial. The bottom line is that the stopwatch method introduces no extra uncertainty due to reaction time while reducing the tape, and will spot a tape which is non-linear (say, from weak batteries). Dawes' method is an excellent one when all goes correctly.

Someone using this method must be careful to have the same reaction time to a called event as to the WWV or CHU minute hacks. Since the minute hacks can be anticipated, there may be a tendency for their reaction times to be shorter than to called events.

The stopwatch method allows one to judge the uniformity of the recording within a single minute. An unfortunate combination of fast and slow speeds could go undetected using Dawes' method.

Noticeable in the plot are some impossibly shaped mountains. Perhaps this is due to problems with the tape reductions, although there is a greater probability that erroneous observer reaction times are at fault. In the ideal case, all observers would be experienced, and would read out their own tapes, applying personal equations they deem to be appropriate to the individual events.

DECEMBER 8TH BAMBERGA OCCULTATION OBSERVED

David W. Dunham

The December 8th occultation of SAO 41263 by (324) Bamberga was successfully timed by eight visual observers in Texas, organized by Paul Maley; and by two portable photoelectric stations set up in New Mexico and Texas by Lowell Observatory astronomers; and by one portable photoelectric station of the University of Arizona, in New Mexico. Astrometries at Lick and Lowell observatories both indicated that the path would shift 0".45 south of my nominal prediction (a regional map was published in the last issue). Based on this information, I sent a detailed notice about the occultation to about 150 *O.N.* readers, astronomy clubs, colleges, and individual Astronomical League members between 0".1 S and 0".8 S. The error in the final prediction computed at Lowell Observatory from all the data, indicated a probable error of ± 0".08. Unfortunately, there were no very short chords observed near the limit, which must have been near 0".25 S (near Rocky Harper's site at La Porte, TX) and 0".48 S (near Brent Sorensen's site near Cedar City, UT). Both Harper and Sorensen reported misses. So the actual center must have been near 0".36 S, 0".09 north of the final prediction. The maximum reported duration was 25 seconds. Both this and the observed path width show that Bamberga had a diameter of 210 to 220 km, less than the 256 km expected. Paul Maley reports that 45 Texan observers, mostly from Houston and San Antonio, and most of them local, bracketed the path from shift values of 0".19 S to 0".60 S. Unfortunately, a majority of them could not observe, due to unpredicted fog that developed in many areas; several others were outside the path and reported a miss; and a few had equipment problems.

Following my suggestion, Wayne Warren, National Space Science Data Center, Goddard Spaceflight Center, made arrangements to send a TELEX informing Shanghai Observatory, China, that they were in the updated path. A couple of days after the event, a TELEX was received from Prof. He Miafu, saying that the occultation was observed in Shanghai, and that details would be sent later.

Peter Manly videorecorded a sharp secondary extinction lasting about 1^{s}5 at his home in Tempe, AZ, well south of the path. Unfortunately, others in the Phoenix area and elsewhere along his path were not able to monitor the star for various reasons, so Manly's event was neither confirmed nor refuted. There also may be a brief secondary extinction in one of the photoelectric records.

Robert Millis, Lowell Observatory, plans to give a presentation about results of the Bamberga occultation at the Asteroids II meeting in Tucson in early March. Jim Stamm will also publish details in a summary article covering the period.

COMPLETE INFORMATION ABOUT THE OCCULTATION OF 1 VELPECULAE BY PALLAS SOUGHT

David W. Dunham

I have finally taken some time to resume analysis of the 1983 May 29th occultation of 1 Vulpeculae by (2) Pallas, with the aim of submitting a paper to the *Astronomical Journal* about this best-observed asteroidal occultation. In November, notices were distributed to photoelectric and video observers of the event, as well as to regional and local coordinators, giving detailed information and charts based on my 1983 August – October preliminary analysis. In the article we want to document the total effort for this historic event. We intend to publish all timed observations, but also we want to publish the names and approximate locations of those who observed a miss, and even the names of those who saw the occultation and made no timings, as well as those who set up to try to observe the event but were clouded out or were not able to get timings for other reasons. If you are in one of these categories and have not reported data to me, or know of others who are in this situation, please send pertinent information to me at P.O. Box 7488; Silver Spring, MD 20907. I thank those who have sent me information in response to my November notices. I am behind the schedule I gave in those notices, and will probably not be able to distribute first drafts of the paper until the end of January.

LUNAR OCCULTATIONS OF M4

David W. Dunham

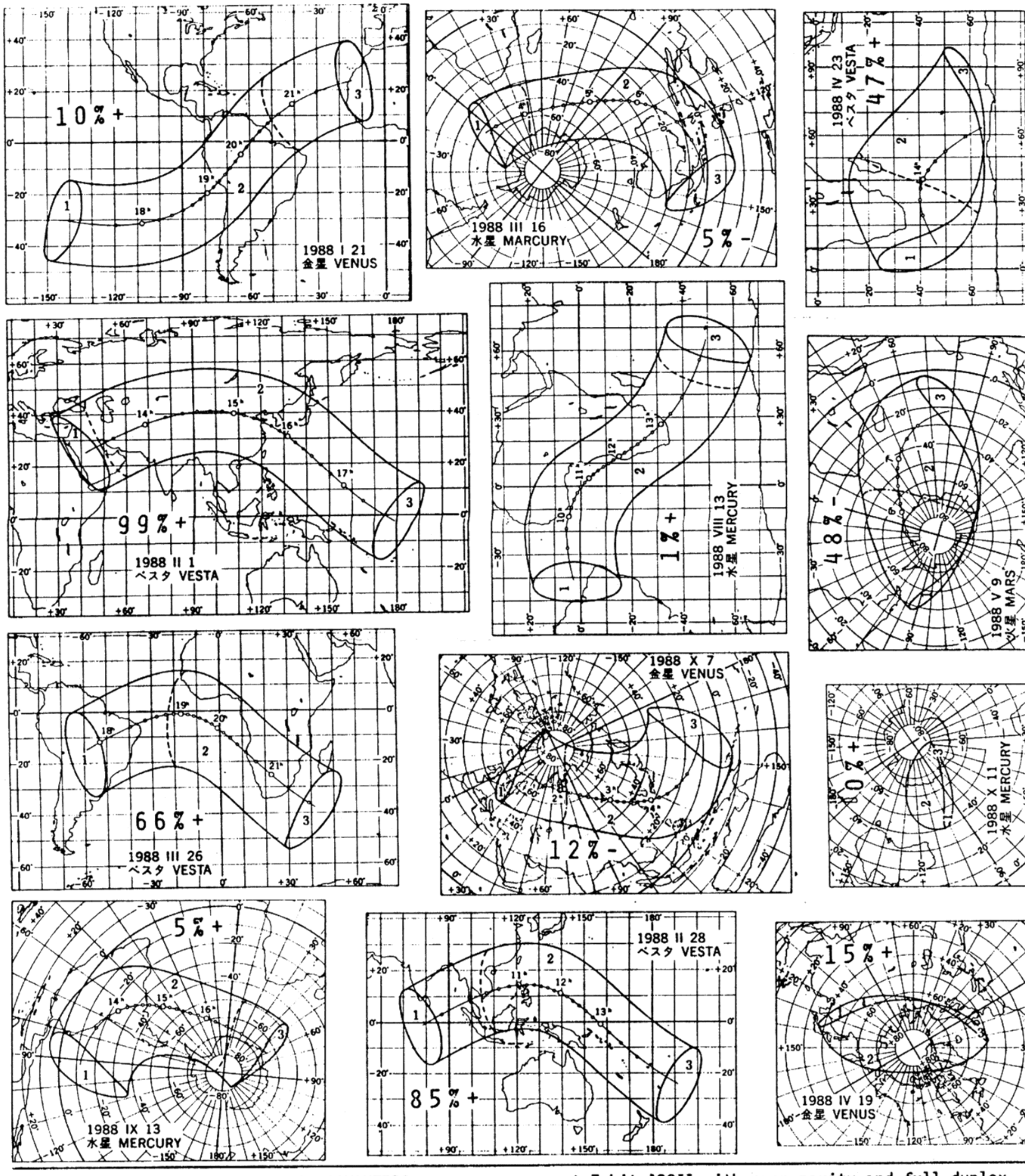
The 6.4-magnitude globular cluster M4 is 14' in diameter, about half that of the Moon. The crescent-Moon occultations in the table will provide interesting views about 2 hours before Antares is hidden.

U.T. Date		U.T.	%Snl	Area of Visibility
February	12	4^h	37-	northeastern Brazil
August	21	12	59+	Australia
September	17	19	36+	South Africa
October	15	1	16+	Chile, Argentina

LUNAR OCCULTATIONS OF PLANETS

The maps showing the regions of visibility of lunar occultations of planets are reprinted by permission, from the Japanese ephemeris for 1988, published by the Hydrographic Department of the Maritime Safety Agency of Japan. In region 1, only the reappearance is visible; in region 3, only the disappearance may be seen. Reappearance occurs at sunset along a dashed curve, while disappearance is at sunrise along a curve of alternating dots and dashes. We have added a legend to each map indicating the phase of the Moon at event time.

Those interested in observing partial occultations should request predictions at least three months in advance (if possible) from Joseph Senne; P.O. Box 643; Rolla, MO 65401; U.S.A.; phone 314,363-6233.



ASTRONOMY AND PERSONAL COMPUTERS

Joan Bixby Dunham

USNO Time Service BBS. The USNO has a bulletin board for time services at (202)653-1079, and a separate, computer-accessible, time service for digital clocks at (202)653-0352. Both of these services expect 7-bit ASCII with even parity and full duplex communications at 300 or 1200 baud. The bulletin board commands begin with an "@" with @TCO the command to produce a table for codes for the digital data access system. The information provided includes UT and polar motion data, codes, and explanations for various time transmission services (NBS, OMEGA, VLF, GPS, TRANSIT, LORAN, TV), standard times for all countries, an explanation for Julian Date conversion, sidereal time, sunrise, sunset, and twilight computations, and time information for those who do not need high-accuracy time. The bulletin board also contains information on measuring transmission delays in the telephone communications. The Floppy Almanac can also be ordered through this bulletin board.

The bulletin board documentation warns users that time taken from that bulletin board is not suitable for precise uses, due to delays from the bulletin board system and, for long-distance callers, delays from the telephone system. The standard long-distance telephone connections to USNO may go either via satellite or land line. Satellite communications add a delay of 250 ms, making telephone time useless for precision timing. The USNO maintains voice announcements at (900)410-TIME, which go exclusively by land lines (50¢/min. for the calls) to avoid the satellite communications delays.

There is a method to measure and remove these telephone communication path delays, which can be used with the service at (202)653-0516 to get more precise timing information. The bulletin board contains an explanation of the service and an example program in BASIC. The technique involves use of computer hardware or a modem that supports the CCITT V.54 Remote Digital Loopback (RDLB), where RDLB allows the calling computer to measure the telephone time delay and apply it as a correction to the time mark. The service can also be accessed with a standard modem, but the time delays cannot be measured then.

The service at (202)653-0351 expects 7-bit ASCII, even parity, at 1200 baud. The time is broadcast in a continuous stream with the format

MJD DOY HHMMSS-UTC <cr><lf>*<cr><lf>

The * is the time mark for the preceding information and is delayed from UTC by 1.7 ms ±.4 ms. This timing generator is independent of computers and is driven directly from master-clock reference signals. The <cr> is the ASCII carriage return, and <lf> stands for line feed. MJD is the mean Julian Date, DOY is the day of year. On UTC December 20, it appears as

```
47148 353 050532 UTC
*
47148 353 050533 UTC
*
```

and so on.

The USNO bulletin board also mentions a public domain timing program for PCs by a Bruce D. Anderson: Bruce D. Anderson; BRAND Consultants; P.O. Box 2425; Brattleboro, VT 05301.

Floppy Almanac 88 and 89. The floppy almanac for 1988 and for 1989 is now ready for distribution. This program gives information from much of the *Astronomical Almanac* to full precision. The price is $20 for 5¼ or 3½ MS-DOS diskette plus users guide, and $4 for additional copies of the users guide. The software is in the public domain, which means it is legal to share with friends. Copies obtained from the USNO come with the users guide, which explains how to create special catalogs for use with the FA, and details about how the computations are performed. (The Floppy Almanac is also available for the DEC MicroVAX II, on 5¼-inch 400k RX50 disk ($20) and for IBM mainframes 370, 43xx, 30xx, on 9-track 1600 bpi computer tape, VM/CMS format ($25).)

This is a new version of the Floppy Almanac. Changes include a new user interface and combining the two MS-DOS versions (plain and coprocessor) into one. If a mathematic coprocessor is detected, it will be used, but the program will run on machines that do not have one. An external file that contains the default coordinates has been added, allowing users to set specific default coordinates.

To purchase, send a check payable to "U. S. Naval Observatory" to: Nautical Almanac Office; Code FA; U. S. Naval Observatory; Washington, DC 20390-5100.

Generating Star Field Plots. Generating plots of star fields, for use as finder charts and for comparing with observations and photographs, requires knowledge of both astronomy and computer graphics hardware. First, the right ascensions and declinations of the stars to be plotted have to be converted from the mean positions of the star catalogs to the apparent positions at the time of observation. Accurate conversion to apparent place includes applying the corrections from precession, nutation, annual and diurnal aberration, proper motion, refraction, orbital motion (for double stars), parallax, and polar motion, although for finder charts the precession corrections alone are sufficient. These are discussed in many textbooks on astronomy and the *Astronomical Almanac*. Meeus' *Astronomical Formulae for Calculators* gives formulae and examples. Trueblood and Genet's *Microcomputer Control of Telescopes* has a nice discussion as well as example programs.

The next step is to convert the apparent place positions to the plot coordinates. Right ascension and declination are coordinates on a sphere, like longitude and latitude, and they need to be projected to a flat surface to be plotted. Map makers' projections can be used, especially if large areas of sky are to be plotted. For smaller areas, standard coordinates or plate coordinates can be computed by considering the area to be plotted as projected onto a plane tangent to the celestial sphere at the center of the plot. Formulae for computing standard coordinates are given in textbooks on positional astronomy, such as Smart's *Spherical Astronomy* or McNally's *Positional Astronomy*. The standard coordinates most closely approximate what is seen through a telescope. With information on focal length, f-ratio, and corrections for lens errors and field curvature, the plots can match photographs made of star fields.

The final computations are those needed to convert the plot coordinates to commands or units the specific graphics device uses. Since virtually every plotter, dot matrix printer, and graphics display device differs from every other, software must be developed for each device used. There are general purpose plotting software packages available for some combinations of computers, printers and/or screens, and many languages, such as BASIC or C, are sold with plotting capabilities. Any program that allows plotting of points on an X-Y graph can be used, although not all allow labels on the stars or an indication of magnitudes. Examples of plots or documentation specific to plotting may not be easy to find. This final step is the easiest to discuss, but potentially the most difficult to implement. It is important to remember when deciding among various approaches that, if the choice is between plotting on a display screen and plotting to a hard-copy output device, the paper copy of the plots is a lot more useful as a finder chart than a display screen of the field.

Plots on a PC. The detailed finder charts that David prepares for asteroid occultations are done with software written in FORTRAN for a mainframe computer using a Calcomp or a Zeta pen plotter. We have recently converted some of the finder chart software to run on a PC, using a Sweet Pea 6-pen plotter or a dot matrix printer. We also have been writing software on the PC to produce reduction data plots of asteroid occultation observations, with the intent of later running them on a mainframe computer. I have written some FORTRAN subroutines to allow the Sweet Pea (using the Hewlett Packard HGL commands) to emulate a Zeta plotter. Also, a co-worker asked us to test a package he has written that allows an Epson dot matrix printer to emulate a Calcomp plotter for FORTRAN software.

One of the surprises we had in doing this work was how well the dot matrix printer does in comparison with the pen plotter, even in comparison with the Zeta and Calcomp plotters on Mainframes. In our case, the pen plotter was roughly four times the cost of the printer, yet the only advantage it offers is the use of color pens — not much of an advantage in our judgment, since color reproduction is very expensive. I doubt that I could ever recommend the purchase of a pen plotter, and we regret having purchased one ourselves.

While the Calcomp and Zeta plotters, and their plot commands, are not particularly difficult to use, they also are far from user friendly. If you are writing software that is going to be used only on a PC, I would recommend that you not follow our approach. There are many plotting packages available for PCs, as well as languages written for PCs that include graphics commands. However, I am willing to distribute the subroutines we have to those who want to try to convert mainframe FORTRAN plotting software to a PC, or need to write software on a PC that will later run on a mainframe.

The plotrite package that allows a dot matrix printer to emulate a Calcomp is approximately $50-$55, and is available from: Ed Hedman; C&B Software; Box 1019; Bowie, MD 20715.

Software Envelopes. Those sold for mailing floppy disks are highly overpriced, @ $1 or more apiece. I found it quite annoying to send a 35¢ floppy in a $1 mailer. I recently found an office supply dealer selling standard 6×9 clasp envelopes @ 14¢ each, and am going to use those as floppy mailers for now. To obtain the software, you may either send me diskettes and stamped, self-addressed mailers, or $1.00 for each floppy ($1.50 for two), which will cover the costs of the diskette, envelope, and US postage. These are MS-DOS 5¼ DSDD diskettes.

1. Generate total occultation predictions, written in GWBASIC (2 diskettes) for 1988
2. FORTRAN subroutines to use a Sweet Pea or Hewlett Packard pen plotter with Calcomp plotter calls
3. Six diskettes of public domain or shareware astronomy software

P.O. Box 7488; Silver Spring, MD 20907

ASTROMETRIC UPDATES FOR ASTEROIDAL OCCULTATIONS

David W. Dunham

1985 Feb 27, BD +10°2203 and (53) Kalypso: A. K. Osipov states in his recently received report of 1985 Soviet occultation observations, that V. Shor of the Institute of Theoretical Astronomy, in Leningrad, updated the predictions for a number of asteroidal occultations during the year, and observations were attempted at several observatories. As a result of this activity, the occultation of BD+10°2203 by Kalypso was observed at Odessa. The path should also have crossed southern Scandinavia, but no observations have been reported from there, probably because it was cloudy.

1987 Nov 25, Anonymous Star and (2060) Chiron: A 1986 observation indicated that the path for this event might shift north onto the Earth's surface, but plates taken by A. Klemola at Lick Observatory on November 23rd showed a 21^m (early) correction to the time and 0".3 south shift, putting the path off the Earth's surface below Antarctica.

1987 Dec 16, SAO 61705 and (250) Bettina: Plates taken December 14th by W. Penhallow at Quonochontaug, Rhode Island, showed that the path shifted about 1".1 west, farther off the Earth's surface.

1987 Dec 19, SAO 59964 and (481) Emita: Penhallow also obtained four exposures of this pair on December 14th. The corrections to Herget's ephemeris, which I used for my predictions, were very large, with the path 5".68 ± 0".3 south, and the time $11^m.2$ early. This put the path over northern and eastern Kenya, the southern Sudan, and the Sahel region of western Africa. I tried to telephone the Kenya Astronomical Society in Nairobi, but the telephone number turned out to be that of a small school, and they did not know anything about the astronomical society, or about astronomical observing. A new orbit computed by Edwin Goffin early in 1987, and published in MPC 11621, agreed much better with Penhallow's observations. If Goffin's orbit had been used originally, the path shift would have been only 0".53 south and the time correction also would have been much smaller.

SOLAR SYSTEM OCCULTATIONS DURING 1988

David W. Dunham

Predictions of occultations of stars by major and minor planets, and by Comet P/Schwassmann-Wachmann 1, during 1988 are given in two tables below, which are presented in a format similar to those for last year's events published in *O.N. 4* (3), 41, and described in *O.N. 4* (1) (July, 1986). See also *O.N. 4* (3), p. 45-47 for star designations and new source codes. A new source code, U, is used for USNO's new zodiacal zone catalog mentioned on p. 140. For 1988, unlike the tables for 1987, the ephemeris source column has been moved back to Table 1. Like last time, no values are listed under Δm for occultations by major planets, since the extent of the planet, and the fact that events can occur against its dark side, make it meaningless. Similarly, no value is listed under the Table 2 RSOI column, since this is always greater than 99999 km. Like last time, no information relating to the estimated angular diameters of the occulted stars is given, as was the case for 1986 and 1987. This information has been computed and is available upon request to me at P.O. Box 7488; Silver Spring, MD 20907; It would be of use for analysis of high signal-to-noise photoelectric records. In the notes, I will include a remark about the stellar angular diameter if it is large enough for the edge of the asteroid to require more than 0.05 second to geometrically pass across the star during a central occultation. In this case, it might be noticed by visual observers, especially in the case of a nearly grazing event if the observer is near one of the edges of the occultation path.

Additions for Path Computation. Following a suggestion by Leif Kristensen, I have added columns giving the geocentric Universal Time and distance of closest approach of the center of the planet to the star. These are given under the columns "Min. Geocentric U. T." and "Sep." in Table 2, between the stellar duplicity and source catalog codes (columns headed "D" and "S"), where the ephemeris source was given last time. Following the separation value is a letter indicating its direction, usually north or south. But in unusual cases (there are none during January through March) when the motion is nearly due north-south, with the motion in declination four or more times that in right ascension, the direction is given as east (E) or west (W). These quantities, along with the position angle of the object's motion and its distance from the Earth "Δ,AU" in Table 1; both this and the P.A. are now given to one more decimal place than previously), can be used with a linear approximation of the motion to calculate the path of the occultation on the Earth's surface, or the time and distance of closest approach for a specified station. Kristensen has promised to submit an article to *O.N.*, telling how this might be done using these quantities. In the meantime, readers with some familiarity with astronomical computations probably can figure out how to do this from discussions of occultation calculations in books such as Jean Meeus' *Astronomical Tables of the Sun, Moon, and Planets* (Willmann-Bell, 1983); the Explanatory Supplement to the *American Ephemeris and Nautical Almanac*; or Isao Sato's "Catalog of 3539 Zodiacal Stars for the Equinox J2000.0" described in the last issue (although he uses standard notation in his formulae, the discussion is in Japanese). A useful PC project would be to program the use of these quantities to produce paths or local circumstances, and distribute this software to other IOTA PC users. Then, they could quickly update paths or compute new local circumstances when an update is obtained from "last-minute" astrometry, which would be especially useful if a detailed regional map or IOTA local circumstance prediction is not available.

The "linear motion" approximation is very accurate for nearly all events; it is invalid only if the object's path in the sky is significantly curved during the time the object's shadow is on the Earth's surface. This can happen when the object is close to a stationary point and its motion is unusually slow. The non-linear terms may be significant if the motion is less than 0°.05 per day and the P.A. is within 30° of either 0° or 180°.

Local Circumstances/Appulse Predictions. Joseph E. Carroll; 4261 Queen's Way; Minnetonka, MN 55345, computes the IOTA appulse predictions for all IOTA members. Carroll's predictions are computed and listed in the same order as tables 1 and 2 here. I have modified the computer program to implement the changes described in *O.N. 4* (3), 42. The changes to the predictions include the elimination of comparison star data to make room for new columns. Columns headed "D" and "S," following the SAO number, give the double star code and star position source code, respectively. This is followed by the star's DM/ID NO, then the star MAG (m_V), OCC. DMAG (occultation Δm), and DUR SEC (central occultation duration in seconds). This is followed by the previously given UT and distances (in arc seconds, kilometers on the sky plane, and in terms of object diameter) of local closest approach. The elongation (ELG, angular distance from the star) of the Sun and Moon are given, as is also the Moon's percent sunlit (PSNL). I believe that these revisions give virtually all the information needed by observers, so that they do not need to consult tables 1 and 2 here.

Coverage for Early 1988. Only data for January, February, and March are given here, with the two tables on facing pages. Tables covering the rest of the year will be included as a continuation of this article in the next issue. Finder charts are included here only for North American and European events that are not included in Edwin Goffin's supplements. I have mailed finder charts for other non-Goffin events, through March, to regional coordinators.

Since I was not able to send complete data for 1988 events to Matsuru Sôma until a few days before I had to transmit this to the editor, his maps will not appear in this issue. We will publish his maps for future events in the next issue. In the meantime, when possible, rely on the similar maps by Goffin. There is also not time to produce regional maps for individual events. To overcome this lack of maps, I modified my map-plotting programs to produce new maps whose input is much easier to prepare. This time these are the only maps that show events not in Goffin's coverage. They are described below.

New Maps. Six maps show all the events listed in the tables. They are like the maps in the 1987 grazing occultation supplements, covering latitudes -50° to +65°. The maps covering the Western Hemisphere has similar longitude boundaries, 30° west to 180°. The Eastern Hemisphere had to be covered by two maps divided at longitude 70° east. Hence, there are three maps for each of two time periods, January plus the first half of February, and the last part of February plus March.

The narrow paths on the maps are my predicted paths for the occultations. These are bracketed with wide paths that would be the centerlines in the cases of 1.0-arc-second shifts to the north and south from my predicted path. "A-10" at the end of a path indicates that the star's altitude is 10 degrees, while "S= -8" shows that the Sun is 8 degrees below the horizon. The altitude limit in degrees is the same as the star's magnitude, while the Sun altitude limit in degrees is 2 minus the star's magnitude. The month, day, and asteroid's number and name are written just above the center of the northern limit and above the 1".0-north-shift line (unless it is off the map, in which case, it is written above the 1".0 south-shift line). A dashed line marks moonrise or moonset. I have put crosses through a few spurious lines where the plotter failed to lift the pen when it was supposed to do so; I may have missed some. I have also drawn lines through a few spurious labels. If a path crosses a map boundary it ends a short

Table 1, Part A

1988 DATE	Universal Time	PLANET Name	PLANET m_v	PLANET Δ,AU	STAR SAO No	STAR m_v	STAR Sp	STAR R.A.(1950)	STAR Dec.	Occultation Δm	Occultation Dur	Occultation df	Occultation P	Possible Area	El Sun	MOON El	MOON %Snl	N Up	Ephem. Source
Jan 7	19h23m38m	Hippo	12.2	1.746		11.1	F5	8h31.m1	26°42'	1.4	10s	21	20	P.I.,se Asia,s.Africa	161°	24°	88-	e 20E	MPC12305
Jan 8	16 50	Juewa	12.1	2.082		10.9		13 8.9	-5 14	1.5	8	15	18	swAustralia;Tasmania?n	89	40	82-	all	MPC12303
Jan 9	1 26-32	Zelinda	10.0	0.871	77647	7.0	K5	5 48.8	23 22	3.1	11	19	11	western North America	160	74	79-	none	Goffin87
Jan 9	11 41-53	Concordia	12.5	1.712		10.1		6 58.4	16 10	2.5	8	21	24	w.USA;s.AK;s.Siberia	172	63	76-	e140E	MPC12189
Jan 10	8 05	Psyche	12.0	3.606	158872	9.2	G5	14 49.9	-13 47	2.9	9	13	21	Colombia, n. Brazil	65	47	69-	all	Herget79
Jan 12	2 45	Wratislavia	12.7	2.791	128290	8.9	K0	23 34.8	6 33	3.9	6	10	23	n.Mexico,Cuba,Bahamas	67	158	52-	none	Goffin87
Jan 13	17 52	Adeona	12.7	2.167		11.0	K0	13 36.2	4 55	1.9	8	17	23	China; Japan?n	92	26	35-	e115E	EMP 1984
Jan 15	13 03-30	Victoria	11.7	2.055	137799	9.2	F2p	10 46.1	-4 26	2.6	27	57	22	Japan?n; Canada	129	78	18-	none	MPC12187
Jan 16	7 56	Adeona	12.6	2.139		10.2	G0	13 38.8	4 51	2.5	9	18	23	Bolivia, s. Brazil	94	57	12-	e 80W	EMP 1984
Jan 16	14 00	Wratislavia	12.7	2.844	128351A	8.8	F2	23 41.4	6 58	4.0	5	10	24	1".2 miss over Arctic	64	101	10-	none	Goffin87
Jan 16	14 00	Wratislavia	12.7	2.844	128351B	8.8	F2	23 41.4	6 58	4.0	5	10	24	s.cen.U.S.S.R.,n.China	64	101	10-	none	Goffin87
Jan 18	17 47	Parthenope	11.6	2.356		10.7		13 31.2	-4 58	1.3	10	20	22	Australia	94	88	1-	none	Herget78
Jan 21	22 24-37	Sylvia	12.6	2.905		11.6		10 42.2	22 43	1.3	24	29	15	Mauritius?s; n.Africa	145	167	11+	none	MPC11507
Jan 25	9 26-41	Sylvia	12.5	2.880		11.7		10 40.7	23 2	1.3	22	27	15	Venezuela, N. America	148	123	44+	w140W	MPC11507
Jan 28	22 44-54	Hygiea	10.0	2.209		10.6		10 39.4	4 16	0.5	51	34	7	Mauritius, s. Africa	148	87	79+	w 40E	Schmadel
Feb 2	22 01-07	Germania	12.5	2.415		9.9	G0	10 15.7	3 53	2.7	15	24	19	Mauritius?n; S.Africa	157	23	100-	all	EMP 1986
Feb 3	5 20-36	Elpis	13.0	2.580	139502	9.1	F8	13 40.3	-7 3	3.9	23	43	23	Peru, Brazil; Ghana?n	107	69	100-	all	EMP 1979
Feb 7	11 46	Sappho	11.4	1.581	115926	8.6	A3	7 44.5	7 14	2.9	8	23	27	western Canada,Alaska	155	71	82-	all	Herget78
Feb 10	20 33	Pallas	10.4	4.074	124606	8.9	A0	19 23.0	4 44	1.8	13	10	11	Nullarbor Plain	38	69	51-	all	Landgraf
Feb 11	3 06	Melpomene	11.2	3.057		9.7		19 3.4	-15 57	1.8	3	8	30	South Africa	36	53	48-	all	EMP 1980
Feb 12	12 55-68	Hippo	12.3	1.750	79790	8.5	A5	7 51.9	24 18	3.8	11	22	20	s. Pacific, Australia	153	137	33-	e178E	MPC12305
Feb 13	0 09-38	Zelinda	10.8	1.059	94765	7.7	G0	5 38.7	15 11	3.1	17	31	14	e. Canada, Atlantic	121	165	28-	e 2W	Goffin87
Feb 22	2 43	Hygiea	9.7	2.073	118291	9.0	F5	10 22.9	5 22	1.2	34	22	7	Patagonia, s. Chile	174	123	26+	w 90W	Schmadel
Feb 22	7 10	Boliviana	13.8	3.532	163378	7.5	K0	20 12.1	-11 3	6.3	3	8	40	Ireland	31	92	27+	none	EMP 1982
Feb 24	9 09-19	Isolda	13.7	3.112	183657	7.7	K5	15 36.1	-22 19	6.0	16	33	27	Mexico?n;n.Chile,Parag.	97	174	49+	none	MPC12304
Feb 27	2 45-54	Dido	12.7	2.174	99328	9.0	K5	10 49.2	11 44	3.8	10	21	23	Europe,U.K.,n.Canada	176	62	75+	w 25E	MPC12304
Feb 28	10 25-50	Emita	12.9	1.880	59244	9.0	F5	6 31.3	33 28	3.9	23	58	25	e. Siberia; Hawaii?n	118	17	85+	all	MPC11621
Feb 29	22 53	Antiope	13.5	2.923	185574	9.0	K5	17 35.1	-23 6	4.6	5	13	31	Mongolia	76	134	93+	all	MPC12190
Mar 1	2 21-47	Vesta	6.9	1.680	79685	8.6	G5	7 43.9	26 9	0.2	153	68	4	w.Europe, Greenland	133	19	94+	all	EMP 1986
Mar 5	8 59	Mars	1.0	1.606	187025	9.3	A0	18 32.9	-23 35		207	8	1	Caribbean, S.America	67	94	97-	all	NA0001
Mar 5	19 33	Nemausa	12.7	2.749		13.0		2 58.9	8 23	0.6	4	10	28	northern Africa	60	143	96-	e 5E	Krstnn77
Mar 6	3 24	Pallas	10.5	3.920		11.7		19 52.4	6 48	0.3	15	11	11	n.Namibia,Angola,Zambia	50	108	94-	all	Landgraf
Mar 8	0 27-38	Hygiea	9.7	2.072		10.7	A5	10 11.2	6 19	0.4	36	23	7	Mideast,Europe,n.Canada	165	63	83-	e 23W	Schmadel
Mar 8	17 18	Hermione	13.5	3.652	186959	6.8	B3	18 30.2	-24 9	6.6	8	14	26	sw.Australia, Tasmania	71	52	77-	all	MPC12191
Mar 10	19 28	Pallas	10.5	3.882	125328	8.6	B9	19 57.6	7 16	2.0	16	11	11	South & e. Australia	52	59	57-	all	Landgraf
Mar 15	9 57	Kassandra	11.4	1.398	139205	8.8	K0	13 8.7	-3 39	2.7	17	30	15	eastern Canada?s	157	120	10-	e 68W	MPC12191
Mar 16	3 17	P/SM-WM-1	13.6	6.669	164663	9.1	K0	21 45.4	-12 24	4.5	3	13	97	South Africa?n	31	5	5-	all	MPC11510
Mar 16	15 14-24	Aurora	12.4	2.356	138924	8.2	F2	12 40.0	-5 12	4.3	14	23	18	Hawaii?s; s. Siberia	164	144	3-	none	EMP 1988
Mar 21	1 09-15	Niobe	10.4	1.430	202846	9.5	K	11 47.3	-32 46	1.3	9	20	20	(Mauritius,S.Africa)?n	147	142	12+	none	EMP 1982
Mar 21	12 08-28	Hygiea	9.9	2.126		11.4		10 2.5	7 8	0.2	48	31	7	cen.&w.Pacific, China	149	104	15+	w136E	Schmadel
Mar 23	17 23	Helena	12.6	2.325	210436	7.1	K0	18 37.3	-33 54	5.5	3	14	47	western Pacific Ocean	85	158	36+	none	EMP 1986
Mar 24	18 55-78	Irene	9.0	1.200	99847	9.0	K0	11 51.2	19 3	0.7	21	29	11	China, USSR, Europe	159	80	46+	w 95E	Herget77
Mar 25	13 00-15	Cybele	11.6	2.329	138918	8.9	F5	12 39.1	-1 15	2.7	17	23	15	s.Pacific,P.I.,se.Asia	174	91	53+	w165E	MPC12302
Mar 29	19 33-39	Amphitrite	10.5	2.119		11.3		7 22.9	27 8	0.4	15	22	15	Urals, Himalayas	100	41	89+	all	Landgraf

variable distance from the map edge, since the plotted points are computed at approximately 2° intervals of the star's altitude, with no interpolation to the map edge; I will try to fix this deficiency in the future. For occultations by major planets, the centerline and northern and southern limits are plotted, as well as one or more intermediate isoskiatics. Dashed lines show moonrise or moonset. I plan to publish maps like these in future issues, since they are useful for immediately seeing all events potentially visible from a given area. But I feel that the current format is too cluttered. Next time, I will plot only the paths, leaving out the 1".0 shift lines, which will be on Sôma's or Goffin's world maps. I included them this time only because we do not have world maps for several events. With less clutter, fewer maps can be published covering more months. Addition of time information along the

Table 2, Part A

1988	MINOR PLANET						Motion		STAR			Min. Geocentric			COMPARISON DATA			APPARENT	
DATE	No.	Name	km-diam.	-"	RSOI	Type	°/Day	P.A.	SAO No	DM/ID No	D	U. T.	Sep.	S	AGK3 No	Shift	Time	R.A.	Dec.
Jan 7	426	Hippo	126	0.10	491	C	0.233	260°.2		+27°1628		19 30.6	1".20S	A	N26 941			8h33m.4	26°35'
Jan 8	139	Juewa	165	0.11	625	C	0.310	122.0		L 2 1321		16 51.0	3.76S	H				13 10.9	-5 26
Jan 9	654	Zelinda	112	0.18	279	U	0.376	219.9	77647	+23 1087	K	1 30.4	9.01N	ZA	N23 564	0".22	-0m.1	5 51.1	23 23
Jan 9	58	Concordia	103	0.08	362	C	0.235	281.0		A1653206		11 46.8	3.54N	C				7 0.6	16 7
Jan 10	16	Psyche	249	0.10	1673	M	0.256	104.1	158872	-13 4003		8 8.2	0.19S	XS				14 52.0	-13 57
Jan 12	690	Wratislavia	175	0.09	764	CEU	0.375	76.1	128290	+ 6 5177		2 42.2	0.45N	AS	N 6 3212	0.03	0.9	23 36.7	6 46
Jan 13	145	Adeona	137	0.09	497	C	0.259	96.2		0 0		17 58.1	1.27N	A	N 4 1725			13 38.1	4 43
Jan 15	12	Victoria	135	0.09	561	S	0.079	244.4	137799	- 3 2997		13 19.7	2.72N	S				10 48.1	-4 38
Jan 16	145	Adeona	137	0.09	498	C	0.247	95.0		+ 5 2781		7 59.7	1.72S	A	N 4 1728			13 40.8	4 39
Jan 16	690	Wratislavia	175	0.08	765	CEU	0.384	75.4	128351	+ 6 5194	A	13 57.4	4.32N	AG	N 6 3225	-0.22	1.3	23 43.3	7 11
Jan 16	690	Wratislavia	175	0.08	765	CEU	0.384	75.4	128351	+ 6 5194	B	13 58.4	1.36N	AG	N 6 3225	-0.22	1.3	23 43.3	7 11
Jan 18	11	Parthenope	155	0.09	652	S	0.210	101.6		L 2 2604		17 50.8	1.64S	H				13 33.2	-5 9
Jan 21	87	Sylvia	275	0.13	2205	P	0.132	313.9				22 29.2	1.52S	C				10 44.3	22 31
Jan 25	87	Sylvia	275	0.13	2205	P	0.143	310.7				9 33.0	0.68N	C				10 42.8	22 50
Jan 28	10	Hygiea	443	0.28	3708	C	0.129	280.5				22 47.9	1.59S	C				10 41.4	4 4
Feb 2	241	Germania	187	0.11	1103	C	0.176	282.8		+ 4 2308a		22 4.0	2.23S	XA	N 3 1379	0.05	0.4	10 17.7	3 42
Feb 3	59	Elpis	165	0.09	825	C	0.094	81.4	139502	- 6 3873		5 33.8	0.31N	HX		-0.25	-0.9	13 42.3	-7 15
Feb 7	80	Sappho	84	0.07	249	U	0.223	291.4	115926	+ 7 1834		11 47.1	5.20N	AS	N 7 1092	-0.46	-1.3	7 46.6	7 9
Feb 10	2	Pallas	533	0.18	5303	U	0.328	77.4	124606	+ 4 4096		20 35.3	0.61S	AS	N 4 2522	0.17	1.3	19 24.9	4 48
Feb 11	18	Melpomene	148	0.07	542	S	0.475	84.0		B1756153		3 8.6	1.12S	C				19 5.6	-15 53
Feb 12	426	Hippo	126	0.10	486	C	0.224	245.6	79790	+24 1800		13 2.1	3.43S	XA	N24 899	-0.20	0.9	7 54.2	24 12
Feb 13	654	Zelinda	112	0.15	273	U	0.202	144.8	94765	+15 896		0 23.3	2.91N	RA	N15 511	0.37	-0.2	5 40.9	15 13
Feb 22	10	Hygiea	443	0.29	3674	C	0.206	287.4	118291	+ 5 2332		2 43.5	3.70S	XA	N 5 1522	0.46	1.8	10 24.9	5 10
Feb 22	712	Boliviana	128	0.05	509	C	0.412	72.7	163378	-11 5269		7 10.6	2.35N	PY		-0.39	1.0	20 14.1	-10 56
Feb 24	211	Isolda	168	0.07	950	C	0.112	106.3	183657	C2211112		9 18.9	0.08S	7P		0.07	-0.0	15 38.3	-22 26
Feb 27	209	Dido	137	0.09	653	C	0.207	284.7	99328	+12 2268		2 49.6	3.11N	XA	N11 1262	-0.09	0.2	10 51.2	11 32
Feb 28	481	Emita	108	0.08	361	C	0.082	111.4	59244	+33 1360		10 33.5	2.09N	A	N33 670			6 33.8	33 26
Feb 29	90	Antiope	138	0.07	594	C	0.293	93.6	185574	C2313472		22 54.2	2.77N	XS				17 37.4	-23 7
Mar 1	4	Vesta	576	0.47	4387	V	0.074	291.4	79685	+26 1647		2 36.9	4.22N	UA	N26 863	-0.37	2.1	7 46.3	26 3
Mar 5	4	Mars	6782	5.82			0.675	88.0	187025	C2314525		9 1.8	1.63N	HX		-0.13	-0.1	18 35.2	-23 33
Mar 5	51	Nemausa	141	0.07	521	CU	0.384	70.5				19 30.4	0.58N	C				3 0.9	8 32
Mar 6	2	Pallas	533	0.19	5336	U	0.296	70.3				3 26.5	0.01N	C				19 54.3	6 54
Mar 8	10	Hygiea	443	0.29	3653	C	0.194	289.6		+ 6 2274		0 32.7	3.11N	XA	N 6 1290	0.21	1.2	10 13.3	6 8
Mar 8	121	Hermione	201	0.08	1269	C	0.236	92.1	186959	C2414462		17 20.9	1.29S	ZY		0.31	0.2	18 32.5	-24 7
Mar 10	2	Pallas	533	0.19	5342	U	0.289	68.9	125328	+ 7 4328		19 31.1	0.61S	AS	N 7 2808	-0.29	1.4	19 59.5	7 22
Mar 15	114	Kassandra	131	0.13	453	C	0.183	308.1	139205	- 3 3421		9 55.1	6.97N	XS				13 10.7	-3 51
Mar 16	1	P/SM-WM-1	100	0.02	752		0.190	67.1	164663	-12 6096		3 19.4	0.71S	XS				21 47.5	-12 13
Mar 16	94	Aurora	191	0.11	1131	C	0.187	283.1	138924	- 4 3335		15 19.8	2.91N	XS				12 42.0	-5 24
Mar 21	71	Niobe	106	0.10	328	S	0.273	255.7	202846	C32 8347		1 16.5	3.46S	S				11 49.3	-32 59
Mar 21	10	Hygiea	443	0.29	3634	C	0.145	292.1				12 18.9	0.49N	C				10 4.5	6 57
Mar 23	101	Helena	72	0.04	193	S	0.315	96.4	210436	C3313454		17 26.1	1.57N	G				18 39.8	-33 52
Mar 24	14	Irene	155	0.18	537	S	0.207	285.5	99847	+19 2514		19 6.5	3.05N	RA	N19 1171	0.28	-0.4	11 53.2	18 50
Mar 25	65	Cybele	230	0.14	1493	C	0.188	297.5	138918	- 0 2600		13 7.5	0.84S	XA	S 1 1686	-0.05	0.3	12 41.1	-1 28
Mar 29	29	Amphitrite	199	0.13	900	S	0.203	113.4				19 34.5	3.19N	C				7 25.2	27 4

paths would also make them too cluttered; this is also available on the world maps. If you have any other ideas for these maps, let me know.

Occultations by Major Planets. Only occultations by Venus and Mars were found, although Jupiter and Saturn were also included in the search. Predictions for the outer three planets are not included in my tables, but data about events through 1990 have been published by D. Mink and A. Klemola in *Astron. J. 90* (9), 1894 (1985 September; I incorrectly gave December on p. 48). The brightest star listed by them to be occulted during 1988, by Neptune on October 22nd, visible from the western Pacific around 9^h UT, is magnitude 12.2. All the Uranus and Neptune events involve small magnitude drops, and are well beyond the range of capabilities of most *O.N.* readers. On June 9th, around 10^h UT, Pluto will occult a 13.2-mag. star, with the area expected to be the northern Pacific. This is brighter than Pluto, so observers with large telescopes in Hawaii and around the edge of the Pacific are encouraged to watch for an occultation. The prediction will be improved early in 1988 with Lick Observatory astrometry. Work is also being done on possible occultations by Neptune's satellite Triton, with a possible event in May or June; it will be mentioned in *O.N.* and publicised elsewhere when details become available.

Occultations by Minor Planets. For the asteroids, I computed ephemerides for combined catalog searches for all objects with angular diameters larger than 0".08 during 1988, according to a list supplied by Robert Millis at Lowell Observatory. Also, several smaller asteroids were selected on the basis that they will occult relatively bright stars, according to Goffin's predictions. A few other asteroids with diameters larger than 250 km were also included. Searches were performed with Fresneau's astrographic catalog only for the larger or more important asteroids, including numbers 1-4, 6, 7, 8, 10, 13, 14, 15, 18, 19, 29, 45, 51, 52, 65, 87, 139, 324, 444, 451, 511, 532, 624, 704, 2060, and 3123. Combined catalog searches were performed for these and also for numbers 11, 12, 16, 20, 25, 31, 41, 43, 48, 49, 53, 54, 57, 58, 59, 63, 66, 70, 71, 78, 80, 81, 89, 90, 93, 94, 98, 101, 103, 104, 105, 111, 112, 114, 115, 121, 128, 134, 137, 144, 145, 150, 152, 159, 175, 192, 194, 200, 202, 209, 211, 216, 230, 241, 250, 275, 313, 345, 356, 360, 361, 381, 386, 387, 393, 409, 415, 423, 426, 466, 498, 506, 508, 521, 545, 554, 566, 579, 626, 643, 654, 690, 712, 735, 772, 804, 899, and 1262. Events were rejected if:

Angular Diam. Less Than	and	Star Mag. Greater Than
0".080		9.0
0.055		8.5
0.045		8.0
0.035		7.0

These tests were not performed for special relatively small objects, including numbers 12, 18, 46, 49, 51, 532, 624, 1262, 2060, and 3123. By adding logic to compare right ascensions rather than declinations when the asteroid's motion in declination was three times larger than its R.A. motion, I was able to generate all of the events for 1988 published by L. H. Wasserman, E. Bowell, and R. L. Millis in "Occultations of Stars by Solar System Objects. VII. Occultations of Catalog Stars by Asteroids in 1988 and 1989," *Astron. J. 94* (5),1364 (November 1987), except for one occultation of a 10.2-mag. star by (128) Nemesis on March 14. They also used a 0".08 angular diameter criterion, but used a TRIAD diameter that was larger than a more recent value derived by E. Tedesco. Hence, their angular diameter was greater than 0".08, while mine was less. The expected area of visibility is "southern Indian Ocean," so I did not make a special effort to get it. Since Goffin used different rejection criteria, he found many occultations of SAO and AGK3 stars not in my list. For example, he found an occultation of 8.9-mag. AGK3 +03°1002 by (137) Meliboea predicted for southwestern Canada on January 3rd. My search rejected the occultation because the angular diameter was 0".075, although Goffin rounded up to print 0".08 on his predictions. As Bob Millis says, "You have to draw the line somewhere."

During the last year and a half, Edwin Goffin has been doing valuable work improving many of the orbits of the larger asteroids useful for occultation work. Most of the orbits whose source is the Minor Planet Circulars (MPCs) with numbers greater than 10,000 are from this work. For three asteroids, Goffin provided me with preliminary orbital elements early in December; these are given as "Goffin87." He did not publish these because there have been no recent observations of these objects, the last being in 1982. Hence they are not quite as accurate as his other orbits. However, they should be much better than the older Herget and EMP orbits that they replace.

Astrometric Updates. The main source for astrometric updates is my recorded message on the IOTA occultation line, telephone 301,495-9062. Information can also be obtained from other recordings at 312, 259-2376 (Chicago), or 713,488-6871 (Houston). Call 301,585-0989 if you want to talk to me rather than just obtain a prediction update recording.

A list of early 1988 priority occultations worthy of concerted efforts to obtain astrometric updates and observational coverage is given below:

Date	Asteroid	Star
Jan 09	(654) Zelinda	SAO 77647
Jan 09	(58) Concordia	A.C. +16°53206*
Jan 12	(690) Wratislavia	SAO 128290
Jan 15	(12) Victoria	SAO 137799
Jan 21	(87) Sylvia	Anonymous*
Jan 25	(87) Sylvia	Anonymous*
Feb 07	(80) Sappho	SAO 115926
Feb 13	(654) Zelinda	SAO 94765
Feb 27	(209) Dido	SAO 99328
Mar 01	(4) Vesta	SAO 79685
Mar 08	(10) Hygiea	BD +06°2274
Mar 24	(14) Irene	SAO 99847

The positions of stars ending with an asterisk are taken from old Astrographic Catalog data. For them, an update to the star position from a plate taken any time during the last several years would be valuable to see whether the occultation is really potentially in an area with many observers, and worthy of last-minute astrometry.

Notes About Individual Events. Wayne Warren supplied important information about some stars, especially doubles.

Jan 9, (654) Zelinda and SAO 77647: The star is ZC 887. The star's angular diameter is 0".0014, requiring 0°.09 for the edge of the asteroid to cover, for a central occultation. Gradual events reported by visual observers of lunar occultations suggest that the star may be a close double.

Jan 16, (690) Wratislavia and SAO 128351: The equally bright components are 3".1 apart in position angle (PA) 3°. Separate predictions are given for the two components. If the seeing is not good enough to resolve the stars, the apparent Δm will be 0.8, rather than the 4.0 given in the table, which assumes that the component is clearly resolved.

Jan 28, Feb 22, Mar 8, and Mar 21: (10) Hygiea is the fourth largest asteroid; no occultation by it has been observed previously.

Feb 3: The star's angular diameter is 0".0003, requiring 0s.08 to centrally cover.

Feb 24: The star is ZC 2234. The star's angular diameter is 0".0010, requiring 0s.22 to centrally cover.

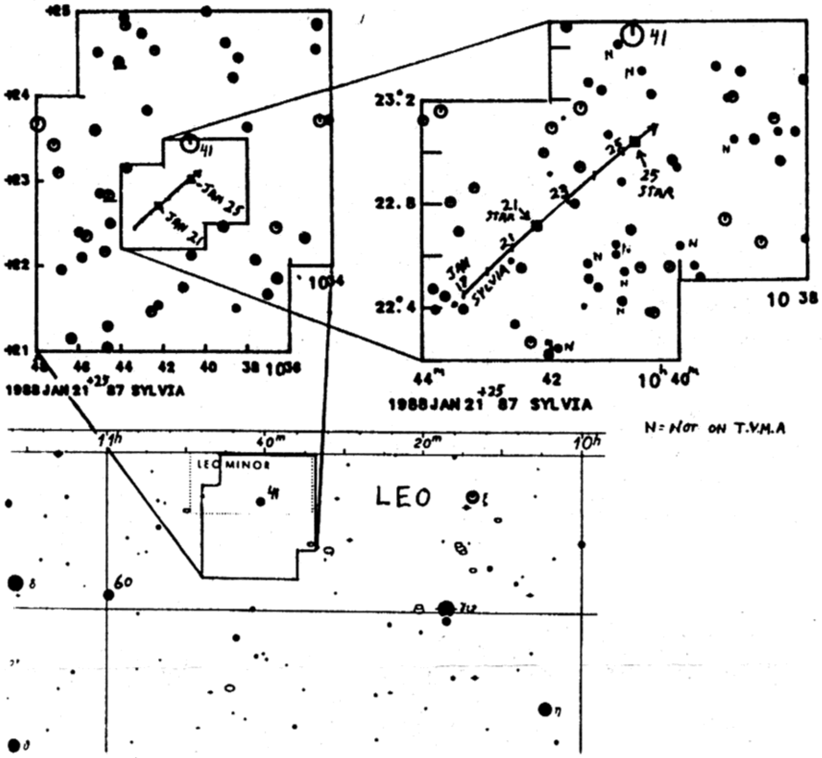
Feb 28: This event was added too late to be included on the maps.

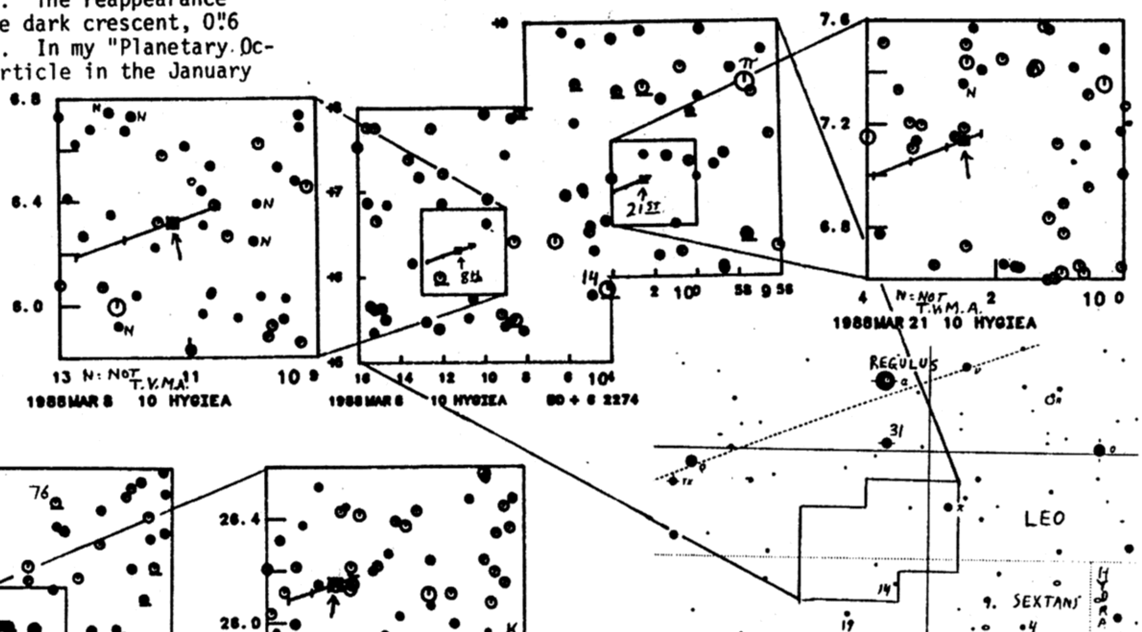
Mar 1: Vesta is either the second or third largest asteroid, and the largest for which there are no previous occultations of stars observed. A lunar occultation has been photoelectrically recorded, but lack of knowledge of the local lunar slope allows only a crude estimate of its diameter. Consequently, photoelectric observations of this occultation would be extremely valuable. Many European observatories are located within the wide nominal path.

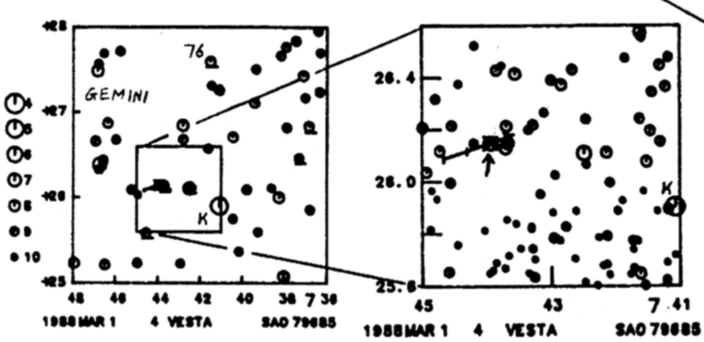
Mar 5: Mars' 6-second disk will be 90% sunlit. The reappearance will be on the dark crescent, 0".6 wide, at most. In my "Planetary Occultations" article in the January issue of *Sky and Telescope*, I incorrectly said that the disappearance would be on the dark crescent.

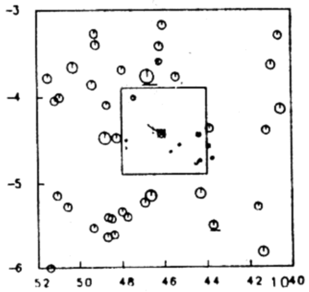
Mar 8: (121) Hermione and SAO 186959; the star is ZC 2689.

Mar 16, P/SN-WM-1 and SAO 164663: P/SN-WM-1 is periodic comet Schwassmann-Wachmann 1.

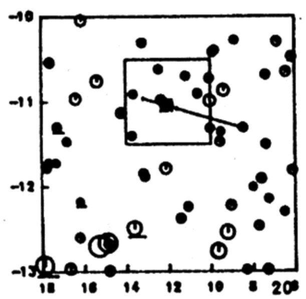




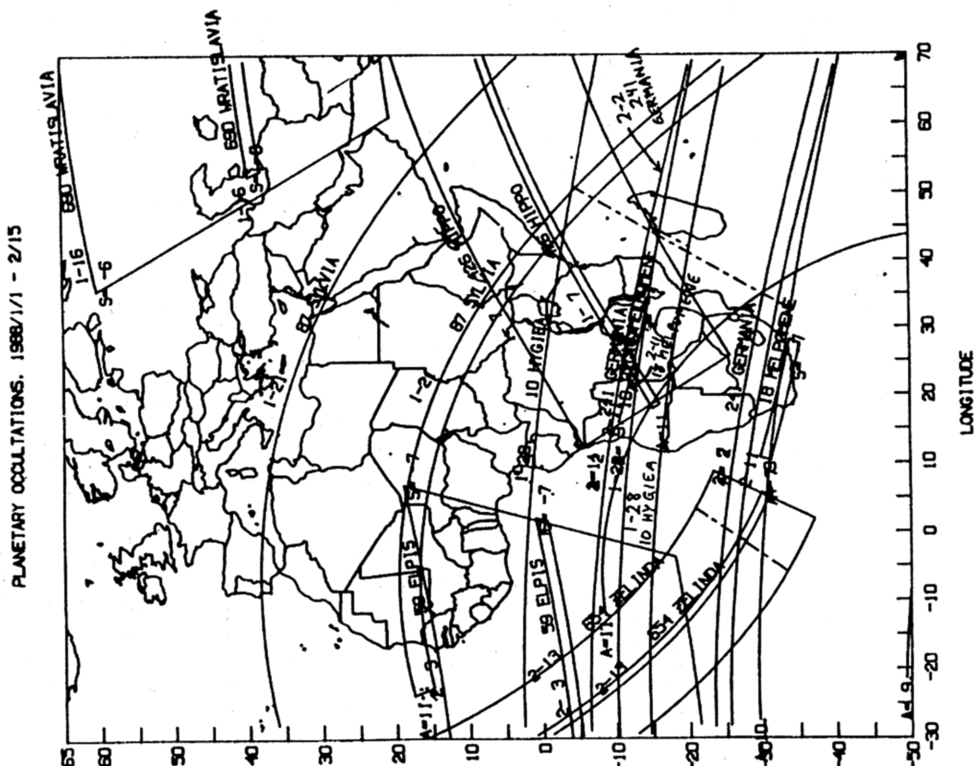




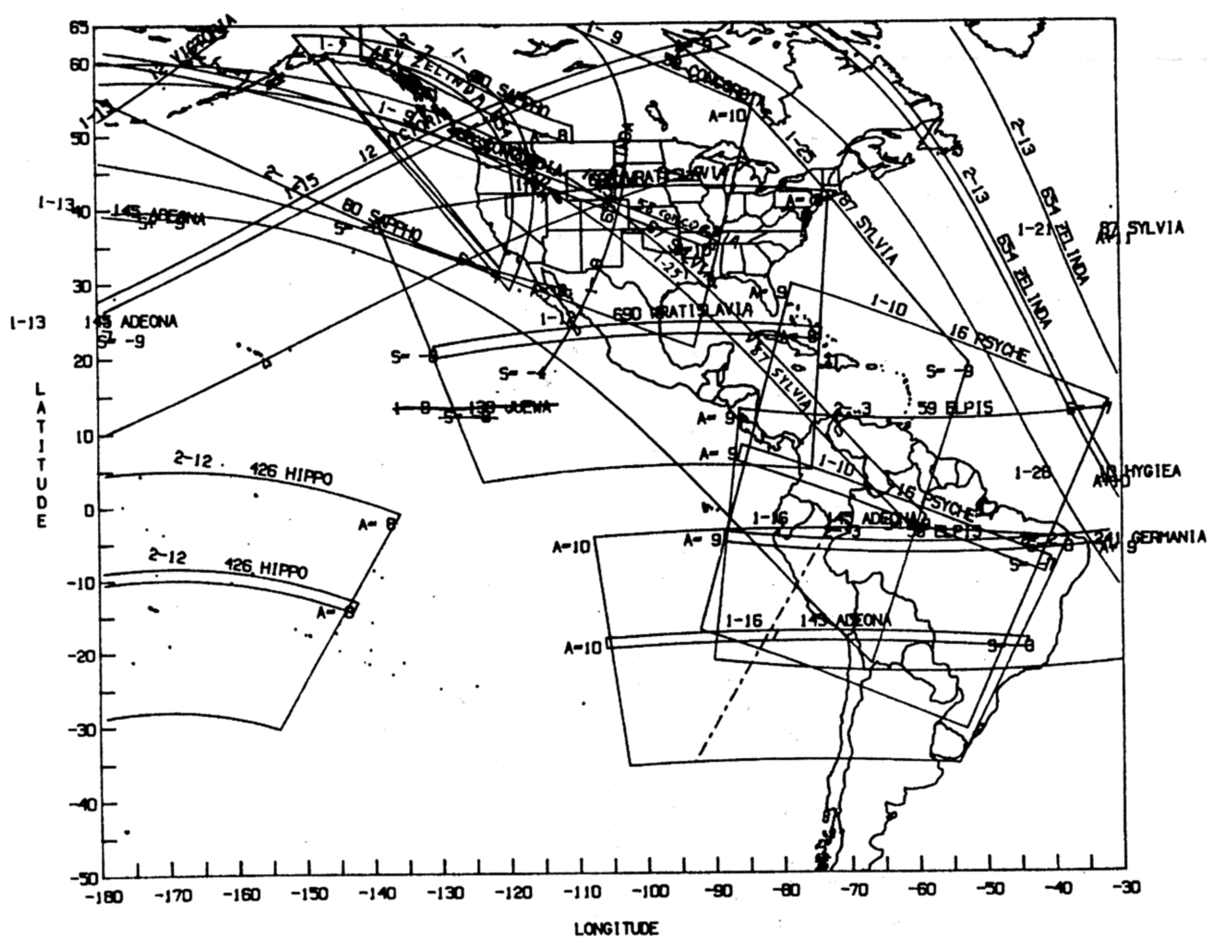
1988 JAN 15 12 VICTORIA SAO 137799

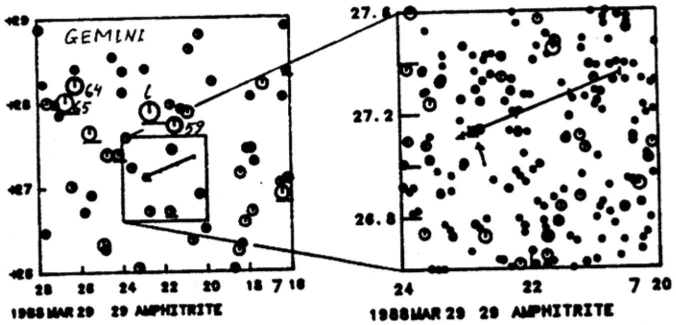


1988 FEB 22 712 BOLIVIANA SAO 163378



PLANETARY OCCULTATIONS. 1988/1/1 - 2/15





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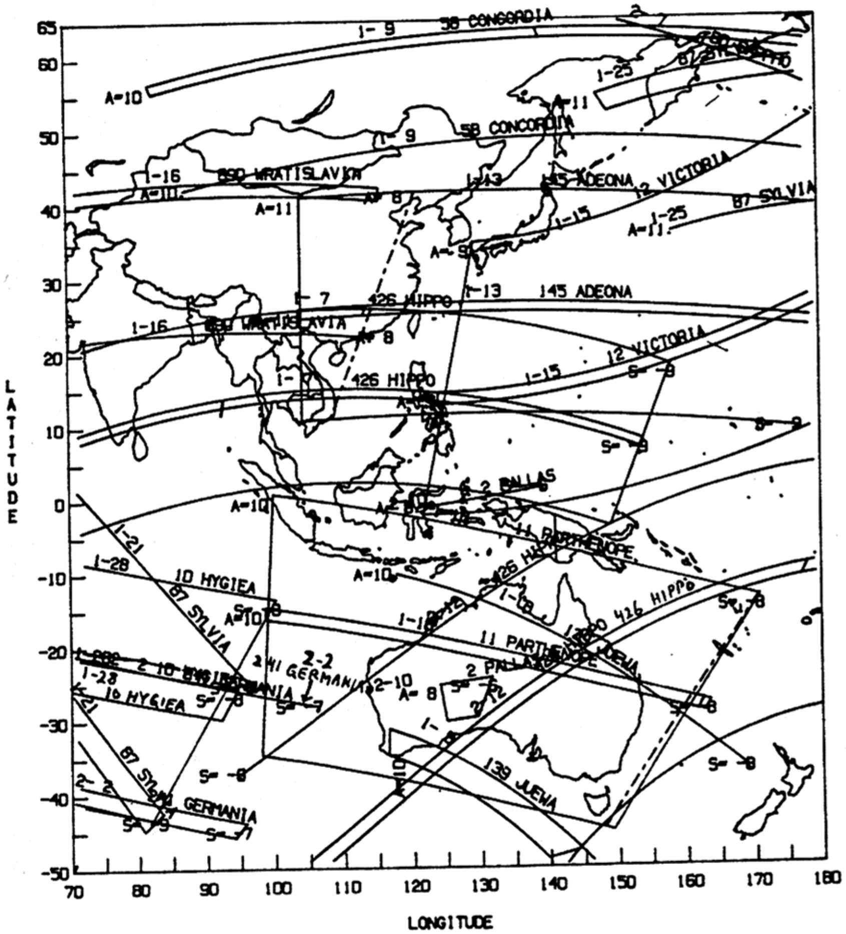
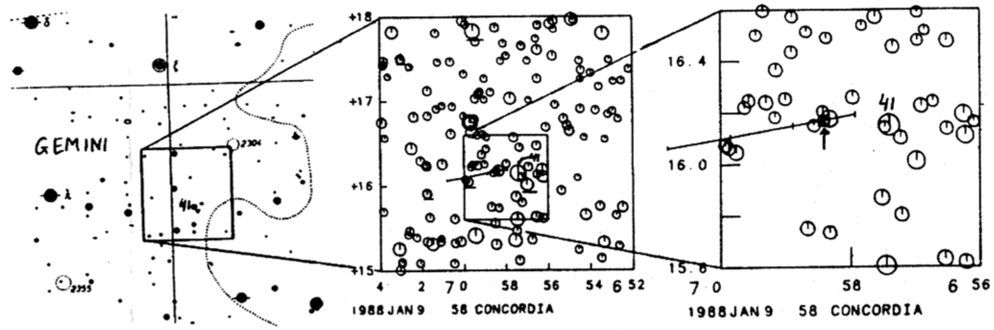
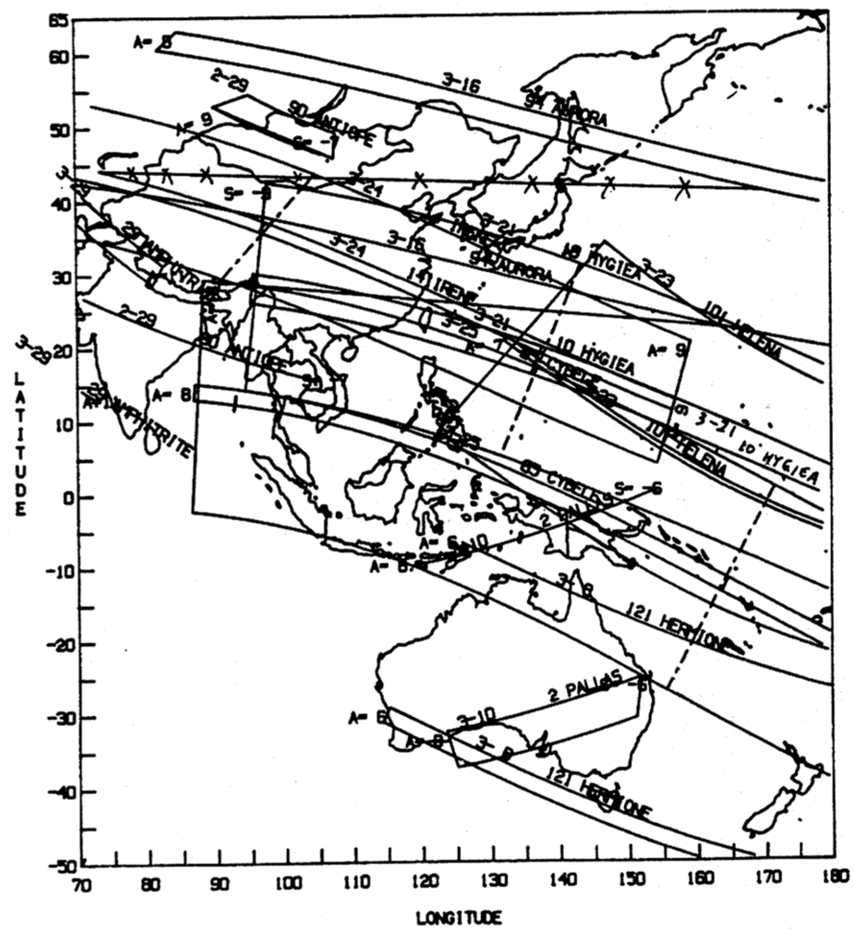
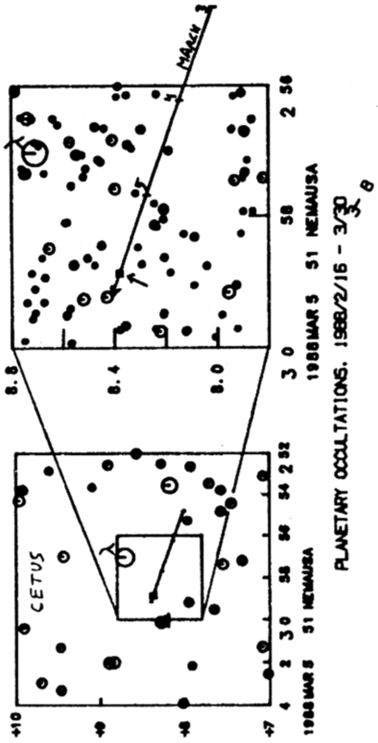
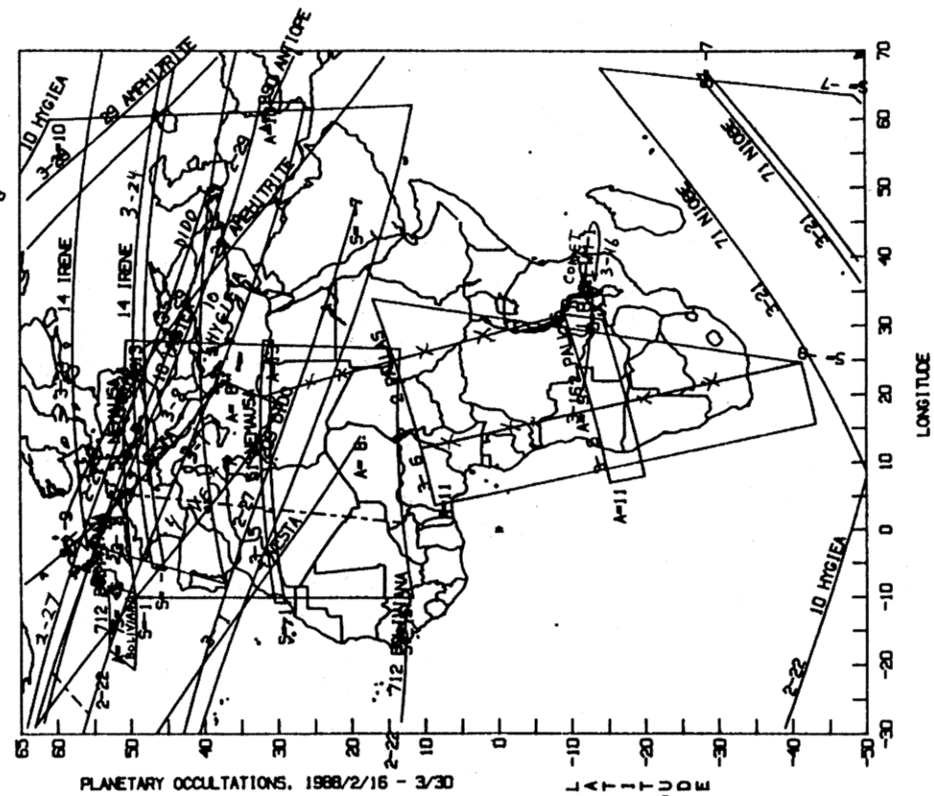


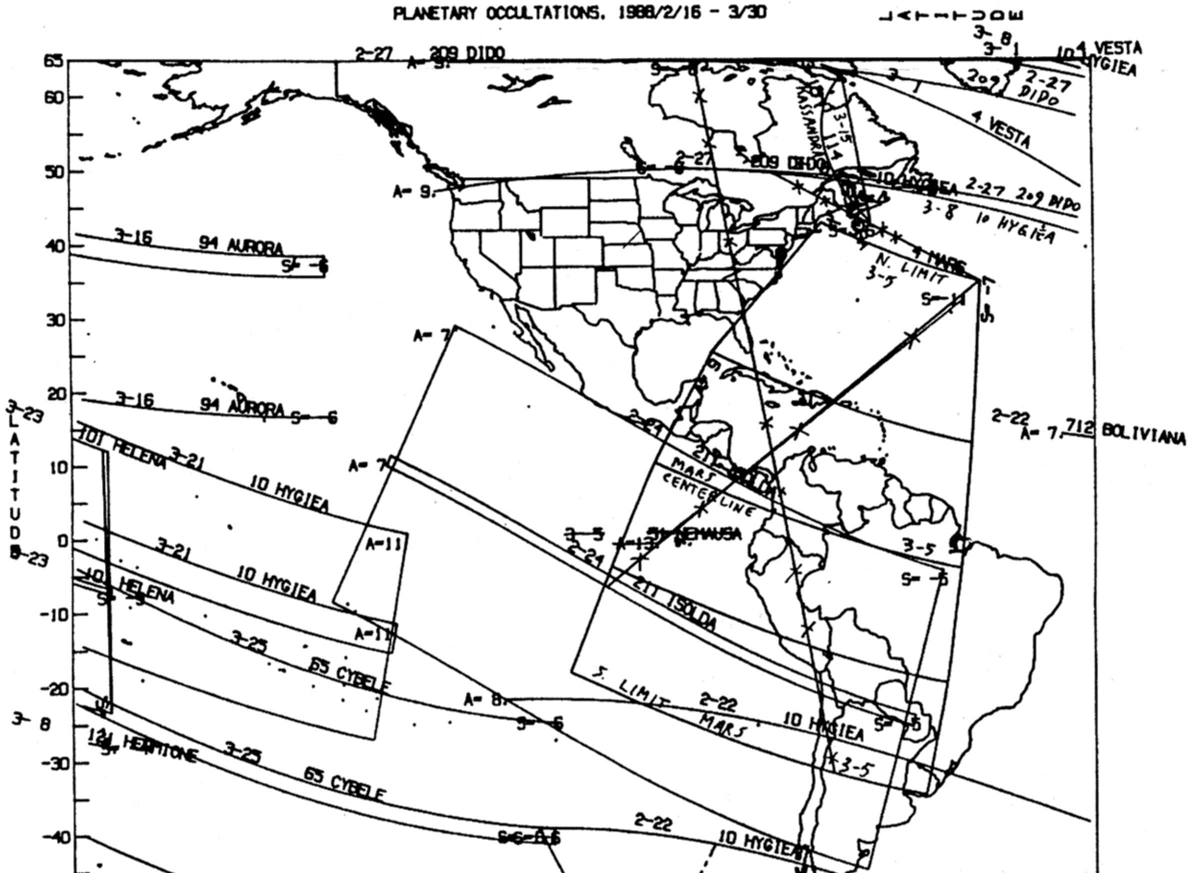


PLANETARY OCCULTATIONS. 1988/2/16 - 3/30




CETUS
1988MAR5 51 NEMAUSA
MARCH 3


PLANETARY OCCULTATIONS, 1988/2/16 - 3/30
LONGITUDE
LATITUDE
10 HYGIEA
14 IRENE
71 NIOBE
712 BOLIVIANA
51 NEMAUSA
4 VESTA
209 DIDO


LONGITUDE
LATITUDE
94 AURORA
101 HELENA
10 HYGIEA
65 CYBELE
211 ISOLDA
51 NEMAUSA
4 VESTA
209 DIDO
712 BOLIVIANA
MARS CENTERLINE
N. LIMIT
S. LIMIT