Occultation Newsletter

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FROM THE PUBLISHER

For subscription purposes, this is the first issue of 1982.

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

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IOTA NEWS

David W. Dunham

Unfortunately, we are again rushed to distribute this issue, so that you might receive it in time to use finder charts, and other information, about asteroidal occultations which occur during the second half of March. Many new asteroidal occultations described on p. 198, and other work have kept me busy, so that again I have not had time to write articles about grazing occultations or new double stars, and had to curtail the article on observations of asteroidal occultations. I hope that I can finish those articles for inclusion in the next issue, which we plan to distribute early in June and which will have information and charts of the star field to be occulted by the moon during the total lunar eclipse of July 6.

The next issue will be the last of Volume II. A few months after it is distributed, I hope that we can distribute an index to both Volumes I and II, perhaps with the first issue of Volume III. Volunteers are sought who might help with the preparation of the Volume II index; write to me at P.O. Box 7488, Silver Spring, MD 20907, U.S.A., if you are interested in this. Most of the work for an index for Volume I was completed long ago, but originally I had wanted to include with it a comprehensive stellar index. The latter is too ambitious at this point, so rather than delay things further, we will plan not to have a stellar index for the first volumes; perhaps in the future we can reconsider it.

One or two more volunteers could also help with the calculation of our graze predictions, if they have access to a relatively large computer which can read and write standard 2400-foot magnetic tapes, preferably can read and punch cards, and compile FORTRAN. In principle, all the predictions could now be computed at USNO, but in practice, manual work is still needed to include double star data, and with the asteroidal occultation and star catalog (especially for lunar eclipses) work which I need to do, I do not expect the double star data to be automated this year. Two computors lost access to the machines they had been using late last year, which caused some problems with the calculation and timely distribution of predictions for the first half of 1982.

With the help of the word-processing capabilities of an Apple-II computer, we also hope to start the task of producing a comprehensive manual of occultation observation. Volunteers with access to Apples are sought for possible help with this project, to enter the current papers, and some of the early work towards producing a rough draft of "the manual", onto diskettes which we can edit to produce an up-to-date comprehensive product.

IOTA incorporation is progressing. We are starting the process of completing the IRS forms to obtain tax-exempt status.

I thank the many observers who have sent me reports of their timings of occultations during the total lunar eclipse of January 9. Of special interest were the observations made at both the northern and southern limits of the occultation of Z.C. 1110 = δ Geminorum = Wasat during totality. As far as I know, this is the first time that grazes of the same star have been observed at both limits of the same occultation. Paul Maley and Charles Herold traveled farther than anyone else has for a graze, from Houston, TX, to Dagupan City, Philippine Islands, at the northern limit. They made 14 timings from two stations. About 11 more timings were made from Rosales by an independent expedition led by Ernesto Calpo of PAGASA, the Philippine Weather Bureau. At the southern limit, David Herald observed from the central Australian desert about 150 miles east of Ayres Rock. He had to travel over hundreds of miles of dirt roads with temperatures ranging up to 46° C. Unfortunately, clouds prevented observation of the second half of the graze, but one good disappearance was timed. My analysis of the observations shows

(Continued on page 200)

MORE PLANETARY OCCULTATIONS DURING 1982

Andrew Lowe and David W. Dunham

Lowe has manually compared the SAO catalog with asteroid ephemerides generated with Keplerian formulae using the precision osculating orbital elements published in the Leningrad *Ephemerides of Minor Planets for 1982*, similar to the calculations he performed to find the additional asteroidal occultations during 1981 published in *O.N.* 2 (12) 164. Although planetary perturbations were neglected, accurate calculations by Dunham again showed that Lowe's selections were quite good. Again, the searches were restricted to minor planets with *TRIAD* diameters between 100 and 200 km which might not have been included in Gordon Taylor's or the Lowell Observatory searches which formed the basis for the list of 1982 events published in *O.N.* 2 (13) 179. In addition, Lowe searched the paths for some of the major planets. The results are presented in two tables in the same format as those for the main list of 1982 events referenced above. The occultation by Pluto's satellite, Charon, was not found by us, but rather by Gordon Taylor, who searched special plates of the region ahead of Pluto and distributed a prediction for the event, along with his planetary occultation predictions for 1983, in Bulletin 27 of the IAU Commission 20's Working Group on Predictions of Occultations by Satellites and Minor Planets dated 1982 January 10. Robert Harrington, U. S. Naval Observatory, provided Charon's position relative to Pluto at the time of the occultation for our calculations.

1982 DATE	UNIVERSAL TIME	PLANET NAME	PLANET m_v	PLANET Δ,AU	SAO No	STAR m_v	STAR Sp	R.A.(1950)	Dec.	OCCULTATION Δm	Dur	df	P	Possible Area	El SUN	MOON El	%Snl	Up
Feb 1	5^h31^m-36^m	Devosa	11.2	1.16	81136	9.0	A3	$9^h57^m.8$	21°42'	2.3	12^s	24	16	central South America	165°	108°	46+	none
Feb 7	4	Venus	-4.1	0.31	162831	6.9	K0	19 35.0	-14 04	0.0	$2^h.3$	75	1	Caucasus; Mideast: n.c. Africa	25	168	98+	w 30°E
Feb 17	4 03-08	Aeria	12.6	1.89	60710A	8.3	F2	8 14.9	30 59	4.4	12^s	28	23	eastern Europe?s	149	131	38-	e 10°E
Feb 24	3 44	Meliboea	14.0	3.27	112400	7.4	B9	5 02.5	8 52	6.6	16	37	31	Canada?s	100	96	0+	none
Feb 27	7 44	Athor	12.5	1.68	99379	8.1	G5	10 55.7	16 52	4.4	8	19	24	Patagonia?n; se Pacific Ocean	171	138	14+	w165°W
Mar 3	12 39-45	Meliboea	14.1	3.39	112446	8.8	F5	5 05.3	9 19	5.3	12	29	32	Mongolia; e. Siberia; Japan?s	94	12	57+	all
Mar 9	18 12	Myrrha	13.9	3.33	162917	9.4		19 39.9	-16 21	4.5	4	10	32	Australia; w. New Zealand	55	126	100-	all
Mar 12	15 12-24	Aemilia	13.6	2.76	159799	8.8	G5	16 11.3	-13 52	4.8	20	47	28	(e. Siberia, Japan, Alaska)?s	108	38	91-	all
Mar 15	19 10	Hippo	14.2	3.64	75028	9.3	G5	1 53.0	28 36	4.9	3	10	42	nw Africa?n	44	147	68-	none
Apr 18	4 06	Tercidina	13.0	2.14	96799	8.8	F5	7 18.0	12 15	4.2	5	13	28	Peru	82	151	34-	none
Apr 18	5 17	Xanthippe	13.5	2.53	145044	7.7	K2	20 59.8	-9 39	5.8	4	12	34	Iberia?s	73	10	34-	all
Apr 20	16 35	Philomela	12.5	3.66	77331	8.5	A2	5 34.6	26 11	4.0	5	12	33	se Africa?n	55	96	13-	none
May 6	19 41-48	Charon	13.7	29.06		14.5		13 56.5	6 54	0.4	69	49	14	Asia, Europe; Africa?s	153	15	98+	all
Jun 13	5 45-50	Eva	14.4	2.97	100452	9.1	G5	13 09.0	16 43	5.3	9	27	39	se Canada, USA, nw Mexico	106	141	65-	e 90°W
Jun 24	12 39	Gyptis	13.3	2.84	138868A	8.6	K2	12 33.4	-1 08	4.7	15	30	25	Manchuria, Japan	96	53	13+	w142°E
Jun 25	23 57	Medea	13.7	2.93	109515	8.6	K0	0 49.9	8 24	5.1	6	15	32	ne Africa, Mideast	79	140	27+	none
Jul 5	15 15	Emita	13.5	2.45	110134	9.4	K	1 45.5	1 16	4.1	4	12	33	Hawaii?n	78	109	100+	all
Jul 8	5 02-18	Sapientia	14.2	2.80	128582	9.0	K0	0 03.6	-2 26	5.2	16	48	38	Caribbean; Cape Verde Islands	105	54	97-	all
Jul 16	4 13	Chloris	13.6	3.39	99171	7.9	G0	10 29.4	18 15	5.6	4	9	35	(cen.Canada, Rocky Mtns)?s	40	104	28-	none
Jul 17	9 06	Liberatrix	14.5	3.53	94036	6.8	G0	4 34.3	18 27	7.7	2	10	78	(e. Canada, e. USA)?s	44	3	16-	all
Jul 19	2 20	Artemis	13.7	3.12	111464	8.6	K2	3 48.6	9 54	5.1	4	11	35	southern Africa	59	36	4-	e 40°E
Jul 20	18 32-43	Thia	11.5	1.38	161675	6.9	F8	18 34.7	-12 24	4.5	15	28	16	Japan, China, sw Asia, Balkans	159	158	0+	none
Jul 28	11 30	Comacina	14.3	3.84	94827	6.6	A3	5 42.2	12 52	7.7	3	10	43	central Chile	40	137	57+	none
Aug 4	14 25	Hippo	14.1	3.56	58847	8.7	A0	6 08.9	36 09	5.4	3	9	41	Hawaii?s	41	143	100+	all
Aug 10	12 38-63	Lilaea	12.4	1.59	146853	8.6	G0	23 39.8	-9 06	3.9	16	38	22	(Baja Calif., New Zealand)?n	145	31	70-	e150°E
Sep 28	2 29	Comacina	14.0	3.12	114680	9.0	A5	6 54.8	9 59	5.0	6	16	35	Africa	81	153	76+	w 5°W
Oct 11	11 54	Bruchsalia	14.2	3.34	159277	9.5	G5	15 24.9	-16 59	4.7	2	9	48	sw Australia?n	36	106	33-	none
Oct 31	15 02	Laurentia	14.9	3.66	188343	8.8	K0	19 33.9	-27 37	6.1	5	16	49	w. Australia?s	73	94	99+	all
Nov 24	3 58	Emma	13.3	2.25	146191	9.4	F8	22 33.8	-0 37	3.9	8	21	29	Mexico, Cuba; USA?n	99	13	53+	all
Dec 29	22 38	Liberatrix	13.1	2.00	94582	7.7	B9	5 25.9	16 23	5.4	5	22	44	South Africa?n	163	10	100+	all

By the time this issue of *O.N.* is distributed, some of the occultations already will have occurred. Preprints of this article, and finder charts, have been distributed to IOTA coordinators in the possible areas of visibility. Regional maps and finder charts for the upcoming events will be distributed, or published here, as appropriate. You can receive local circumstances for these additional appulses by sending a self-addressed stamped (for those in the U.S.A.) envelope to Joseph Carroll, 4216 Queen's Way, Minnetonka, MN 55343; see *O.N.* 2 (13) 178.

Notes about observational attempts for some of the occultations which already have occurred are given in the article on p. 200. Wayne Warren provided Yale Catalog data used for the predictions of the occultations on Feb. 24, July 20, and July 28, since the SAO Catalog used less accurate G.C. data for those stars. No Yale data were available for SAO 60710 occulted on Feb. 17, and were not necessary for SAO 162831 on Feb. 7, since Venus had such a large angular diameter on that date that even a rather large star position error would have little effect on the prediction. When possible, the predictions here have been computed using ephemerides generated from orbital elements published by Paul Herget in the Minor Planet Circulars in 1978. Predictions for all events have been computed using Leningrad (I.T.A.) elements, usually taken from the E.M.P. for 1981. New orbital elements given in the 1982 E.M.P. have been used for the occultations by (137) Meliboea and (159) Aemilia. The differences between the Herget and the I.T.A. predictions are not significant – less than 0"6 for the path shift and less than 3 minutes of time – for the events which occur on the following dates: Mar. 9, March 15, June 24, July 5, July 17, July 19, Oct. 31, and Dec. 29. When the ephemeris differences are larger, they are indicated in the notes about some of the events which are given below.

Feb. 17: The star's 9.8-mag. companion, 5" away, was not predicted to be occulted from the earth's surface, missing by about 4" to the north. The path for the primary was predicted to miss the surface by 0"4, so that a south shift at least this large was needed for the occultation to be visible from eastern Europe.

May 6: The planet magnitude is for Pluto, since Charon can not be directly resolved from the planet. The rather small magnitude drop and the faintness of the objects only 15° from a nearly full moon will make this event extremely difficult to observe at best with very large telescopes. Dunham will supply a finder chart based on Astrographic Catalog data upon request to anyone who wants to try to observe this event in spite of the considerable obstacles.

June 13: The E.M.P. 1981 path is 2"21 west and 2.2 min. earlier than the Herget path, and would cause the occultation possibly to be visible from Hawaii or New Zealand rather than from North America; astrometry a month or two before the event is needed to resolve the difference.

June 24: The star's 12th-mag. companion, 5" away, will not be occulted from the earth's surface.

June 25: SAO 109515 is Z.C. 116.

July 17: SAO 94036 is Z.C. 697. The Zodiacal Catalog shows that the star's mag. varies from 7.2 to 7.4 in a 3.15-year period. David Herald gives a magnitude range of 0.6 for this long-period variable in *O.N. 2* (12) 162. The star is not indicated as variable in the SKYMAP catalog.

July 20: The I.T.A. 1975 path is 1"22 south and 1.1 minutes earlier than the Herget path.

Aug. 4: The E.M.P. 1981 path is 0"79 north and 2.8 minutes later than the Herget path.

Nov. 24: The E.M.P. 1981 path is 4"87 north (= miss earth's surface by 1"36) and 42.0 min. earlier than Herget's path. The last-published astrometric observations of (283) Emma were made in 1972, 1974, and 1976. Although these observations have a rather large scatter, they agree much better with Herget's orbit than with E.M.P. 1981. But the corrections to my Herget-based prediction could shift the path over

1982	MINOR PLANET						MOTION		STAR			STELLAR DIAMETER					COMPARISON DATA			APPARENT	
DATE	No.	Name	km-diam.	"	RSOI	Type	°/Day	PA	SAO No	DM No.	D	M"	M	Time	df	S	AGK3 No	Shift	Time	R.A.	Dec.
Feb 1	337	Devosa	107	0.13	304	C	0.248	279°	81136	+22°2153		0.06	50	6	0.2	S	N21°1086	0.75	1.1	9h59m6	21°33'
Feb 7		Venus	12220	54.31	*****		0.157	246	162831	-14 5480		0.88	197	134	1.8	G				19 36.8	-14 00
Feb 17	369	Aeria	120	0.09	472	CMEU	0.170	288	60710	+31 1779	A	0.13	172	18	0.6	G				8 17.0	30 53
Feb 24	137	Meliboea	153	0.06	873	C	0.098	53	112400	+08 852		0.11	255	26	0.7	Y	N 8 548	-0.37	1.2	5 04.2	8 55
Feb 27	161	Athor	100	0.08	344	CMEU	0.261	285	99379	+17 2300		0.30	371	29	1.4	S	N16 1158	-0.39	-0.6	10 57.4	16 42
Mar 3	137	Meliboea	153	0.06	876	C	0.124	62	112446	+09 738		0.12	297	23	0.8	S	N 9 487	-0.26	0.7	5 07.1	9 21
Mar 9	381	Myrrha	150	0.06	679	C	0.348	83	162917	-16 5415						X				19 41.7	-16 16
Mar 12	159	Aemilia	141	0.07	691	C	0.084	76	159799	-13 4384		0.22	431	62	1.3	S				16 13.1	-13 57
Mar 15	426	Hippo	126	0.05	549	C	0.347	77	75028	+28 321		0.14	382	10	1.0	S	N28 214	-0.69	-1.6	1 54.8	28 45
Apr 18	345	Tercidina	109	0.07	328	C	0.350	87	96799	+12 1504		0.12	180	8	0.6	S	N12 882	0.56	0.3	7 19.8	12 11
Apr 18	156	Xanthippe	109	0.06	356	C	0.343	63	145044	-10 5577		0.59	1089	42	3.5	S				21 01.5	-9 31
Apr 20	196	Philomela	162	0.06	847	S	0.295	86	77331	+26 876		0.07	199	6	0.5	X	N26 519	0.38	0.3	5 36.5	26 12
May 6		Charon	1500	0.07	*****		0.025	283								R				13 58.1	6 44
Jun 13	164	Eva	111	0.05	511	C	0.143	191	100452	+17 2599		0.20	420	33	1.2	S	N16 1328	1.01	-2.1	13 10.5	16 32
Jun 24	444	Gyptis	167	0.08	867	C	0.128	104	138868	-00 2592	A	0.40	822	75	2.5	P	S 1 1681	0.41	-0.3	12 35.0	-1 19
Jun 25	212	Medea	133	0.06	574	C	0.263	62	109515	+07 124		0.40	845	36	2.5	Z	N 8 93	-0.30	1.3	0 51.6	8 34
Jul 5	481	Emita	108	0.06	354	C	0.340	73	110134	+00 292		0.27	485	19	1.6	S	N 1 191	0.99	0.4	1 47.2	1 25
Jul 8	275	Sapientia	107	0.05	459	C	0.081	85	128582	-02 6097		0.26	531	78	1.6	X				0 05.3	-2 15
Jul 16	410	Chloris	142	0.06	587	C	0.378	113	99171	+18 2372		0.24	588	15	1.6	S	N18 1057	0.44	0.4	10 31.1	18 05
Jul 17	125	Liberatrix	66	0.03	200	M	0.348	84	94036	+18 661		0.30	770	21	2.1	Z	N18 355	0.59	0.0	4 36.2	18 30
Jul 19	105	Artemis	129	0.06	518	C	0.329	94	111464	+09 502		0.39	882	28	2.5	S	N 9 357	-0.56	-0.9	3 50.4	10 00
Jul 20	405	Thia	126	0.13	429	C	0.196	279	161675	-12 5120		0.31	311	38	1.3	Y		1.04	-1.8	18 36.6	-12 22
Jul 28	489	Comacina	130	0.05	598	C	0.340	92	94827	+12 884		0.18	489	12	1.3	Y	N12 591	0.43	0.3	5 44.0	12 53
Aug 4	426	Hippo	126	0.05	524	C	0.365	91	58847	+36 1380		0.07	176	4	0.5	S	N36 631	-1.74	-0.5	6 11.0	36 08
Aug 10	213	Lilaea	105	0.09	345	CMEU	0.136	218	146853	-09 6237		0.18	206	31	0.8	X				23 41.5	-8 55
Sep 28	489	Comacina	130	0.06	595	C	0.225	109	114680	+10 1343		0.07	152	7	0.4	S	N 9 805	-0.26	0.5	6 56.6	9 56
Oct 11	455	Bruchsalia	101	0.04	340	C	0.402	110	159277	-16 4087		0.16	397	10	1.1	X				15 26.7	-17 06
Oct 31	162	Laurentia	109	0.04	514	C	0.212	75	188343	-2714128		0.16	423	18	1.1	X				19 35.9	-27 32
Nov 24	283	Emma	111	0.07	391	C	0.207	75	146191	-01 4324		0.10	163	12	0.5	S	S 0 2884	-0.17	1.7	22 35.4	-0 29
Dec 29	125	Liberatrix	66	0.05	204	M	0.208	271	94582	+16 786		0.09	135	11	0.5	S	N16 482	0.17	-0.3	5 27.9	16 25

1" and the time error could exceed 5 minutes, so the occultation could occur in virtually any part of North America. Astrometry 2 or 3 months in advance would be valuable for refining this inaccurate prediction. A special astrometric opportunity will occur on Sept. 15, when Emma will be near opposition and ½ degree north of SAO 146191.

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that there is no significant correction to the polar radius of Watts' datum near zero latitude libration, an important result for our analysis of solar eclipse observations for determining small variations of the solar radius. This means that, to about 0".1 accuracy, the solar radius determinations we make from the solar eclipse observations are made in an absolute sense, not just relative to each other. Paul Maley used an unguided, undriven C-90 camera to photograph the star's trail, which is broken twice while the star was behind lunar mountains. It will be published in the 1982 issue of *Sky and Telescope*.

A short account of our efforts to record the occultation of Nunki by Venus is given in *Sky and Telescope 63* (2) 207. I will try to write a longer account for a future issue of *o.N.* In the meantime, we continue to use the video equipment for lunar occultations, almost routinely now. It is well-suited for field use and can be set up rather quickly. On March 2, I traveled with two other observers to Myrtle Grove, NC, just south of Wilmington, to observe a graze of 6.8-mag. Z.C. 726 by a 50% sunlit moon. We met several NC observers there, and by the time all observing site arrangements had been made, time was becoming short. I arrived at my site less than 25 min. before the graze began, yet I was able to set up the 20-cm Schmidt-Cass and the video equipment, make adjustments, and begin recording the graze a minute before the first disappearance. I recorded twelve events; a visual observer 400 feet to the north had 16. Eight minutes after the graze ended, the equipment, still partly connected but powered off and stowed safely, and the other two observers and I were driving north, to a pre-arranged site just north of Warsaw, NC, 100 km north of Myrtle Grove, since 95 minutes after the ZC 726 graze ended, a graze of 97 Tauri would begin at the new site. We arrived there 12 minutes before the appointed time, and had the video equipment set up in time for that graze, but even a 5th-mag. star could not penetrate the clouds which now veiled the moon. The exercise nevertheless proved the utility of the video setup. We had a little more time to reach Rocky Mount, another 100 km farther north, for a third graze, of 6.2-mag. Z.C. 736, but when we got there, the clouds were so thick that the moon could not be seen. We relaxed and played back the tape of the first successful graze made at Myrtle Grove a few hours before.

Peter Chen, University of Texas, Austin, has sent me diagrams of the electronics for the portable photoelectric occultation system which he has designed. I don't know what the arrangements for duplication of the system (fabrication) will be, and plans for the photometer head were not included. We'll publish more about it when we know.

In a related development, Glenn Schneider, University of Florida, Gainesville, made the first photoelectric recording of a grazing occultation with portable equipment on January 21st. The star was 4.5-mag. Z.C. 2498 = ξ Ophiuchi. A 20-cm Schmidt-Cass was used with a 30" diaphragm; with a sun alt. of -7°, the sky background was quite bright. Heavy dew reduced the paper in the chart recorder to something resembling wet tissue paper, so it had to be abandoned. The data were collected at $^1/_{25}$th-second intervals and stored in a small computer. The circulating buffer was commanded to stop just after the graze ended, but for some unknown reason, it continued for another 90 seconds. The last four events were saved. Several visual timings were made by members of the Tampa Amateur Astronomical Society led by Tom Campbell, and by a couple of Univ. of FL students. An expedition in eastern FL led by H. Povenmire was also very successful. Due to thick fog, it was possible to get only one timing at an 8-station effort near Tallahassee led by Chris Hunter and me.

If your astronomical society is not listed already in one of the directories of such organizations, you might write asking for forms from: GALL Publications, Box 6666 Station A, Toronto, Ontario M5W 1X4, Canada and/or André Heck, c/o ESA Satellite Tracking Station, Apartado 54065, Madrid, Spain.

Brian Loader, 273 Scott St., Blenheim, New Zealand, has designed forms for recording timings of eclipses, occultations, and transits of the Galilean satellites of Jupiter. Jay Lieske, Jet Propulsion Laboratory, says that timings of these events, especially eclipses, will be of use for the Galileo mission.

Starting this year, the graze predictions have been computed with USNO version 80F, which is easier to use than the other versions, although some of the star catalog reference data for southern stars is lost. However, the ACLPPP profiles continue to use version 78A, and this is what observers should use for finally setting up. One word of caution: Version 80F includes Perth70 catalog data, whereas 78A does not. If there is a large (over 0".4) VPC given on your ACLPPP profile for southern-declination stars, especially ones of medium brightness, version 80F has probably used Perth70 data so that the limit predictions will be a better representation of where the extreme part of the moon's mean limb will be than ACLPPP. But sometimes version 80F uses SAO-G.C. data instead of Z.C. data, in which case, the ACLPPP and version 78A probably will be better. This is rather infrequent and can be spotted by large (greater than 0".5) probable errors of star's declination listed in the limit prediction heading.

I was moved to a different office than expected, so the extension given at the bottom of p. 196 of the last issue is wrong. My home telephone is 301, 585-0989 and my work number is now 301, 589-1545, ext. 603 or 326.

OBSERVATIONS OF ASTEROIDAL OCCULTATIONS AND APPULSES

David W. Dunham

Reports of attempts to observe occultations of stars by asteroids, at least when clouds do not prevent observation, should be sent to me at P.O. Box 7488, Silver Spring, MD 20907, U.S.A., and to Gordon Taylor, H.M. Nautical Almanac Office, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, Sussex BN27 1RP, England. If any possible occultation events are timed, it is recommended that you use the ILOC lunar occultation report forms, writing the number and name of the asteroid at the top of the form; but do not send a copy of the report to ILOC, since they collect only lunar occultation timings.

Due to a shortage of time, only a few events will be discussed here. More will be described in the next issue. In general, only events of wide interest for which some astrometry was obtained, or events where either primary or secondary occultation timings were reported, will be described here.

(739) Mandeville and SAO 118438, 1980 December 10: Observations of this occultation were noted in *O.N.* *2* (11) 143, but I did not even know the star then. Some information about the event has been obtained from a Japanese publication sent by Toshio Hirose. Shio Oikawa translated the article, "Pursuing the Minor Planets' Shadow," by Masahiro Ogasawara. One observer reported a 5 or 6-second occultation, corresponding to a chord of about 100 km, about the expected diameter of the asteroid. But an observer less than 40 km north of him reported no occultation, while another about 160 km to the north (on the Besselian plane) nearly simultaneously timed a 2.1-second occultation. The observations indicate a rather flattened shape for Mandeville, with the possibility of a substantial satellite, but neither occultation was confirmed by a second observer.

(9) Metis and SAO 184474, 1981 February 12: Metis is of special interest due to the possibility that it has a large satellite; see *O.N.* *2* (11) 123. Astrometry by Pennallow and by Klemola indicated a path at 0".75 north, over central Zambia. Unfortunately, it rained in Salisbury, Zimbabwe; several observers in South Africa, well south of the expected path, reported no occultation. A telegram sent to an astronomy club on Mauritius was received after the appulse.

(48) Doris and SAO 118552, 1981 March 19: Klemola's astrometry of Mar. 10 indicated a path 0".27 south crossing the southwestern U.S.A., generating considerable interest. Klemola provided fainter reference star positions to other astrometrists from his large-field AGK3R-reduced plate. Plates taken at New Mexico State University a few days later indicated a path about a diameter farther north, and a plate taken with the 61-inch USNO telescope at Flagstaff, AZ, the night before the event predicted the occultation nearly exactly, placing the center of the path at about 0".09 south. In spite of low altitude, a 99%-sunlit Moon only 7° away, and cloudy skies over western Washington and most of the southwestern U.S.A. and part of British Columbia, the following observations of the occultation of the 9.0-mag. star were made:

Observer	Location	Aper.	Longitude W.	Latitude N.	Height	Disappearance	Reappearance
Tom Lutz	Pullman, Wash.	30 cm	117° 09' 10"	46° 43' 44"	800 m	11^h 40^m 37^s	11^h 40^m 52^s
Neil Laffra	S. Langley, B.C.	20 cm	122 36 44	49 03 12	82 m	11 41 13.8	11 41 18.9
Leigh Palmer	Burnaby, B.C.	20 cm	122 56 05	49 16 55	285 m	11 41 16.1	11 41 22.2

The observations at the two stations in British Columbia were confirmed by other observers. Both of them reported that the star began to fade about 0^s.6 before the complete disappearance time given above. The times are UTC, determined from voiced calls on tape recorders recording WWV time signals. Reaction times were not estimated or applied. The observations are plotted in Fig. 1. The chord length at Pullman was 196 km, considerably larger than the 149-km diameter given by TRIAD. But the assymetric chords, nearly on top of each other, obtained at the B.C. sites indicates a very irregular shape, probably with more of a slope on the disappearance side, which could explain the observed fading by prolonged Fresnel diffraction. With essentially only two chords and an irregular shape, a meaningful diameter of Doris' outline can not be determined. My guess is that Doris was elongated in the direction of motion, with Pullman near the center of the path, so that the mean diameter is less than the Pullman chord length, but more than the TRIAD value.

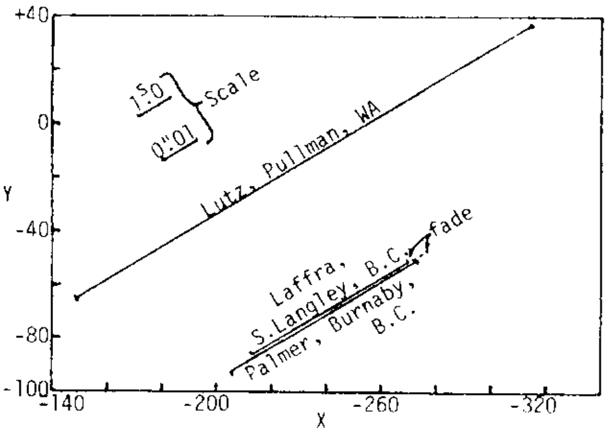


Fig. 1. The observations of the occultation by (48) Doris are shown projected onto the plane of the sky. X and Y are differences in R.A. and Dec. from the nominal prediction multiplied by the observer's distance to the asteroid. The plotted chords show when the star was behind Doris; disappearances are on the right, reappearances on the left. The short bars above the Pullman path are not observations, but only show the scale: 1^s.0 = 13.0 km and 0".01 = 15.2 km.

(344) Desiderata and SAO 42418, 1982 January 11: Shortness of time makes it necessary to skip several events, including the well-observed occultation by (88) Thisbe on 1981 Oct. 7 and photoelectric observations at Austin, TX, on 1982 January 24 which indicate that (532) Herculina may have a large cloud, or even ring, of debris; these other events will be described in more detail in the next issue. But due to the impending occultation by (344) Desiderata on Mar. 20, I felt it useful to discuss the two recent events involving this asteroid here. I do not know of any astrometry for the Jan. 11 event, but Jukka Piironen, Dept. of Astronomy, University of Oulu, Oulu, Finland, reports a 0^s.6 occultation of the star beginning at U.T. 20^h 17^m 59^s.0 from a photoelectric record; the rest of the 30-minute record was smooth. the time is about ½ minute earlier than the time of closest approach. Oulu was 1".3 north of the pre-

dicted nominal path. The astrometry for the Feb. 8 event indicated a substantial south shift, which would put the path for the Jan. 11 occultation south of the nominal path, probably over Algeria and the eastern Mediterranean. Also, since the predicted central duration was 9^s, it is very unlikely that the Oulu event was an occultation by the asteroid itself, which would have to be grazing. I have not received any other reports; the Oulu observation was announced on an I.A.U. card.

(344) Desiderata and B.D. +45° 1520, 1982 February 6: Plates exposed by Penhallow on Jan. 28 indicated a substantial ephemeris south shift from the EMP 81 path, such that it might cross the north-central U. S.A. Klemola obtained a plate exposed at Lick connecting the star and asteroid on Feb. 1, but problems with the plate measuring engine delayed the plate reduction until Feb. 5. This refined the path to 0".63 ±0".07 south, putting the path over Lake Winnipeg, Manitoba. Although weather was uncertain and twilight would be a problem, I telephoned the result to Richard Bochonko at the Univ. of Manitoba. The path also should have crossed central Scandinavia and the western U.S.S.R., passing near Leningrad and northeast of Moscow. I tried to telephone Gordon Taylor the result to disseminate to European observers, but discovered that he had left that day for Israel, probably to try to observe the occultation of SAO 162831 (= Z.C. 2867) by Venus on Feb. 7; see p. 198. In an earlier telex message, I had requested that he notify observers in the area about the Venus occultation. For Desiderata, I telephoned Hans Bode, asking him to notify Scandinavians. I then checked our foreign weather service, which said a large North Atlantic storm was headed for Scandinavia, with better prospects for clear skies in the U.S.S.R. It was by then Saturday morning there. Don Trombino, who had organized a tour for the recent Siberian eclipse, gave me the home telephone of Alexander Kovall in Moscow. We telephoned him, and he said that he would disseminate the prediction. Although Silver Spring was over 1" south of the newly-predicted track, I decided to attempt it. A large patch of cirrus blanketed the area at the time, so I traveled to Gaithersburg, MD, about 40 km to the northwest, where I set up my 25-cm reflector under clear skies. The 10.7-mag. star was at the threshold of visibility and could not be effectively monitored due to glare from the full Moon 31° away. Craig Patterson was able to monitor the star using a 40-cm Cassegrain reflector, f/13.5, at the Grundy Observatory at Lancaster, PA, and saw no events. On Mar. 20, the star will be a little brighter, and there will be no moon, so the observation should be possible with smaller telescopes, probably down to 15 cm aperture.

LETTER TO THE EDITOR

The University of Arizona
Lunar and Planetary Laboratory

I would like to call your attention to the "Planetary Appulses and Occultations," published in *The Observer's Handbook - 1982* of the Royal Astronomical Society of Canada. The table indicates that coordinates are for epoch 1950, whereas they actually are for 1982. Maybe a note in *Occultation Newsletter* would be useful.

W. Wisniewski

ANOTHER PLUTO APPULSE

David W. Dunham

On *IAU Circular* 3674, M. P. Candy, Perth Observatory, notes a possible occultation of a 13th-magnitude star, at 1950 R.A. $13^h\ 58^m\ 43^s$, Dec. +6° 43'.7, by Pluto on 1982 April 15.067, with a miss distance of 0".35. I calculate a miss distance of 0".7 also to the south, at 4^h U.T., when the appulse will be visible from the Americas and Atlantic between longitudes 20° E. and 130° W.; a 63% sunlit waning moon will be up east of 70° W. Since Charon will be south of Pluto, it is less likely that it will occult the star. Measurement of a plate taken by Klemola in 1973 gives a star position 0".4 north of Candy's position, which would increase the miss distance by that amount. Results of any more astrometry (Klemola hopes to expose a plate late this month) will be announced in a future *IAU Circular*, and distributed to appropriate IOTA members if the results show that an occultation is likely. A central occultation would last about 2 minutes with a 1-mag. drop.

PLANS FOR UPCOMING ASTEROIDAL OCCULTATIONS

David W. Dunham

The recorded messages for asteroidal occultation prediction updates can no longer be obtained from the Little Rock, AR, telephone number, now disconnected, given in *o.N.* 2 (13) 182 and in *Sky and Telescope* 63 (1) 63. However, they can still be obtained from the Chicago, IL, number, 312, 259-2376. Berton Stevens updates these messages, but he can not do so when he is not home. Consequently, if you call on a weekday, you might wait until after 8 pm Central time to be sure to obtain any news which I may have relayed to him that day. It is possible that updates might be obtained by telephoning The Astronomical Unit in Little Rock at 501,771-0940, but it is not known if the recorded message machine will be connected to that number in order to obtain the information when the store is closed.

Most of us will miss the occultation of θ Aurigae by (250) Bettina discussed below, but it is interesting to compute how frequently occultations of stars as bright as, or brighter than, this star by asteroids as large as, or larger than, Bettina occur. If we accept Brian O'Leary's calculation, published in *Science* several years ago, that any given main-belt asteroid will occult one SAO or AGK3 star somewhere on the Earth's surface, on the average, each year, then I calculate that occultations as good as the upcoming one by Bettina occur only every 106 years. But this is based on Bettina's diameter of 211 km from TRIAD, which assumes a dark C-type albedo, although in TRIAD it has an uncertain CMEU classification. David Tholen, Univ. of Arizona, reports that recent colorimetry shows that it is an M-type asteroid, so that it should be much smaller, as was the case for (216) Kleopatra, an occultation by which was observed in 1980 October; see *o.N.* 2 (11) 140. If Bettina has a diameter of 150 km, occultations of stars as bright as θ Aurigae by asteroids this large occur about every 34 years. However, radiometric observations made during the last year have shown that the M-type asteroids in the outer part of the asteroid belt have low albedoes, similar to C-type asteroids. A new classification has been proposed for them, pseudo-M or P. Unfortunately, the semi-major axis of Bettina's orbit is near the Hungaria gap; the closer M-type asteroids all have typical M high albedoes, while most of those farther away are P-type. Tholen thinks that Bettina is probably a regular M-type, but Ed Tedesco, another who has worked with the recent observations at Jet Propulsion Laboratory, believes that at Bettina's distance, it is probably P. Unfortunately, as far as either knows, no radiometric albedo measurements were made of Bettina during the recent opposition. Tholen and David Morrison, Univ. of Hawaii (contacted by Wayne Warren), said they would check into the possibility of having suitable observations made before the occultation to determine Bettina's albedo and diameter. If this is done before the event, I will notify Paul Maley or Jorge Polman of the result.

In the meantime, Gordon Taylor has predicted that an even brighter star, 1.9-magnitude ε Sagittarii = Kaus Australis = SAO 210091 = FK4 689, will be occulted by the 175-km C-type asteroid (804) Hispania on 1983 October 23. Although Hispania is smaller than Bettina (assuming optimistically that its type is P), the brighter star makes such events rarer, occurring only once every 141 years. The predicted path of the occultation, using the EMP 1982 orbit, will cross northern Australia in daylight, just north of Fiji and the Samoa Islands shortly after sunset, and near Christmas Is. south of Hawaii, near the equator. The path using Herget's orbit is 2".87 farther south, crossing Antarctica and the surrounding oceans. Rather poor-quality astrometric observations made in 1977 and 1979 favor EMP 1982, but only slightly. More astrometry is needed to improve the prediction, and soon. This year, Hispania has a favorable opposition on March 15 near the celestial equator around 11^h right ascension. Unfortunately, the prospects for astrometry next year are dismal, at least for the Northern-Hemisphere observatories upon which we have almost exclusively depended for occultation improvement astrometry so far. The declination of Kaus Australis is -34°.4 and during Hispania's opposition in 1983 June, the asteroid will be south of -40°. Astrometry this year from the Northern Hemisphere would certainly be of some use. But Gordon Taylor and I would be interested in possible sources of good Southern-Hemisphere astrometry for the event during 1983.

I wonder if we are especially lucky to have asteroidal occultations of two very bright stars in two successive years, or are the probabilities a little better than O'Leary has indicated? I suspect that the latter may be partly the case, but my own figuring indicates that it is off by, at most, a factor of 2. Also next year, we have the occultation of 4.9-mag. 1 Vulpeculae by (2) Pallas, which should be visible from the U.S.A.; a star this bright should be occulted by one of the 4 largest asteroids only once every 60 years. Also next year, Taylor has found that 5.6-mag. 14 Piscium will be occulted by (51) Nemausa in the U.S.A. on Sept. 11, so one does not have to wait too long for a reasonably close asteroidal occultation visible well with binoculars, if not the unaided eye. Notes about some of the more immediate upcoming events are given below.

Mar. 15, (433) Eros: Rainer Kracht, Pinneberg, German Federal Republic, predicts that this small but close asteroid (angular size 0".09) will occult 8.4-mag. SAO 113745 at about 4h0 UT, probably for observers in the southwestern U.S.A. The event will have occurred by the time you receive this, but I will have distributed my own predictions of the event beforehand to potential observers. Kracht notes that the asteroid is 0d012 late in its orbit, derived from recent photographs, and has applied this correction to the EMP 81 orbit which he used for his calculations. I don't know if it will be possible to obtain last-minute astrometry to improve the prediction; the motion is 55'.4/day and a central occultation will last at most 2s.4.

Mar. 20, (344) Desiderata: Klemola's astrometry for the February 8th occultation, based on 3 Lick Observatory exposures taken on February 1, indicate that the path for the Mar. 20 occultation will be 0".54 W, over Alaska and Hawaii. However, no astrometry has yet been done on the star, and the motion on Mar. 20 is nearly due north-south, almost exactly perpendicular to the Feb. 1 motion, so an uncertainty of several tenths of an arc second remain. Attempts at more astrometry will be made, mainly to assess the prospects for Hawaii, but western Canada and the northwestern U.S.A. may still have a chance.

Mar. 20, (250) Bettina: The controversy about Bettina's size is discussed above; hopefully, observations of this occultation will answer that question finally. Four exposures taken by Penhallow on Feb. 2 indicate a correction to the ephemeris of 0".09 S ±0".3, with a negligible correction to the time. Although no correction is available for the star, the occultation almost certainly will occur in Brazil, with no possibility of a northward shift for daytime viewing from North America. Klemola, who will be busy with other events discussed below, will measure good reference star positions for other astrometrists to use for the final prediction. A major problem for accurate astrometry is the star's brightness and rather close duplicity; a very long focal-length telescope will be needed to minimize this problem; the 20-inch twin astrograph at Lick is not sufficient. Unfortunately, the telescope at Allegheny Observatory will not be available for this effort, but we hope that one of the other large refractors in the eastern U.S.A. can be used for the needed astrometry. Penhallow's small update to Bettina's orbit also indicates that the Mar. 3 occultation probably occurred near the nominal path in northern Africa, and not at all in Europe.

Mar. 21, (2) Pallas: The Lowell Observatory requested astrometry at Lick for this event, and Klemola obtained plates in late Feb. The event has a very small magnitude drop, requiring good conditions and photoelectric observation to detect, and the nominal path crosses an astronomically uninhabited part of the Pacific Ocean. However, Klemola's astrometry gives a path shift of 1".4 east and time correction of only 0m2 late, so an occultation might occur in the western Hawaiian Islands. The path predicted by Larry Wasserman, Lowell Obs., using the same data, goes centrally over the Hawaiian Islands. Between Mar. 21 and 31, radar observations of Pallas will be attempted with the Areceibo radio telescope, with hopes of detecting the satellite suspected from speckle interferometry. Photoelectric light curves are sought during this time to help interpret the analysis of the radar data.

Mar. 23, (386) Siegena: Astrometry for this event also was requested by Lowell, and Klemola's preliminary prediction gives a path shift of 1".29 north and a correction to the time of +5.8 minutes, virtually identical to the prediction from the EMP 81 orbit, which clearly is favored over the Herget orbit used to compute the nominal path. Klemola's uncertainty is estimated to be ±0".3 since the objects were near opposite edges of his Feb. 25 plate. He plans to obtain another plate to give an accurate last-minute prediction.

Although I do not now plan to go to Brazil for the occultation by Bettina on the 20th, I may be away all that weekend to record a lunar grazing occultation of a 4.9-mag. star in the Midwest. Prediction updates still will be available from the Chicago recorded telephone message noted above, and possibly also from Lowell Observatory at 602, 774-3358; I will keep in touch with astrometrists, and will be prepared to calculate such prediction updates as may be needed, during the time I am away from Silver Spring.

PLANETARY OCCULTATION PREDICTIONS FOR 1982

David W. Dunham

This is a continuation of the article in *O.N.* 2 (13) 178, which includes tables of all of the planetary and asteroidal occultations predicted to occur during 1982, with the exception of the new events listed by Lowe and me in this issue. The rest of this article consists of notes for the events in the earlier article, and of world maps, regional maps, and finder charts for events in both articles, for specific occultations which will occur during the next few months of 1982.

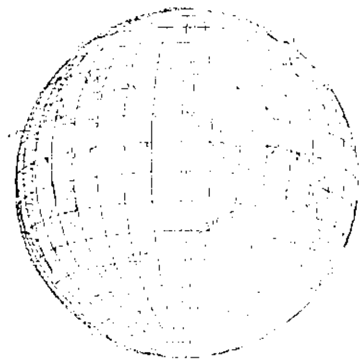
Notes about Individual Events

Apr. 13: SAO 78094 is WY Geminorum, an irregular supergiant with a magnitude range of 0.6.

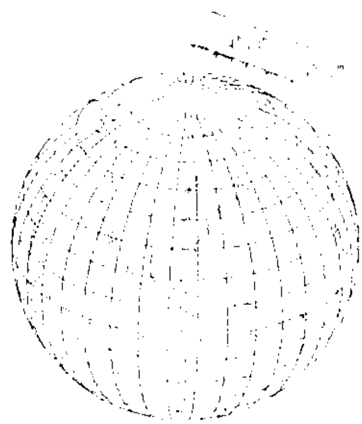
June 5: SAO 162993 is Z.C. 2891.

Nov. 2: SAO 148612 is Z Eridani, an RR CrB variable with a magnitude range of 1.6 and a period of about 80 days.

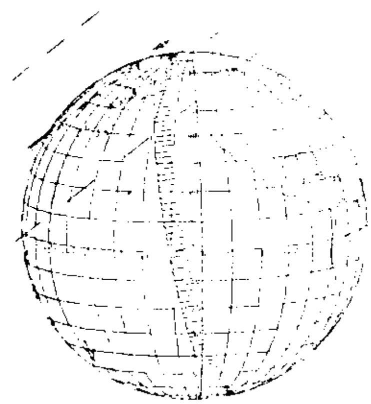
Nov. 22: SAO 76017 is ADS 2633; separate predictions are given in the table for the components, which are separated by 3".6 in p.a. 339°.



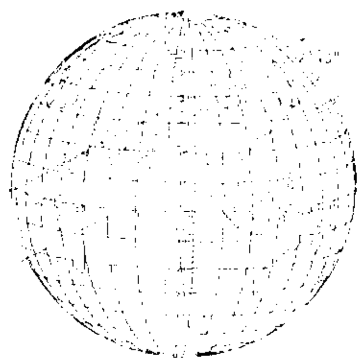
SAO 162831 by Venus 1982 Feb 7



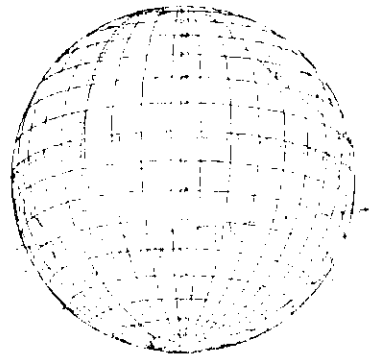
SAO 60710A by Aeria 1982 Feb 17



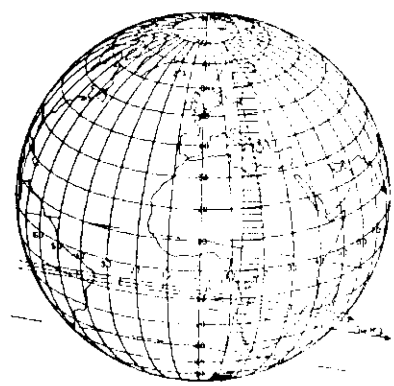
SAO 112400 by Meliboea 1982 Feb 24



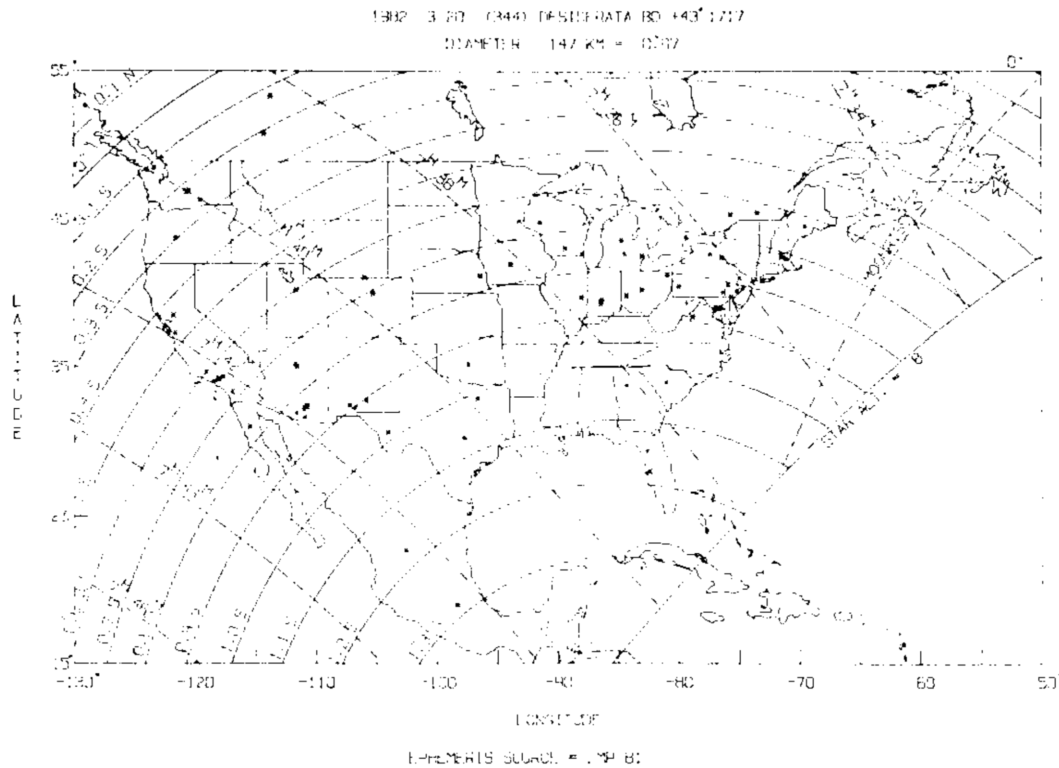
SAO 112446 by Meliboea 1982 Mar 3

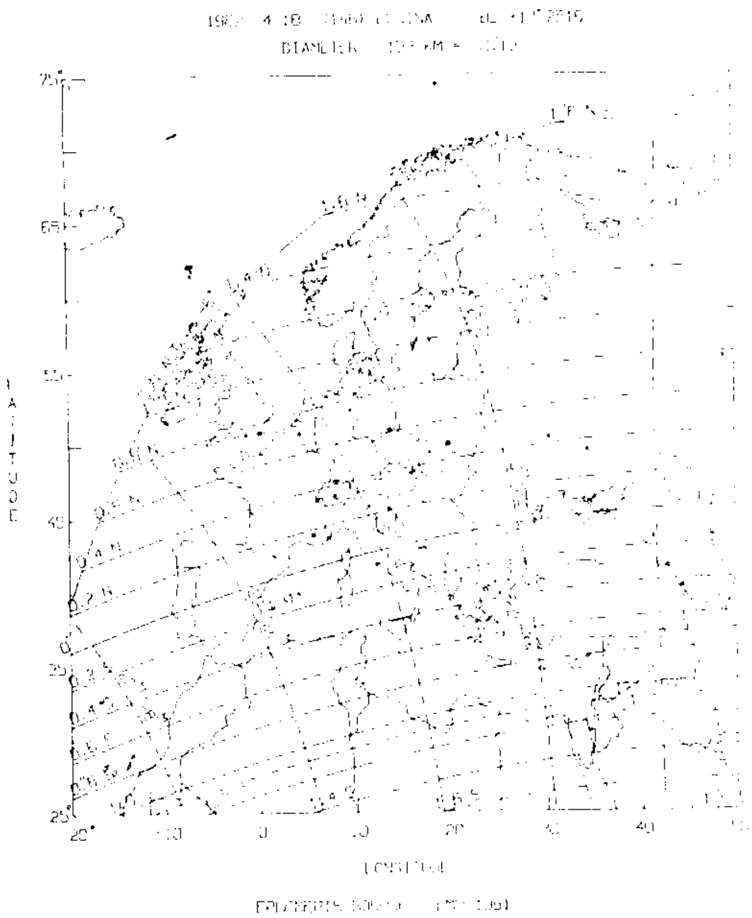


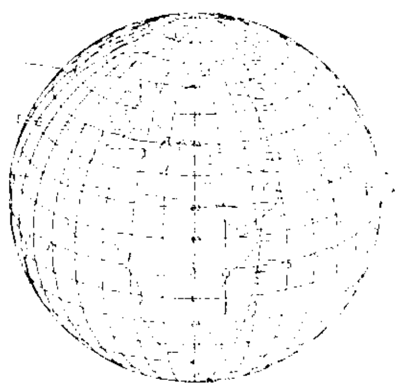
SAO 162917 by Myrrha 1982 Mar 9



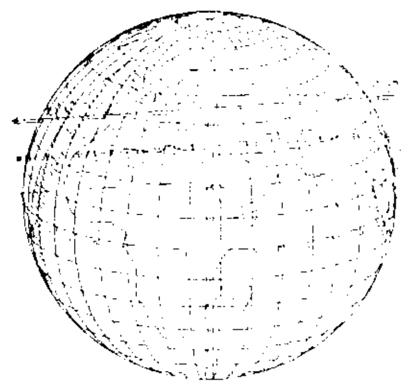
SAO 77636 by Eunomia 1982 Mar 30



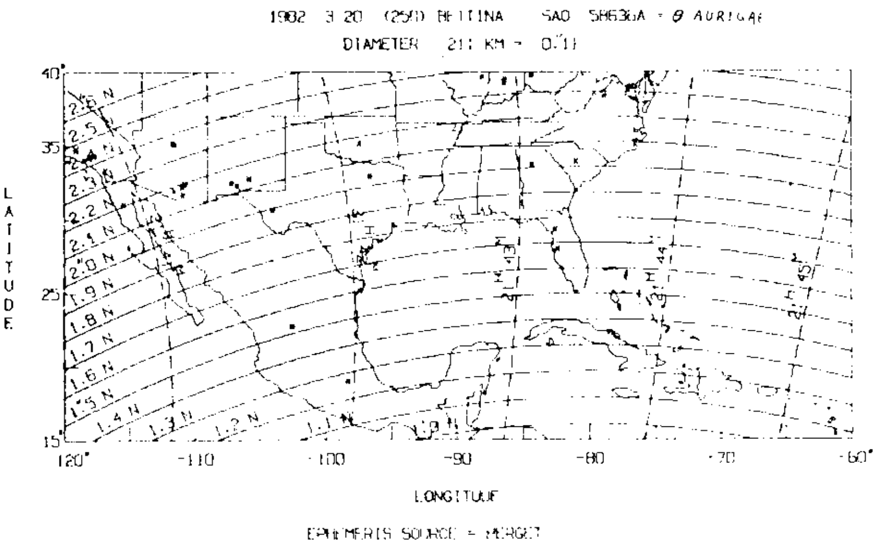


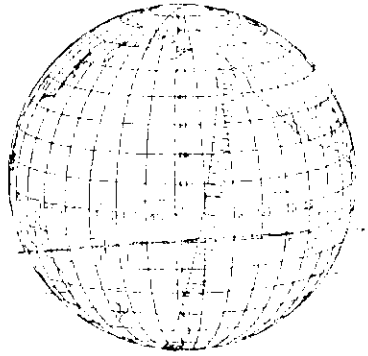


SAO 78094 by Eunomia 1982 Apr 13

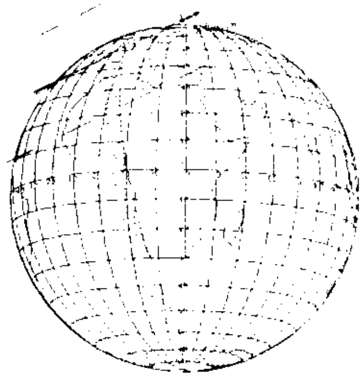


+17° 2516 by Lucina 1982 Apr 18

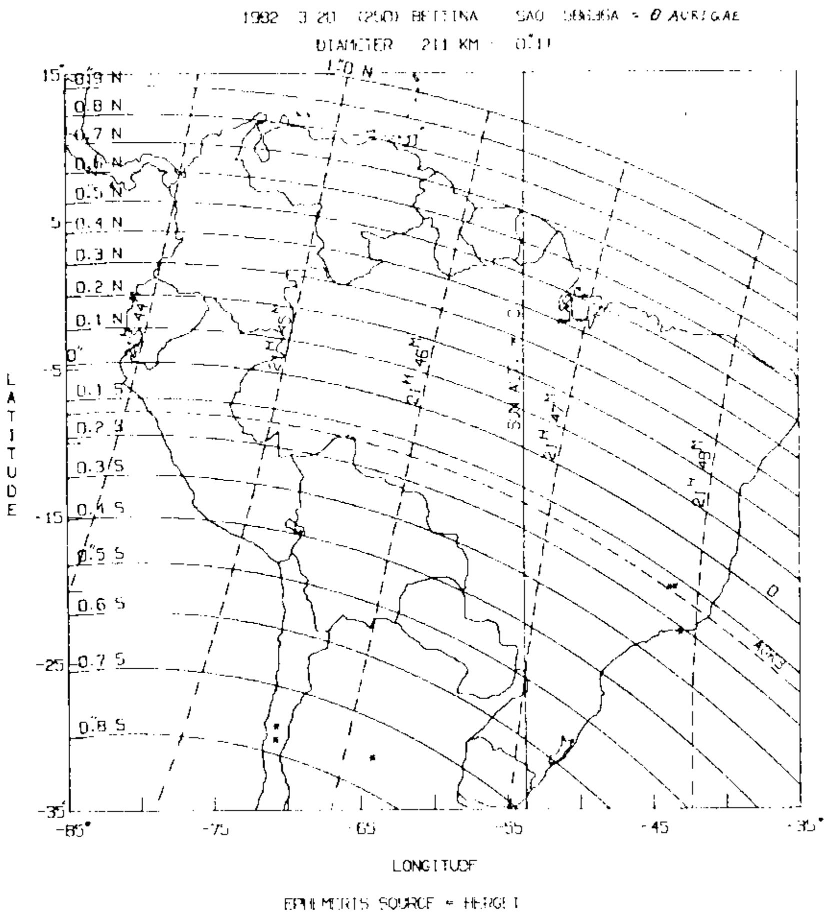


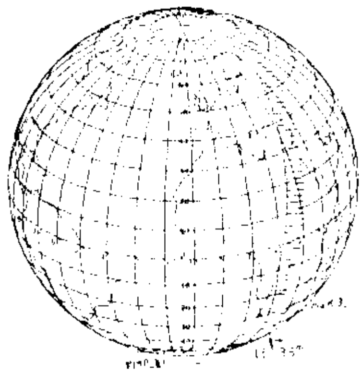


SAO 96799 by Tercidina 1982 Apr 18

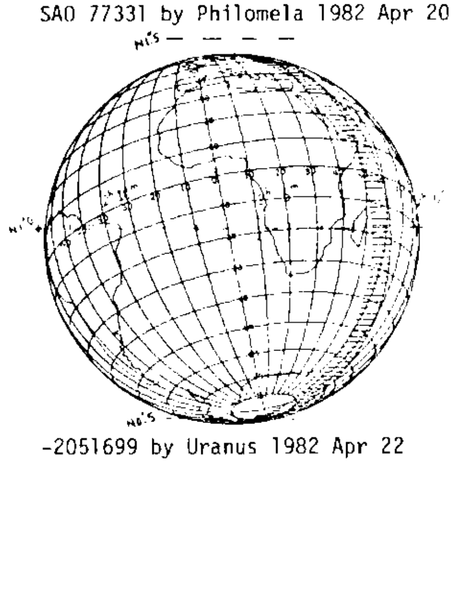


SAO 145044 by Xanthippe '82 Apr 18

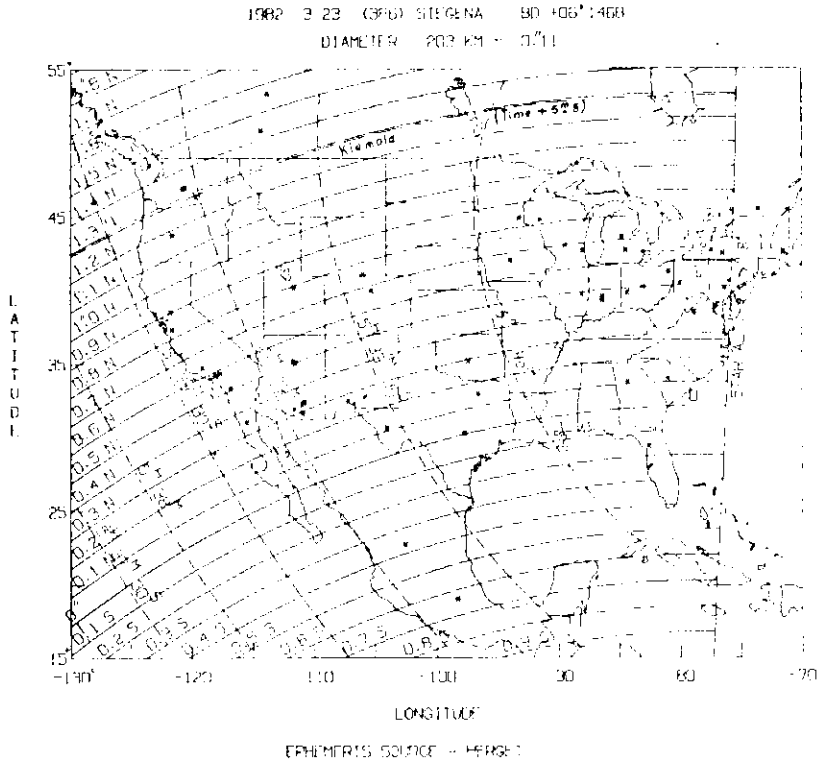


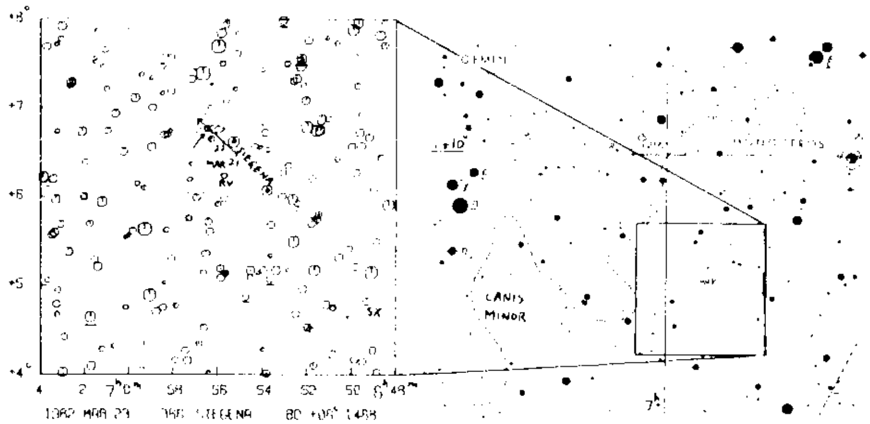


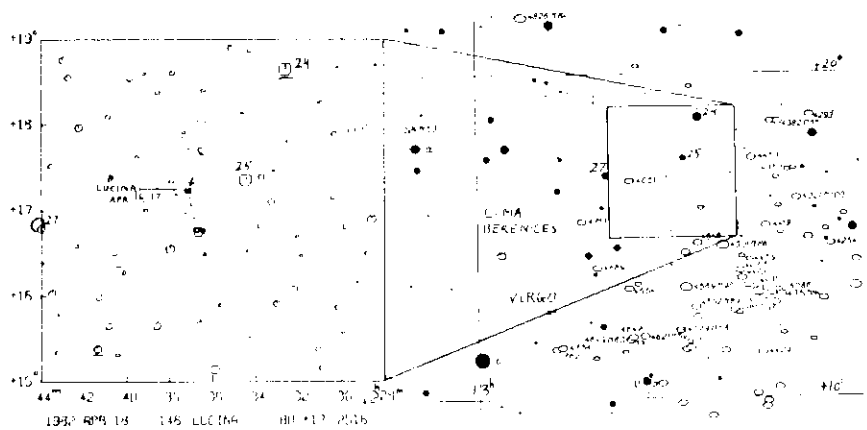
SAO 77331 by Philomela 1982 Apr 20

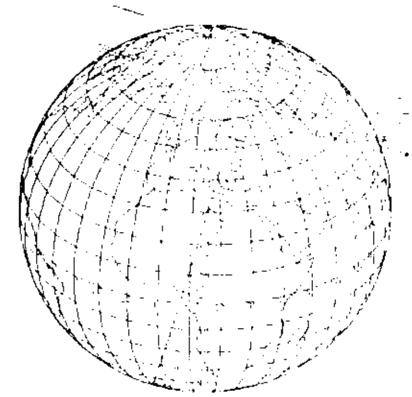


-2051699 by Uranus 1982 Apr 22

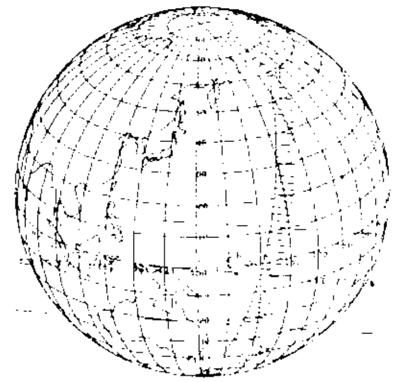




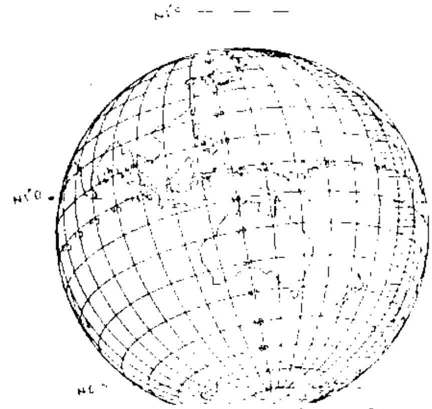




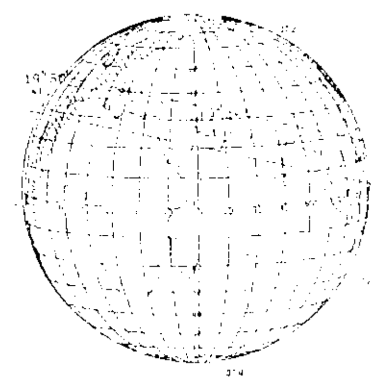
SAO 61101 by Herculina 1982 Apr 27



+24°1572 by Flora 1982 Apr 29



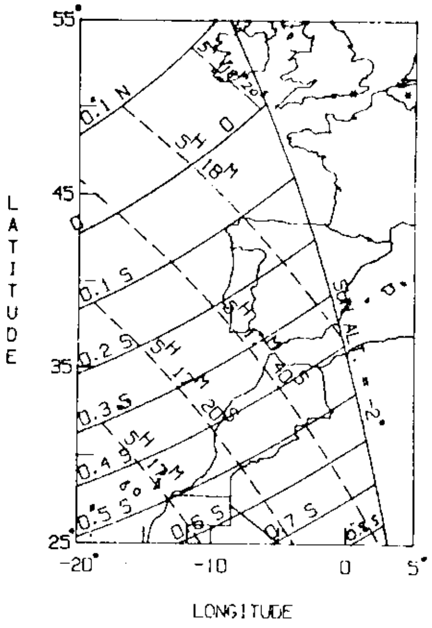
-2051615 by Uranus 1982 May 1



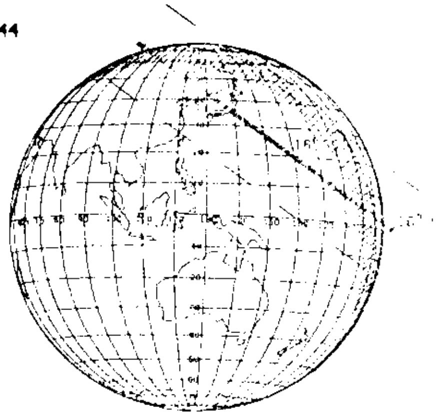
Anonymous by Charon 1982 May 6

1982 4 18 (156) XANTHIPPE SAO 145044

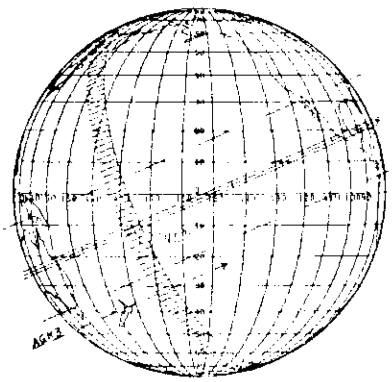
DIAMETER 109 KM = 0."06



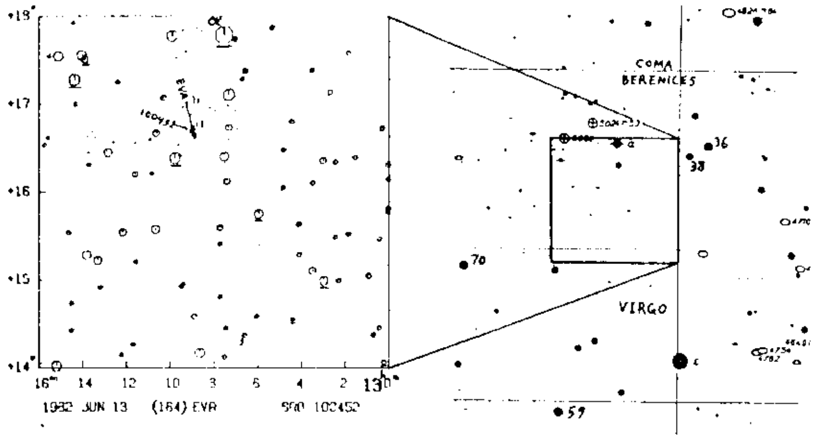
E. HEMERIS SOURCE = EMP 1981



SAO 141346 by Adelheid 1982 May 17

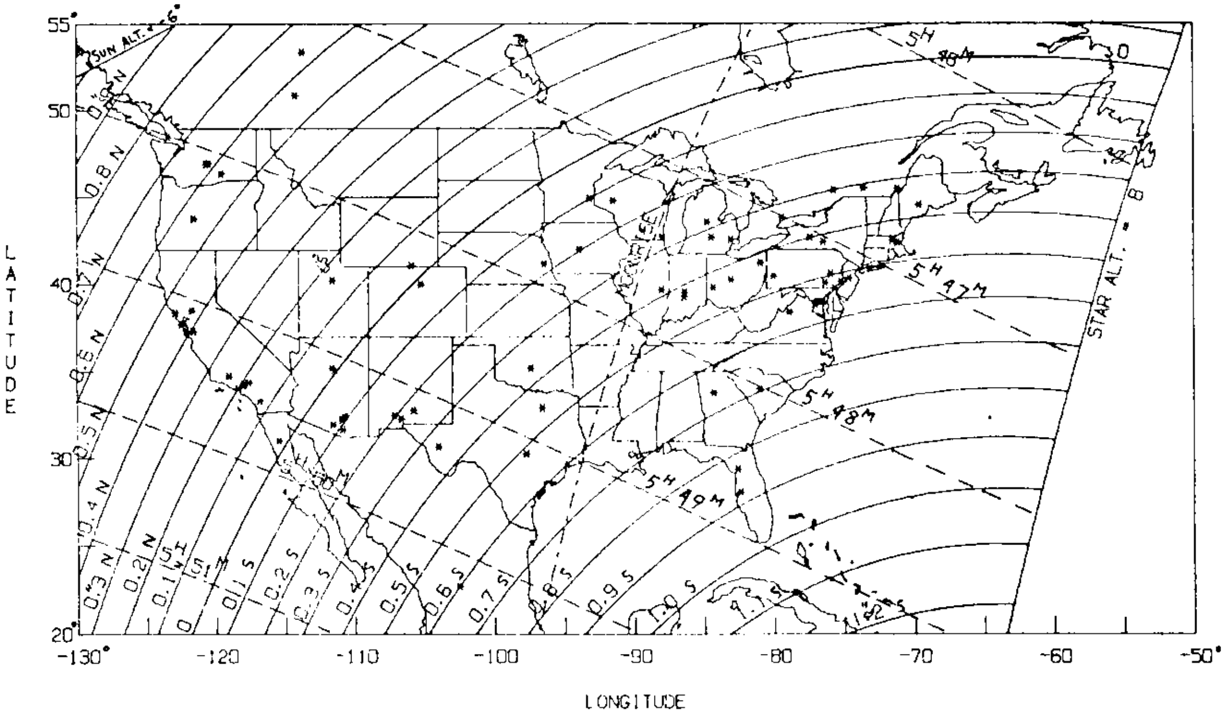


SAO 128460 by Fortuna 1982 May 28



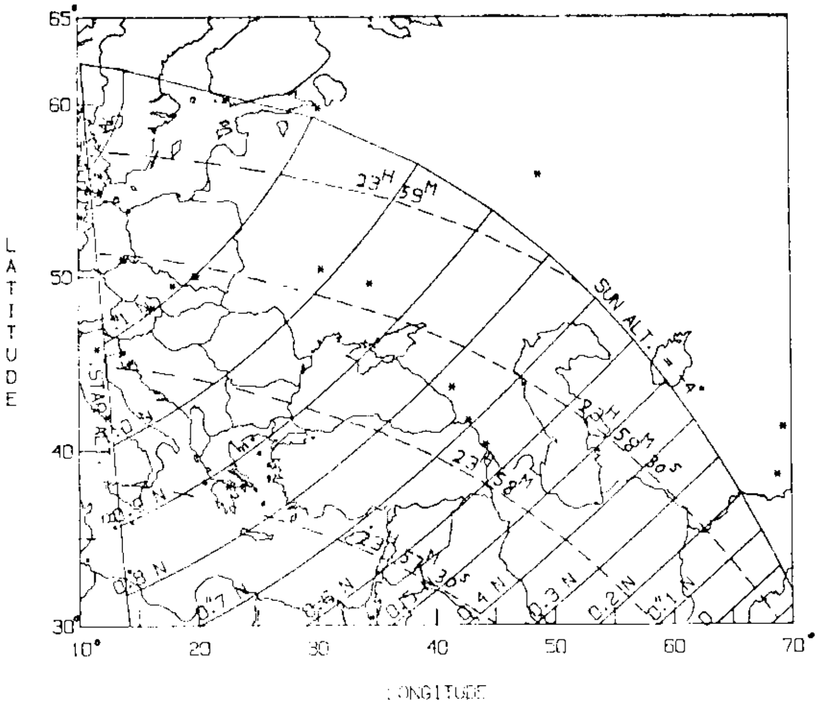
1982 6 13 (164) EVA SAO 100452

DIAMETER 111 KM = 0."05



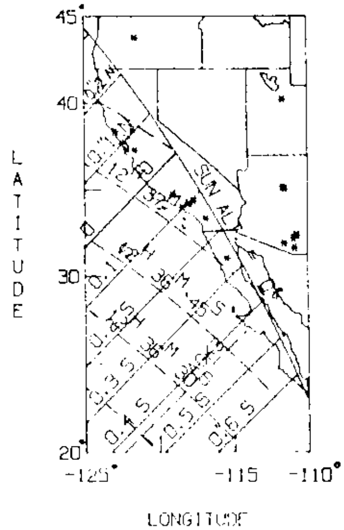
EPHEMERIS SOURCE = HERGET

1982 6 25 (212) MEDEA SAO 109515
DIAMETER 133 KM = 0."06

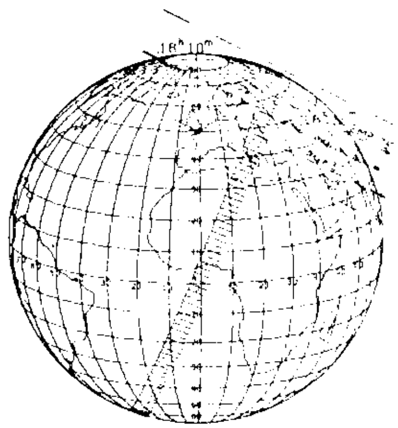


EPHEMERIS SOURCE = HERGET

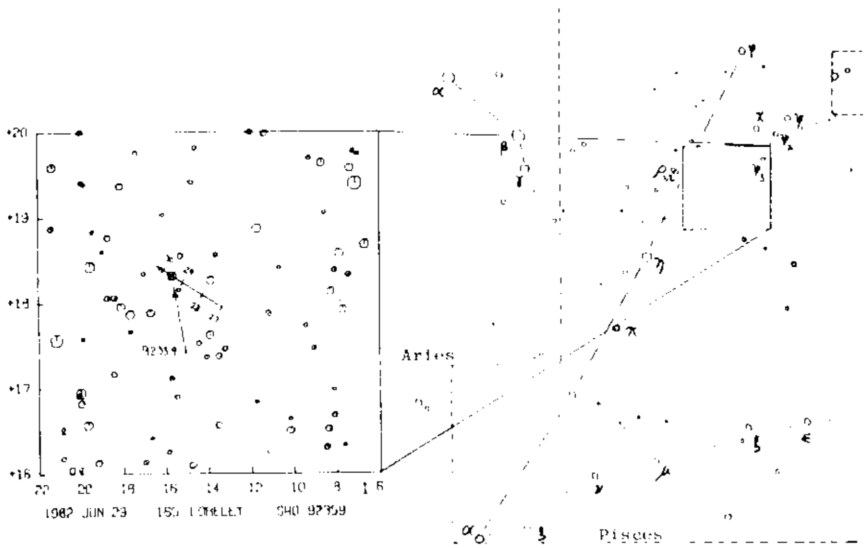
1982 6 29 (165) LORELEY SAO 92359
DIAMETER 228 KM = 0."10



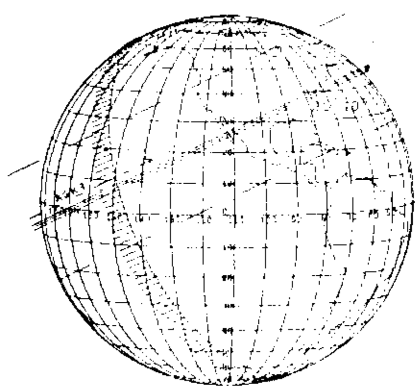
EPHEMERIS SOURCE = HERGET



SAO 99172 by Harmonia 1982 May 28

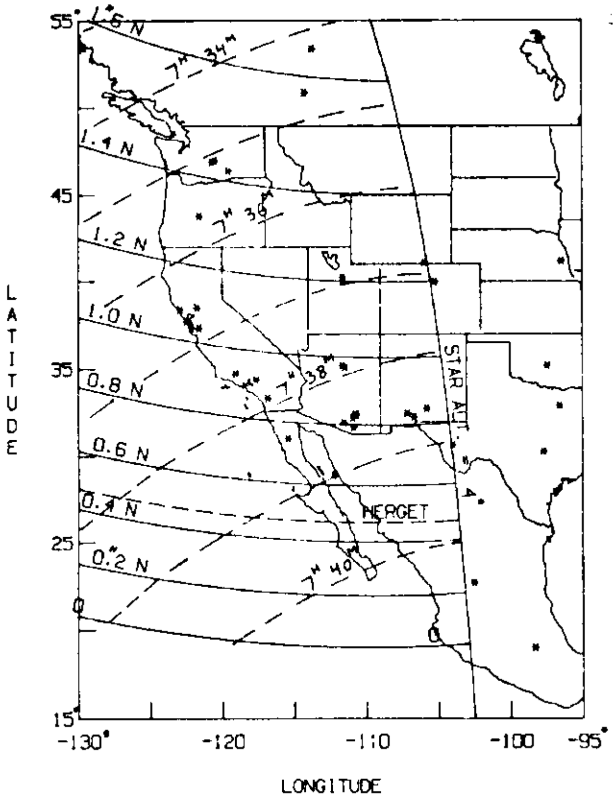


Richard Nolthenius



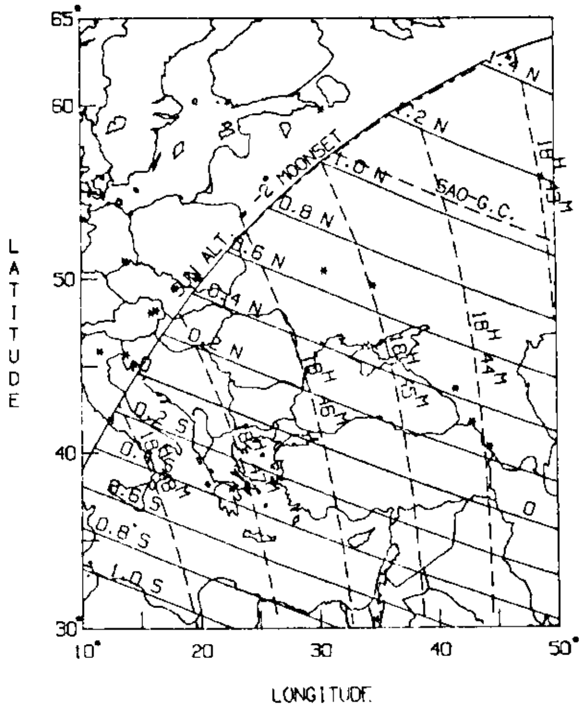
SAO 109635 by Pandora 1982 Jun 4

1982 7 7 (56) MELETE SAO 139812
DIAMETER 142 KM = 0."12

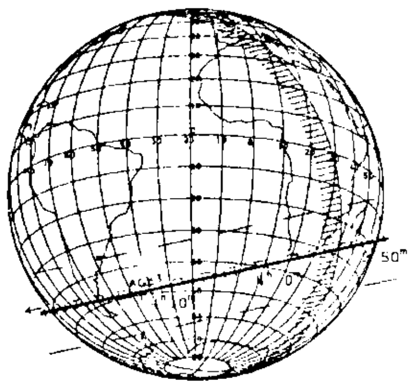


EPHEMERIS SOURCE = EMP 1980

1982 7 20 (405) THIA SAO 161675
DIAMETER 126 KM = 0."13

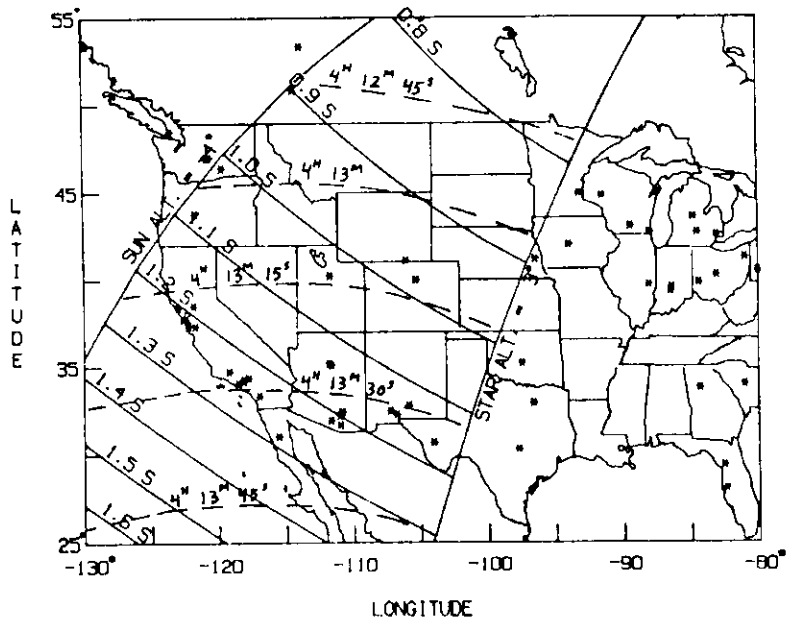


EPHEMERIS SOURCE = HERGET

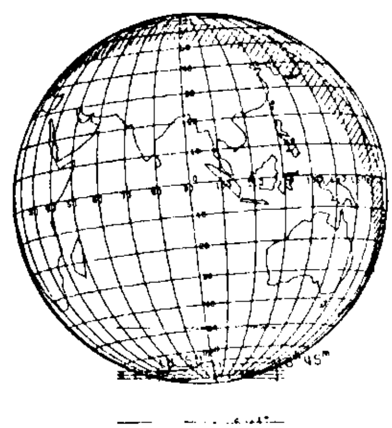


SAO 162993 by Nysa 1982 Jun 5

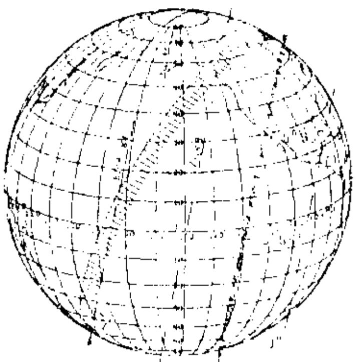
1982 7 16 (410) CHLORIS SAO 99171
DIAMETER 142 KM = 0."06



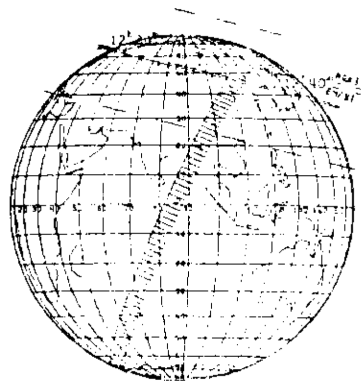
EPHEMERIS SOURCE = EMP 1981



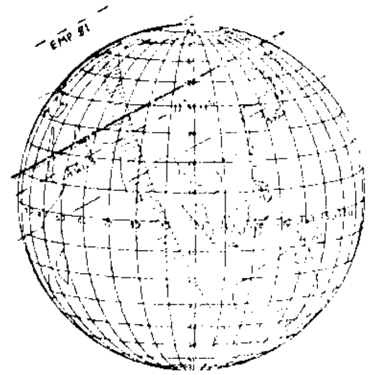
SAO 142233 by Juno 1982 Jun 11



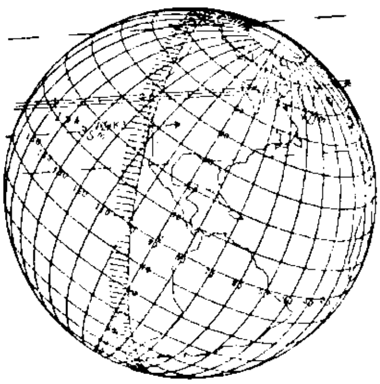
SAO 100452 by Eva 1982 Jun 13



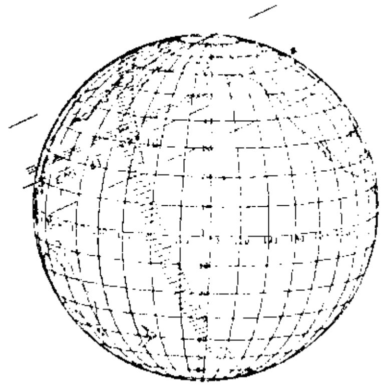
SAO 138868 by Gyptis 1982 Jun 24



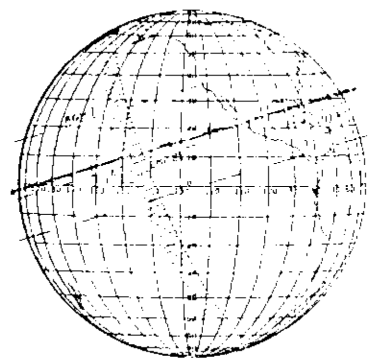
SAO 109515 by Medea 1982 Jun 25



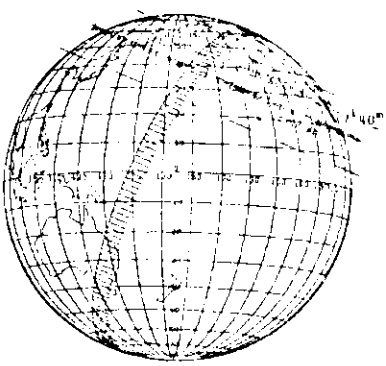
SAO 92359 by Lorely 1982 Jun 29



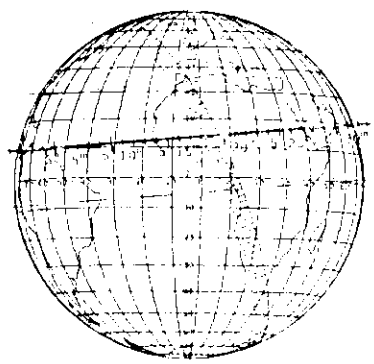
+09° 219 by Pandora 1982 Jul 4



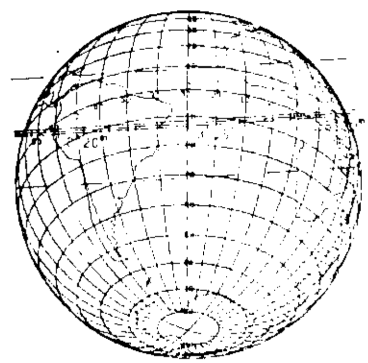
SAO 110134 by Emita 1982 Jul 5



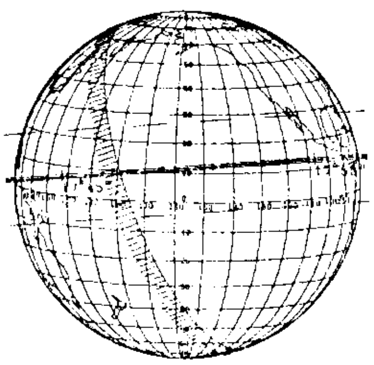
SAO 139812 by Melete 1982 Jul 7



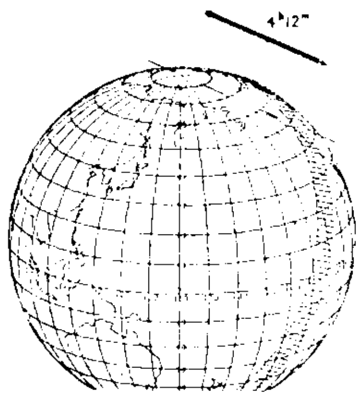
SAO 128582 by Sapientia 1982 Jul 8



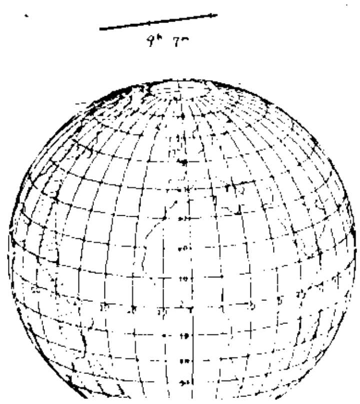
SAO 212479 by Palma 1982 Jul 14



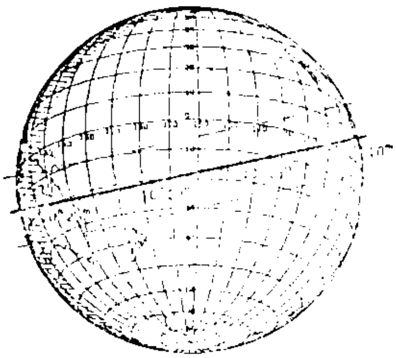
SAO 110836 by Ino 1982 Jul 14



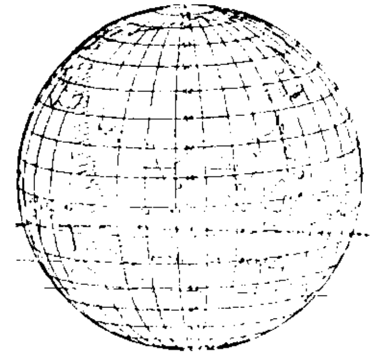
SAO 99171 by Chloris 1982 Jul 16



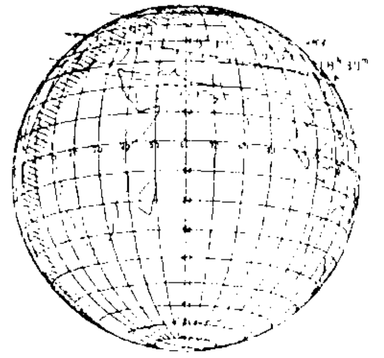
SAO 94036 by Liberatrix '82 Jul 17



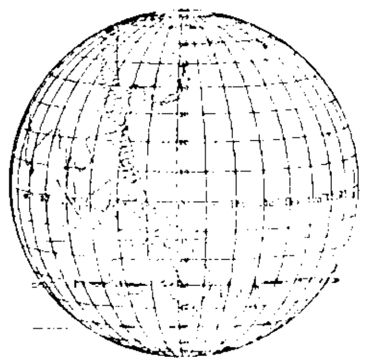
SAO 197802 by Nysa 1982 Jul 18



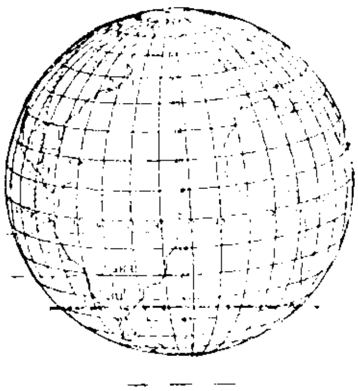
SAO 111464 by Artemis 1982 Jul 19



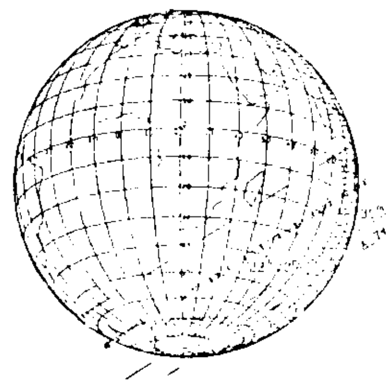
SAO 161675 by Thia 1982 Jul 20



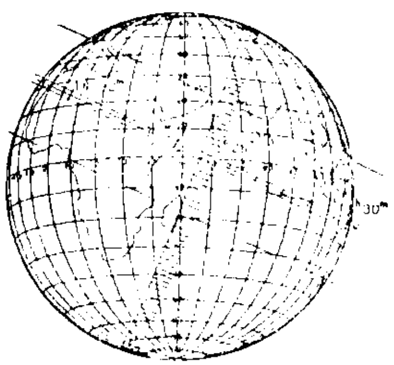
-05° 471 by Ino 1982 Jul 27



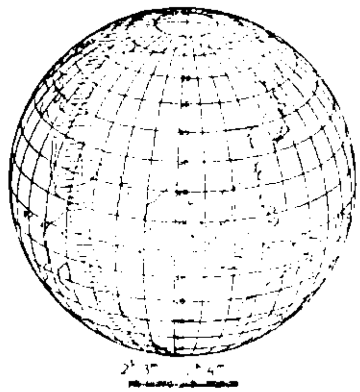
SAO 94827 by Comacina 1982 Jul 28



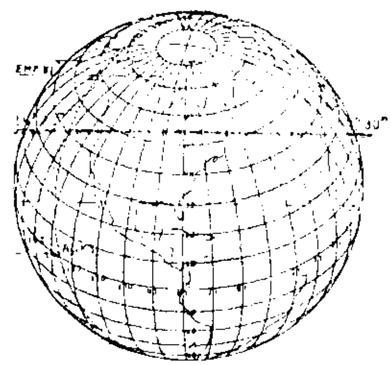
SAO 163787 by Myrrha 1982 Jul 28



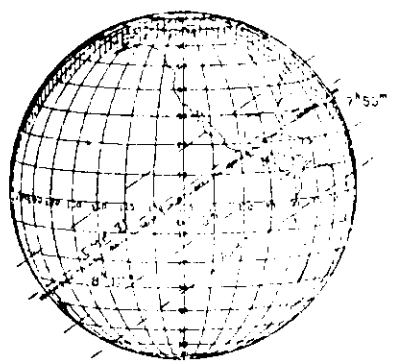
SAO 139825 by Cybele 1982 Jul 30



+23° 755 by Aspasia 1982 Aug 1



SAO 58847 by Hippo 1982 Aug 4



SAO 127592 by Mnemosyne '82 Aug 29