Occultation Newsletter

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Joan Bixby Dunham, Editor

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Occultation Newsletter is published by the International Occultation Timing Association. Editor: Joan Bixby Dunham; 7006 Megan Lane; Greenbelt, MD 20770-3012; U.S.A.; e-mail dunham@erols.com. Please send editorial matters to the above. Send new and renewal memberships and subscriptions, back issue requests, address changes, graze prediction requests, reimbursement requests, special requests, and other IOTA business, but not observation reports, to: Craig and Terri McManus; 2760 SW Jewell Ave.; Topeka, KS 66611-1614; U.S.A.

FROM THE PUBLISHER

For subscription purposes, this is the third issue of 1995. It is the ninth issue of Volume 6. IOTA annual membership dues, including **ON** and supplements for U.S.A., Canada, and Mexico $30.00

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

Local circumstance (asteroidal appulse) predictions	1.00
Graze limit and profile predictions (per graze)	1.50
Papers explaining the use of the predictions	2.50

Asteroidal occultation supplements will be available at extra cost: for South America via Orlando A. Naranjo (Universidad de los Andes; Dept. de Fisica; Mérida, Venezuela), for Europe via Roland Boninsegna (Rue de Mariembourg, 33; B-6381 DOURBES; Belgium) or IOTA/ES (see below), for southern Africa via M. D. Overbeek (Box 212; Edenvale 1610; Republic of South Africa), for Australia and New Zealand via Graham Blow (P.O. Box 2241; Wellington, New Zealand), and for Japan via Toshio Hirose (1-13 Shimomaruko 1-chome; Ota-ku, Tokyo 146, Japan). Supplements for all other areas will be available from Jim Stamm (11781 N. Joi Drive; Tucson, AZ 85737; U.S.A.) for $2.50.

Observers from Europe and the British isles should join IOTA/ES, sending a Eurocheck in the amount DM 40.-- to the account IOTA/ES; Bartold-Knaust Strasse 8; D-30459 Hannover, Germany; Postgiro Hannover 555 829 - 303; bank-code-number (Bankleitzahl) 250 100 30. German members should give IOTA/ES an "authorization for collection", or "Einzugs-Ermaechtigung" in German, to their bank account. Please contact the secretary for a blank form.

IOTA NEWS

David W. Dunham

Urgent Events: The main purpose of this issue is to distribute detailed up-to-date predictions of the first lunar occultation of a comet ever predicted, visible from western North America on Wednesday morning, May 8th; see the article starting on page 193. But there is another event, an occultation of a 9th-mag. star by Europa on June 28th also visible from western North America, but also much of the Pacific Ocean, Japan, and part of eastern Asia. An article about it is on p. 198.

The Western Hemisphere Grazing Occultation Supplement for 1996 is also being distributed with this issue. On its last two pages are important updates to corrections that need to be applied to the ACLPPP profiles to avoid seeing a close miss (no occultation) rather than the desired multiple events, especially for northern-limit grazes. As this issue goes to press, I can not find the files needed for the 1996 Eastern Hemisphere graze supplement. I should have those soon, but there is some chance that the Eastern graze supplement may be distributed with the next **ON** rather than with this one.

ESOP XV: The 15th European Symposium on Occultation Projects will be held August 23-27 in Berlin; there are some deadlines at the end of this month. See the next page for some details.

This issue: This issue, along with the graze supplement, is being mailed to IOTA members and **ON** subscribers in western North America early enough so that it will arrive before the occultation of Comet Hale-Bopp. Many of you will already have received information about the occultation, but not the graphics given here, by e-mail. Much information about the occultation was given in the May issue of **Sky and Telescope**. For those outside the comet occultation area, this issue will be duplicated by Tony Murray and distributed from Topeka.

This issue of **ON** is long overdue, so although the occultation of the comet will be a rather difficult event, it does help us to get back on schedule. An issue should have been sent out earlier to give information about the March 6th occultation of ν^2 Sagittarii by Jupiter and the April 10th occultation of an SAO star by Uranus, its rings, and some of its satellites, events that occur less than once a decade. Also, we missed occultations during the April 4th total lunar eclipse that was very favorable for Europe. Information was prepared for each of those events, but with so little time before them that the only way to distribute it was by e-mail, and by posting it on IOTA's Web sites.

E-mail: Our e-mail address is dunham@erols.com. It should be used for all IOTA and occultation correspondence, except for time-critical messages (such as update astrometry for asteroidal occultations) that need my attention during weekdays, when they should be copied to my work e-mail address: david_dunham@jhuapl.edu. Messages with astrometric observations in the IAU format should be sent (or copied) to the new address, when possible, since regular messages received with our Eudora-based e-mail server accepts 80-character lines (which the IAU format uses) entact without line wrapping, unlike the Microsoft Mail-based system used with the jhuapl account. The two systems handle attached files differently. Uuencoded attached files should be sent to my jhuapl address, while mime-encoded or binhex attached files, used by Eudora and some other e-mail systems, should be sent to our erols address.

IOTA annual meeting: The annual meeting will probably be held in Houston, Texas, in late July, but that depends on some other arrangements that will soon be made. If it will be held then, some details will be given in the next issue.

Next Issue: The next issue is nearly complete; it might even be distributed with this issue to many of you. It will include articles about lunar occultation reductions by R. Hays; asteroial occultation and appulse reports, for 1993 but also including recent occultations of stars by (14) Irene and by Comet Hyakutake observed from Japan; observed graze profiles that were used to successfully refine the predictions for some recently-observed grazes; and occultation tallies by J. Carroll. The issue after the next issue will be produced by Rex Easton; 2007 S.W. Mission Ave., Apt. 1; Topeka, KS 66604-3341; e-mail skygazer@smartnet.net. Any new contributions should be sent to him; more about this transition of **ON** editorial work will be in the next issue.

SEND REPORTS BY E-MAIL TO ILOC

The International Lunar Occultation Centre has an e-mail address: iloc@ws11.cue.jhd.go.jp. ILOC's Masayosi Yamaguti requests that occultation reports now be sent directly to this address rather than to Toshio Hirose, as mentioned on p. 173 of the e-mail76 format article in the last issue. If your e-mail server can send uuencoded attached files (not mime-encoded like Eudora and some other e-mail systems), it would be best to send your reports that way in the original 80-column format. Otherwise, use the e-mail76 format with the report included as a regular message. For copying reports of grazes to Richard Wilds via the McManuses, it is best to use the e-mail76 format as a regular message.

Be careful when you prepare the reports to use a fixed-space font such as Courier. If you create the file from a Windows editor such as Microsoft Word, WordPerfect, or Write (from Accessories), and use the default proportional-space fonts, it is impossible to line up the reported data in the correct columns in the e-mail message. Most e-mail systems working from Windows display messages with proportional-space fonts, but they usually have an option to use a fixed-space font like Courier. If you set the option to display the message with the fixed-space font, you can verify that the columns of data in your report line up correctly.

ESOP-XV

The 15th meeting of the European Symposium on Occultation Projects will meet at the Archenhold Observatory in Berlin, Germany, from Friday evening, August 23rd, to Tuesday, August 27th. The schedule is:

Fri., 23rd:	Evening, registration and reception.
Sat., 24th:	Morning: Workshop on geographical positions and GPS measurements Afternoon: Scientific program Evening: Dinner & Zeiss planetarium demo
Sun., 25th:	Morning & afternoon: Scientific program
Mon., 26th:	Trip to Potsdam astronomical institutes
Tues., 27th:	Workshop about measurement systems

The fee for the symposium is 90 DM. Prices for dinner on Saturday and for local transport are included. The fee should be paid by May 30th to the HSB Service Bank; bank account number 5767237490; bank code number 86020700.

The Trans-Hotel, Radickestraße 76, 12489 Berlin, is offering a special price, 100 DM for a 2-bed room with bathroom, TV, phone, and breakfast. It is also possible to book private rooms (bed and breakfast) for 40 to 50 DM per day for a 2-bed room.

Registration and lecture specification forms should be completed by prosective attendees and returned to Arcenhold-Sternwarte; Alt-Treptow 1; D 12435 Berlin; Germany; Fax +49-30-5348083; Tel. +49-30-5348080; Secretary Ms. S. Repnow. The contact IOTA/ES member in Berlin is: Konrad Guhl; Am Siebgraben 50; D 16727 Marwitz; Tel. +49-3304-503035; Fax +49-3304-503034. If you have not received the forms in the mail and are interested in attending, the forms are available upon request to Konrad Guhl, Hans Bode, or David Dunham. They will also be placed in the European section of IOTA's Web site at URL
http://www.sky.net/~robinson/iotandx.htm
from which they can be downloaded, and versions that can be sent by e-mail are expected to be available soon.

LUNAR OCCULTATION OF COMET HALE-BOPP

David Dunham, Isao Sato, and David Herald

Much information about the first predicted occultation of a comet by the Moon is given on pages 25 and 26 of the May issue of **Sky and Telescope**. Chances of it also being the first observed lunar occultation are also good since the occultation will be visible from the telescope-rich western U.S.A. and Mexico. Sato first identified the occultation shortly after the comet was discovered and its orbit reasonably established with the help of some pre-discovery observations. The predictions have been refined as our knowledge of the comet's orbit has improved, but the basic geometry has changed little since predictions for the event were first computed. The new times given here are probably accurate to less than 10 seconds, and differ from those given in **S&T** by only a few tenths of a minute, and by 1° in position angle. However, we note some errors in the cusp angle columns in the **S&T** table: The values for Acapulco, Mexico City, and Guatemala City are measured from the south cusp (S), not the north cusp (N) as given.

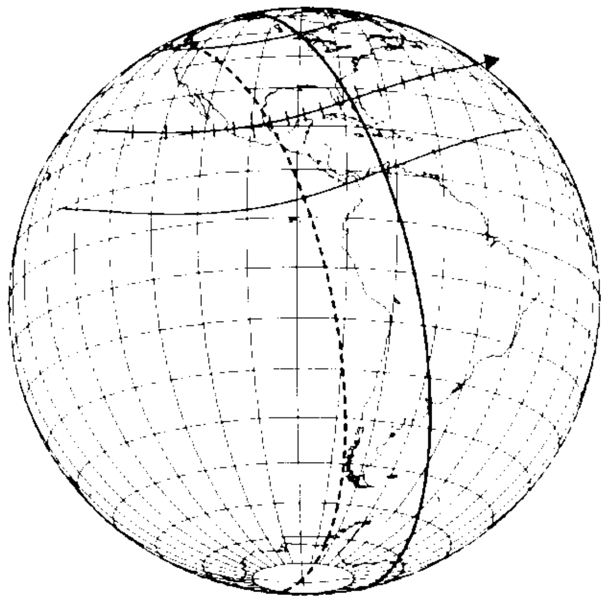
The comet's total magnitude is predicted to be 7.9 on the morning of May 8th. The concentrated light of the near-nuclear region will probably be near 10th mag., not brighter than 9th mag. With the waning gibbous Moon 70% sunlit, such an occultation will likely be visible only with relatively large telescopes. Those with apertures of half a meter or more equipped with high-speed photometer or CCD recording systems might be able to obtain some information about the distribution of light in the near-nuclear region, including two-dimensional information if such observations can be obtained at two different observatories with a large difference in latitude (so that there is a large difference in the position angles of reappearance at the sites).

C/1995O1 (Hale-Bopp) by Moon

<u>Not</u> from most recent orbit

Moon :	Diam. = 3476 km	Comet :	R.A.2000 = 19h42m08.080s	
	= 1950"		Dec.2000 = -16°45'36.90"	
	Mv. = -10.0 mag		Mv. = 7.5 mag	
	Vra = +106.3'/day		Sp. type =	
	Vdec = +17.2'/day	Sun :	elong. = 114°	
	group =	Moon :	elong. = 1°	
Extinct. :	Dur. = 0.1 sec		sunlit = -70 %	
	dmag = 2.5 mag			

08h47m00s - 11h53m00s step 10 min.



Sato's world view shows the northern and southern limits of the occultation, and the central line with an arrow at the east end indicating the motion. The sunrise terminator is also shown, along with a dashed line indicating a Sun altitude of -18°, the beginning of astronomical twilight. But with the glare from the Moon, it is unlikely that twilight will contribute much to the telescopic field of view background for Sun altitudes less than about 10°. The reappearance will occur with the Moon just below the horizon in Hawaii.

Predictions computed with OCCULT version 3.13 are given on the next pages. The first table gives predictions for 57 North American cities. The second gives predictions for 83 IOTA members in the region of visibility. The third table gives predictions for several large observatories that are not in the other two lists.

In each list, the locations are arranged in longitude order from west to east, the direction of motion of the occultation shadow. The Universal Time of reappearance is given following the longitude, latitude, and height above sealevel in meters (h,m). The Sun altitude is given only if the Sun is -12° or less above the horizon. Next are given the cusp, position, and Watts angles of reappearance. You may want to consult the view of the Moon at the time of the occultation, showing the emersion point for several cities, on p. 26 of the May issue of **Sky and Telescope**. Finally, the **a** and **b** factors, in minutes per degree, give the rate of change of the time of the event relative to longitude and latitude, respectively, from the station, for calculating event times for nearby locations.

An hour and a half before the occultation, a pair of spectral type A stars, 7.6-mag. ZC 2870 (SAO 162852 = BD -17° 5699b) and then 7.1-mag. ZC 2871 (SAO 162853 = BD -17° 5699a), will reappear at points on the lunar limb generally a few to 20 degrees south of where the comet will emerge. They should help guide you to the latter point. So predictions for the times of reappearance of these two stars are given, followed by the Moon altitude and azimuth, emersion point angles, and **a** and **b** factors for these events. Since the stars are less than 10″ apart, the circumstances for both are the same; the brighter star will reappear generally 8 to 10 seconds after the fainter one. The Sun will be more than 12° below the horizon for all listed sites when these stars reappear. Predictions are not given for a few locations in Oregon and Washington where the altitude above the horizon is too low to observe the emersions. Also, 2.5 hours after Hale-Bopp reappears, another 7.1-mag. star, ZC 2889 (SAO 162980 = BD -17° 5746), will reappear for observers near the Hale-Bopp northern limit in Washington and Oregon, but in very strong twilight.

In any case, these stars might be used for differential offsets to the comet, so their J2000 and apparent positions, and that of Hale-Bopp (HB) at 10:00 and 11:00 U.T., are given below:

Object	R.A. (J2000) h m s	Dec. ° ′ ″	R.A. (Apparent) h m s	Dec. ° ′ ″
ZC 2870	19 39 12.7	-16 54 31	19 39 00.4	-16 54 53
ZC 2871	19 39 13.0	-16 54 30	19 39 00.7	-16 54 52
HB, 10h	19 42 07.6	-16 45 43	19 41 55.2	-16 46 06
HB, 11h	19 42 06.7	-16 45 31	19 41 54.4	-16 45 54
ZC 2889	19 47 09.1	-17 04 41	19 46 56.7	-17 05 06

Finally, 3 maps generated with OCCULT 3.13 show the northern limit of the Hale-Bopp occultation across the northern U.S.A. The limit latitude is probably accurate to within 3 km. The northern-limit graze is on the Moon's sunlit limb a short distance from the cusp. In Washington, one has to be about 15 km south of the limit in order for the reappearance to occur on the dark side close to the terminator, but there will be strong interference from nearby sunlit features for another 20 km or so farther south. Farther east along the limit, central graze becomes closer to the cusp, so the distance south of the limit to the dark-limb emersion point also decreases.

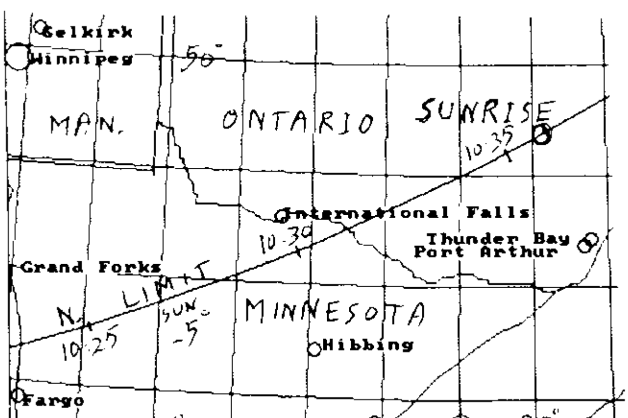
We thank Don Yeomans, Jet Propulsion Laboratory, for supplying the updated orbital elements of Hale-Bopp used for these predictions. They were computed by numerical integration for an osculating epoch of May 8.5 TT and is Yeoman's reference solution 28 for Hale-Bopp, using 860 astrometric observations obtained from 1993 April 27 to 1996 April 18. The elements are given below in the format that they need to be entered into the OCCULT program. Those who have OCCULT version 3.13 can add them to their asteroid.dat file in the planets subdirectory using the update file option provided with the program.

Perihelion date: 1997 3 31.96641
Argument of perihelion: 130.435735
Longitude of node: 282.471617
Inclination: 89.408810
Eccentricity: 0.99640308
Perihelion Distance: 0.916596194
Magnitude constant: -5
Coefficient of log r: 10
Diameter (km): 990

The last is only to get the program to print a value other than 0 seconds for the emersion duration; usually, it will be 1 or 2 seconds. The actual diameter of the nucleus will be much smaller than this.

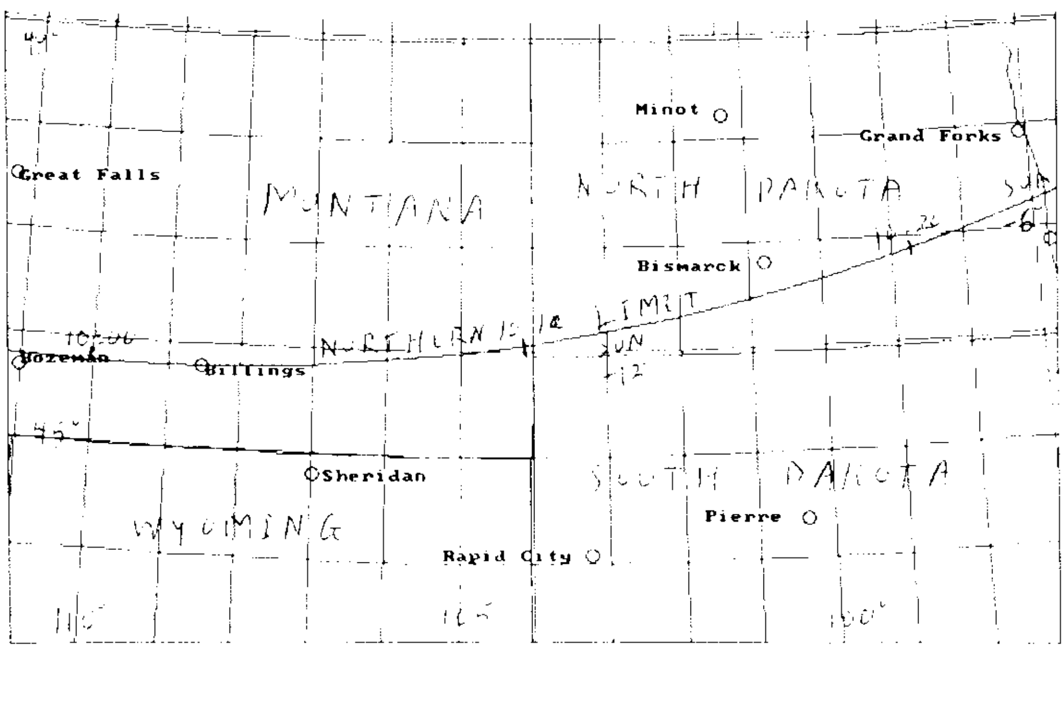
Lunar Occultation of 7.1-mag. sp. M0 Z.C. 2889 on 1996 May 8
Z.C. 2889 = V4026 Sgr, semi-reg. var., mag. 6.69 to 6.90
Reappearance, Moon 69- % sunlit, Solar elongation 112

Location	Univ. T. h m s	Sun Alt	Moon Alt	Moon Az	Cusp Ang	Pos Ang	W. Ang	a m/o	b m/o
Portland OR	12 30 48	-4	27	175	21S	189	200	+0.8	+3.1
Yakima WA	12 35 40	-1	26	178	23S	190	201	+0.8	+2.7
Walla Walla WA	12 35 39	0	27	180	17S	185	195	+0.4	+3.6
UMATILLA OR ANTHON	12 34 39	-1	27	179	18S	186	196	+0.5	+3.4
HOLDMAN OR TONY GE	12 34 35	-1	27	179	17S	185	196	+0.5	+3.5
Goldendale WA vis.	12 33 14	-2	27	177	20S	188	199	+0.7	+3.2



Lunar Occultation of 7.5-mag. Comet Hale-Bopp and two stars on 1996 May 8 Reappearance, Moon 70- % sunlit, Solar elongation 113
North American Cities

Location	E. Long.	Lat.	h,m	Univ. T. h	m	s	Sun Alt	Moon Alt	Moon Az	Cusp Ang	Pos Ang	W. Ang	a m/o	b m/o	ZC 2870 h	m	s	ZC 2871 h	m	s	Moon Alt	Moon Az	Cusp Ang	Pos Ang	W. Ang	a m/o	b m/o
Medford OR	-122.867	42.317	300	9	56	9		19	136	26N	322	332	+1.0	-0.7				8	36	54	8	121	48N	300	310	+0.5	+0.5
Portland OR	-122.650	45.520	7	9	52	37		16	137	12N	336	346	+0.6	-2.1													
San Francisco CA	-122.440	37.760	21	9	58	37		23	136	41N	308	318	+1.2	-0.2	8	34	18	8	34	26	10	121	59N	289	299	+0.6	+0.7
Yakima WA	-120.513	46.595	348	9	49	31		16	138	0N	348	358	-0.6	-9.8													
Reno NV	-119.812	39.525	1445	10	1	13		23	140	34N	314	324	+1.3	-0.5	8	37	6	8	37	15	11	123	53N	295	305	+0.7	+0.5
Fresno CA	-119.780	36.770	94	10	2	23		26	139	43N	306	316	+1.4	-0.2	8	35	31	8	35	40	13	123	60N	288	298	+0.8	+0.6
Los Angeles CA	-118.370	34.080	32	10	4	50		29	140	50N	298	309	+1.6	-0.1	8	34	52	8	35	0	15	123	66N	282	293	+0.9	+0.7
Walla Walla WA	-118.300	46.083	0	9	53	11		18	141	3N	345	355	+0.3	-6.3				8	40	44	9	126	35N	313	323	+0.5	+0.2
San Diego CA	-117.140	32.750	7	10	6	55		31	141	53N	295	305	+1.7	-0.0	8	35	1	8	35	10	17	123	69N	280	290	+1.0	+0.7
Boise ID	-116.220	43.610	931	10	2	6		22	144	18N	330	341	+1.2	-1.7	8	41	17	8	41	24	12	128	40N	308	318	+0.7	+0.3
Las Vegas NV	-115.170	36.170	706	10	9	39		29	145	43N	305	315	+1.7	-0.4	8	39	6	8	39	14	17	126	59N	290	300	+1.0	+0.5
Twin Falls ID	-114.483	42.550	1200	10	5	49		24	146	22N	326	336	+1.4	-1.4	8	42	18	8	42	26	14	129	42N	306	316	+0.8	+0.2
Pocatello ID	-112.450	42.880	1463	10	8	28		25	149	21N	328	338	+1.5	-1.6	8	43	58	8	44	6	15	131	40N	308	318	+0.8	+0.2
Phoenix AZ	-112.080	33.500	366	10	16	4		34	148	51N	297	308	+1.9	-0.3	8	40	51	8	41	0	21	128	64N	285	295	+1.2	+0.6
Salt Lake City UT	-111.870	40.760	1385	10	11	53		27	150	29N	319	330	+1.7	-1.1	8	44	5	8	44	13	17	131	45N	303	313	+0.9	+0.2
Flagstaff AZ	-111.620	35.210	2264	10	16	21		32	150	46N	302	313	+1.9	-0.4	8	42	15	8	42	24	20	129	59N	289	299	+1.1	+0.5
Tucson AZ	-110.920	32.220	784	10	18	37		35	150	54N	294	304	+2.1	-0.2	8	41	29	8	41	38	22	129	66N	282	292	+1.2	+0.6
La Paz Baja Cal Mex	-110.283	24.167	0	10	19	12		43	147	76N	272	283	+2.3	+0.4	8	35	50	8	36	1	27	125	87N	261	271	+1.5	+1.0
Las Cruces NM	-106.730	32.340	1400	10	27	37		38	157	55N	293	304	+2.3	-0.3	8	47	6	8	47	16	26	133	64N	284	294	+1.4	+0.5
Albuquerque NM	-106.667	35.083	1742	10	26	34		35	158	47N	301	311	+2.2	-0.6	8	48	20	8	48	30	24	135	57N	291	301	+1.4	+0.3
El Paso TX	-106.420	31.790	1285	10	28	29		39	157	56N	292	302	+2.3	-0.3	8	47	18	8	47	27	26	133	65N	283	293	+1.5	+0.5
Denver CO	-104.980	39.720	1732	10	26	12		31	160	34N	314	325	+2.1	-1.1	8	51	31	8	51	40	22	138	45N	304	314	+1.3	+0.0
Cheyenne WY	-104.800	41.147	2010	10	24	45		30	161	29N	319	330	+2.1	-1.4	8	51	46	8	51	54	21	139	41N	307	317	+1.2	-0.0
Pueblo CO	-104.640	38.290	1539	10	28	29		33	161	39N	310	320	+2.2	-1.0	8	51	49	8	51	58	23	138	48N	300	310	+1.3	+0.1
Lubbock TX	-101.850	33.583	1048	10	38	28		39	166	53N	295	305	+2.4	-0.6	8	55	4	8	55	13	29	140	60N	289	299	+1.6	+0.3
Amarillo TX	-101.850	35.200	1209	10	37	29		37	166	49N	299	310	+2.4	-0.7	8	55	25	8	55	35	28	140	56N	293	303	+1.6	+0.2
North Platte NE	-100.750	41.133	700	10	33	42	-10	31	167	32N	317	327	+2.3	-1.5	8	57	7	8	57	16	24	143	40N	308	318	+1.4	-0.2
Pierre SD	-100.340	44.370	486	10	28	52	-9	28	167	19N	329	339	+2.4	-2.5	8	56	27	8	56	35	21	144	31N	317	328	+1.3	-0.5
Monterrey NL Mexico	-100.317	25.667	568	10	44	11		47	168	76N	272	283	+2.6	+0.1	8	54	5	8	54	16	36	138	80N	269	279	+1.9	+0.7
Acapulco Mexico	-99.917	16.850	3	10	40	34		55	165	80S	248	258	+2.6	+1.1	8	45	46	8	45	58	41	131	75S	244	254	+2.1	+1.5
Mexico City Mexico	-99.141	19.398	2246	10	44	50		53	169	87S	255	265	+2.6	+0.7	8	50	47	8	50	59	40	134	83S	252	262	+2.1	+1.2
San Antonio TX	-98.500	29.430	213	10	48	37		44	173	67N	281	292	+2.6	-0.3	8	59	39	8	59	50	35	142	70N	279	289	+1.9	+0.4
Austin TX	-97.730	30.290	196	10	50	17	-11	43	175	65N	283	293	+2.6	-0.4	9	1	28	9	1	40	34	144	67N	281	291	+1.9	+0.3
Oklahoma City OK	-97.530	35.480	422	10	47	48	-9	38	175	51N	297	307	+2.5	-0.8	9	2	44	9	2	54	30	146	54N	294	304	+1.8	+0.0
Brownsville TX	-97.490	25.910	5	10	51	35		47	175	77N	271	282	+2.6	+0.0	8	59	54	9	0	5	38	142	79N	270	280	+2.1	+0.6
Corpus Christi TX	-97.410	27.750	11	10	51	45	-12	45	175	72N	276	286	+2.6	-0.1	9	1	3	9	1	14	37	143	74N	274	285	+2.0	+0.5
Wichita KS	-97.330	37.680	423	10	46	16	-8	36	174	45N	303	313	+2.4	-1.0	9	3	2	9	3	12	29	147	49N	300	310	+1.7	-0.1
Fort Worth TX	-97.328	32.748	220	10	50	10	-10	40	175	59N	289	300	+2.5	-0.6	9	2	52	9	3	3	33	145	61N	287	297	+1.9	+0.2
Dallas TX	-96.790	32.790	143	10	51	30	-9	40	176	59N	289	299	+2.5	-0.6	9	3	54	9	4	5	33	146	61N	287	297	+1.9	+0.1
Fargo ND	-96.790	46.870	295	10	29	1	-6	26	171	8N	340	350	+3.4	-6.3	8	59	34	8	59	41	21	149	22N	326	336	+1.4	-1.0
Omaha NE	-95.950	41.300	341	10	45	4	-5	32	176	35N	313	323	+2.4	-1.5	9	4	26	9	4	34	26	150	39N	309	319	+1.7	-0.4
Tulsa OK	-95.940	36.140	264	10	51	10	-7	37	177	51N	298	308	+2.5	-0.9	9	5	39	9	5	49	31	149	53N	296	306	+1.8	-0.1
Topeka KS	-95.690	39.040	305	10	48	48	-6	34	177	42N	306	316	+2.5	-1.2	9	5	40	9	5	50	29	150	45N	303	313	+1.8	-0.3
Houston TX	-95.390	29.750	13	10	56	29	-8	44	180	68N	280	290	+2.6	-0.3	9	5	59	9	6	10	37	147	69N	280	290	+2.1	+0.3
Kansas City MO	-94.583	39.083	243	10	51	27	-4	34	179	43N	305	315	+2.5	-1.2	9	7	38	9	7	48	29	151	45N	303	313	+1.8	-0.3
Des Moines IA	-93.630	41.600	308	10	50	15	-3	32	180	37N	312	322	+2.5	-1.5	9	8	15	9	8	24	27	153	39N	310	320	+1.8	-0.5
Minneaplis MN	-93.270	44.960	274	10	45	6	-2	28	179	25N	323	334	+2.6	-2.3	9	6	33	9	6	41	24	154	29N	320	330	+1.7	-0.9
Duluth MN	-92.110	46.790	200	10	43	25	-1	27	180	18N	330	340	+2.8	-3.1	9	6	46	9	6	53	23	155	23N	325	335	+1.7	-1.2
Guatemala City	-90.517	14.633	1593	11	1	32	-9	58	191	64S	232	243	+2.3	+1.6	9	4	11	9	4	24	51	144	69S	237	247	+2.5	+1.7
Saint Louis MO	-90.250	38.630	149	11	2	39	0	34	188	49N	299	309	+2.4	-1.2	9	16	9	9	16	19	32	158	47N	301	311	+2.0	-0.4
New Orleans LA	-90.080	29.970	2	11	9	52	-1	43	191	73N	275	286	+2.5	-0.4	9	17	39	9	17	51	40	156	69N	279	289	+2.3	+0.1
Merida Yucatan Mex	-89.617	20.967	24	11	10	26	-4	51	194	82S	250	261	+2.4	+0.6	9	14	22	9	14	36	48	152	87S	256	266	+2.5	+0.9
Chicago IL	-87.680	41.850	199	11	4	33	4	31	191	43N	306	316	+2.4	-1.5	9	19	28	9	19	37	30	162	40N	309	319	+2.0	-0.7
San Jose Costa Rica	-84.083	9.933	1234	11	3	34	-4	60	206	37S	205	216	+1.5	+3.4	9	10	10	9	10	24	59	151	.49S	217	227	+2.5	+2.9

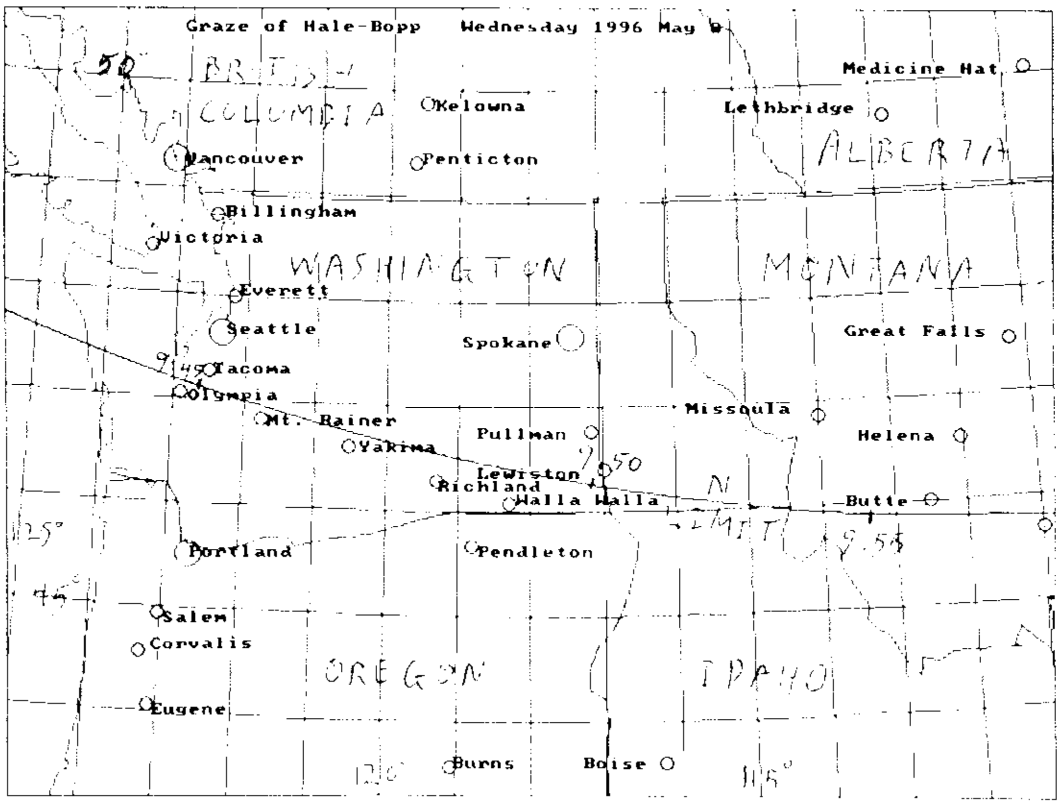


Lunar Occultation of 7.5-mag. Comet Hale-Bopp and two stars on 1996 May 8 Reappearance, Moon 70- % sunlit, Solar elongation 113
IOTA Stations

Location		Observer	E. Long.	Lat.	h,m	Univ. T. h m s	Sun Alt	Moon Alt	Moon Az	Cusp Ang	Pos Ang	W. Ang	a m/o	b m/o	ZC 2870 Univ. T. h m s	ZC 2871 Univ. T. h m s	Moon Alt	Moon Az	Cusp Ang	Pos Ang	W. Ang	a m/o	b m/o
EUGENE	OR	EUGENE	-123.083	44.050	126	9 54 33		18	136	20N	328	339	+0.8	-1.2									
SANTA RO	CA	GEORGE	-122.717	38.433	0	9 58 4		22	136	39N	309	320	+1.2	-0.2	8 34 34	8 34 42	10	121	58N	290	301	+0.6	+0.6
SAN RAFA	CA	HUME OB	-122.685	38.566	329	9 58 5		22	136	38N	310	320	+1.2	-0.3	8 34 41	8 34 49	10	121	57N	291	301	+0.6	+0.6
SAN FRAN	CA	JOHN E	-122.496	37.735	329	9 58 33		23	136	41N	307	318	+1.2	-0.2	8 34 14	8 34 23	10	121	59N	289	299	+0.6	+0.7
SAN FRAN	CA	WILLIAM	-122.479	37.726	0	9 58 35		23	136	41N	307	318	+1.2	-0.2	8 34 15	8 34 23	10	121	59N	289	299	+0.6	+0.7
BELMONT	CA	JIM HAR	-122.400	37.800	0	9 58 40		23	136	40N	308	318	+1.2	-0.2	8 34 21	8 34 29	10	121	59N	289	299	+0.7	+0.7
BERKELEY	CA	TONY FR	-122.294	37.872	10	9 58 46		23	136	40N	308	318	+1.2	-0.2	8 34 28	8 34 36	10	121	59N	289	300	+0.7	+0.7
OAKLAND	CA	DAVID M	-122.265	37.801	8	9 58 49		23	136	40N	308	318	+1.2	-0.2	8 34 26	8 34 34	10	121	59N	289	299	+0.7	+0.7
OAKLAND	CA	NORMAN	-122.220	37.760	0	9 58 53		23	136	41N	308	318	+1.2	-0.2	8 34 26	8 34 35	10	121	59N	289	299	+0.7	+0.7
SAN LEAN	CA	MARK GI	-122.177	37.787	32	9 58 56		23	136	40N	308	318	+1.2	-0.2	8 34 29	8 34 37	10	121	59N	289	299	+0.7	+0.7
OAKLAND	CA	MIKE O	-122.177	37.787	61	9 58 56		23	136	40N	308	318	+1.2	-0.2	8 34 29	8 34 37	10	121	59N	289	299	+0.7	+0.7
CUPERTIN	CA	KENT OK	-122.132	37.363	115	9 59 6		23	136	42N	307	317	+1.3	-0.2	8 34 14	8 34 22	11	121	60N	288	298	+0.7	+0.7
CAMPBELL	CA	RICHARD	-122.131	37.363	115	9 59 6		23	136	42N	306	317	+1.3	-0.2	8 34 14	8 34 22	11	121	60N	288	298	+0.7	+0.7
PLEASANT	CA	JOSEPH	-122.057	37.965	0	9 59 3		23	137	40N	308	319	+1.2	-0.2	8 34 41	8 34 49	10	121	59N	290	300	+0.7	+0.6
WALNUT C	CA	ROBERT	-122.031	37.889	84	9 59 5		23	137	40N	308	318	+1.2	-0.2	8 34 39	8 34 47	10	121	59N	290	300	+0.7	+0.6
SAN JOSE	CA	JAMES H	-121.938	37.262	73	9 59 22		24	137	42N	306	317	+1.3	-0.2	8 34 18	8 34 26	11	121	60N	288	298	+0.7	+0.7
LIVERMOR	CA	WALTER	-121.750	37.750	0	9 59 29		23	137	40N	308	318	+1.3	-0.2	8 34 45	8 34 53	11	121	59N	289	300	+0.7	+0.6
SANTA CR	CA	DR ARN	-121.645	37.340	0	9 59 44		24	137	42N	307	317	+1.3	-0.2	8 34 33	8 34 41	11	121	60N	288	299	+0.7	+0.7
BEND	OR	CHARLES	-120.939	43.792	1914	9 56 39		19	139	19N	329	339	+0.9	-1.3		8 38 36	9	123	43N	305	315	+0.5	+0.4
UMATILLA	OR	ANTHONY	-119.294	45.923	51	9 53 22		18	140	6N	342	352	+0.5	-4.2		8 40 8	9	125	36N	312	322	+0.5	+0.2
HOLDMAN	OR	TONY GE	-119.063	45.881	0	9 53 41		18	140	6N	342	352	+0.6	-4.1		8 40 14	9	125	36N	312	322	+0.5	+0.2
VALENCIA	CA	JERRY M	-118.710	34.576	1010	10 4 15		28	140	48N	300	310	+1.5	-0.1	8 34 53	8 35 2	15	123	65N	283	294	+0.9	+0.7
LA CANAD	CA	STEVE E	-118.173	34.206	479	10 5 8		29	140	49N	299	309	+1.6	-0.1	8 35 7	8 35 16	15	123	65N	283	293	+0.9	+0.7
ALTADENA	CA	GREGORY	-118.129	34.199	0	10 5 13		29	140	49N	299	309	+1.6	-0.1	8 35 9	8 35 18	15	123	65N	283	293	+0.9	+0.7
LAKE WOO	CA	D P W	-118.125	33.835	12	10 5 15		29	140	50N	298	308	+1.6	-0.1	8 34 55	8 35 4	15	123	66N	282	292	+0.9	+0.7
LOS ALAM	CA	JAMES W	-118.100	33.700	0	10 5 19		29	140	51N	297	308	+1.6	-0.1	8 34 51	8 35 0	15	123	67N	282	292	+0.9	+0.7
LOS ALMT	CA	DAVID W	-118.072	33.787	0	10 5 21		29	140	50N	298	308	+1.6	-0.1	8 34 56	8 35 5	15	123	66N	282	292	+0.9	+0.7
FOUNTAIN	CA	DONALD	-117.959	33.727	11	10 5 32		29	140	51N	298	308	+1.6	-0.1	8 35 0	8 35 8	16	123	67N	282	292	+0.9	+0.7
SAN DIEG	CA	DANIEL	-117.150	32.733	84	10 6 54		31	141	53N	295	305	+1.7	-0.0	8 34 59	8 35 8	17	123	69N	280	290	+1.0	+0.7
RUNNING	CA	ROBERT	-117.133	34.217	1829	10 6 47		30	142	49N	299	310	+1.6	-0.1	8 36 2	8 36 10	16	124	65N	284	294	+0.9	+0.7
LAKEWOOD	CA	DAVID P	-116.672	33.684	1353	10 7 38		30	142	50N	298	308	+1.7	-0.1	8 36 7	8 36 16	17	124	66N	283	293	+1.0	+0.7
IDAHO FA	ID	JAMES A	-112.000	43.500	1433	10 8 1		24	149	18N	331	341	+1.5	-2.0	8 44 24	8 44 31	15	131	38N	310	320	+0.8	+0.1
TEMPE	AZ	PAUL C	-111.917	33.417	0	10 16 25		34	149	51N	297	308	+2.0	-0.3	8 41 0	8 41 9	21	128	64N	284	295	+1.2	+0.6
GILBERT	AZ	GERALD	-111.795	33.349	375	10 16 40		34	149	51N	297	307	+2.0	-0.3	8 41 5	8 41 15	21	128	64N	284	295	+1.2	+0.6
TUCSON	AZ	DAVID H	-111.000	32.343	756	10 18 26		35	150	54N	294	305	+2.0	-0.2	8 41 27	8 41 36	22	129	66N	282	292	+1.2	+0.6
TUCSON	AZ	JIM STA	-110.964	32.420	842	10 18 29		35	150	54N	294	305	+2.0	-0.2	8 41 32	8 41 42	22	129	66N	282	293	+1.2	+0.6
TUCSON	AZ	SCIENCE	-110.932	32.193	701	10 18 36		36	150	54N	294	304	+2.1	-0.2	8 41 28	8 41 37	22	129	66N	282	292	+1.2	+0.6
TUCSON	AZ	MICHAEL	-110.925	32.328	857	10 18 35		35	150	54N	294	305	+2.0	-0.2	8 41 32	8 41 41	22	129	66N	282	292	+1.2	+0.6
TUCSON	AZ	ALBERT	-110.794	32.293	805	10 18 52		36	150	54N	294	304	+2.1	-0.2	8 41 40	8 41 50	22	129	66N	282	292	+1.2	+0.6
TUCSON	AZ	RICHARD	-110.776	32.180	876	10 18 55		36	150	54N	294	304	+2.1	-0.2	8 41 39	8 41 48	22	129	66N	282	292	+1.2	+0.6
TUCSON	AZ	DERALD	-110.767	31.950	1024	10 18 59		36	150	55N	293	304	+2.1	-0.2	8 41 31	8 41 41	23	129	67N	281	292	+1.3	+0.6
SONOITA	AZ	MARK TR	-110.602	31.666	1506	10 19 22		36	150	56N	292	303	+2.1	-0.2	8 41 32	8 41 41	23	129	68N	281	291	+1.3	+0.6
ALBUQUER	NM	MACPHER	-106.493	35.072	1750	10 26 57		35	158	47N	301	311	+2.2	-0.6	8 48 34	8 48 43	24	135	57N	291	301	+1.4	+0.3
CLOUDCRO	NM	W & B	-105.771	32.956	2473	10 29 33		38	159	53N	295	305	+2.3	-0.4	8 48 45	8 48 54	26	135	62N	286	296	+1.5	+0.4
LITTLETO	CO	MICHAEL	-105.100	39.600	1896	10 26 7		31	160	34N	314	324	+2.1	-1.1	8 51 21	8 51 30	22	138	45N	303	313	+1.3	+0.1
GREELEY	CO	RICHARD	-104.704	40.405	1459	10 25 55		31	161	32N	316	327	+2.1	-1.3	8 51 54	8 52 3	22	138	43N	305	315	+1.3	-0.0
FALCON	CO	RONALD	-104.561	38.948	632	10 28 2		32	161	37N	312	322	+2.2	-1.0	8 52 2	8 52 12	23	138	47N	302	312	+1.3	+0.1
LUBBOCK	TX	PERRY H	-101.893	33.537	976	10 38 24		39	166	54N	295	305	+2.4	-0.6	8 54 59	8 55 9	29	140	60N	289	299	+1.6	+0.3
SNYDER	TX	EDWARD	-100.917	32.705	369	10 41 14		40	168	56N	292	302	+2.5	-0.5	8 56 24	8 56 34	30	140	62N	287	297	+1.7	+0.3
MEXICO	MX	ING GU	-99.184	19.373	2288	10 44 42		53	169	86S	255	265	+2.6	+0.7	8 50 40	8 50 52	40	134	83S	252	262	+2.1	+1.2
BOERNE	TX	STEPHEN	-98.711	29.795	427	10 47 57		43	173	66N	282	293	+2.6	-0.3	8 59 23	8 59 33	34	142	69N	280	290	+1.9	+0.4
SAN ANTO	TX	TODD A	-98.659	29.492	259	10 48 11		44	173	67N	282	292	+2.6	-0.3	8 59 22	8 59 32	34	142	69N	279	289	+1.9	+0.4
SAN ANTO	TX	RICK FR	-98.653	29.486	258	10 48 12		44	173	67N	282	292	+2.6	-0.3	8 59 22	8 59 33	34	142	69N	279	289	+1.9	+0.4
SAN ANTO	TX	ROBERT	-98.300	29.250	0	10 49 10		44	173	67N	281	291	+2.6	-0.3	8 59 58	9 0 9	35	142	70N	278	288	+1.9	+0.4
AUSTIN	TX	GLENN R	-97.687	30.328	198	10 50 23	-11	43	175	65N	283	294	+2.6	-0.4	9 1 35	9 1 45	34	144	67N	281	291	+1.9	+0.3
ROCKWALL	TX	CHARLES	-96.464	32.916	150	10 52 15	-8	40	177	59N	289	300	+2.5	-0.6	9 4 33	9 4 44	33	147	61N	288	298	+1.9	+0.1
TOPEKA	KS	RICHARD	-96.132	38.947	448	10 47 49	-6	34	176	42N	306	316	+2.4	-1.2	9 4 55	9 5 4	28	149	45N	303	313	+1.7	-0.2
TOPEKA	KS	CRAIG A	-95.703	39.021	280	10 48 47	-6	34	177	43N	306	316	+2.5	-1.2	9 5 39	9 5 48	29	150	45N	303	313	+1.8	-0.3
HOUSTON	TX	WAYNE H	-95.535	29.810	30	10 56 6	-8	44	179	68N	280	290	+2.6	-0.3	9 5 42	9 5 53	36	147	69N	280	290	+2.1	+0.3
TOPEKA	KS	REX EAS	-95.450	39.000	451	10 49 25	-5	34	178	43N	305	316	+2.5	-1.2	9 6 6	9 6 15	29	150	45N	303	313	+1.8	-0.3
HOUSTON	TX	L M R	-95.417	29.750	0	10 56 24	-8	44	180	68N	280	290	+2.6	-0.3	9 5 55	9 6 6	37	147	69N	280	290	+2.1	+0.3
HOUSTON	TX	TOM AND	-95.417	29.750	0	10 56 24	-8	44	180	68N	280	290	+2.6	-0.3	9 5 55	9 6 6	37	147	69N	280	290	+2.1	+0.3
LEAGUE C	TX	PAUL D	-95.075	29.592	6	10 57 20	-8	44	180	69N	279	289	+2.6	-0.3	9 6 35	9 6 46	37	147	69N	279	289	+2.1	+0.3
LA PORTE	TX	ROCKY H	-95.011	29.667	3	10 57 29	-8	44	181	69N	279	290	+2.6	-0.3	9 6 44	9 6 56	37	148	69N	279	290	+2.1	+0.3
BONNER S	KS	WALTER	-94.806	39.048	297	10 50 56	-5	34	179	43N	305	315	+2.5	-1.2	9 7 14	9 7 24	29	151	45N	303	313	+1.8	-0.3
MISSION	KS	J DENN	-94.655	39.027	308	10 51 20	-5	34	179	43N	305	315	+2.5	-1.2	9 7 31	9 7 41	29	151	45N	303	313	+1.8	-0.3
BLUE SPR	MO	ROBERT	-94.497	38.964	290	10 51 47	-4	34	179	44N	304	315	+2.5	-1.2	9 7 50	9 7 59	29	151	45N	303	313	+1.8	-0.3
AMES	IA	DAVID O	-93.569	42.093	317	10 49 40	-3	31	180	35N	313	324	+2.5	-1.6	9 8 7	9 8 16	27	153	37N	311	321	+1.8	-0.6
INDIANOL	IA	ROGER B	-93.560	41.381	273	10 50 45	-3	32	180	37N	311	321	+2.5	-1.5	9 8 31	9 8 38	28	153	39N	309	319	+1.8	-0.5
AFTON	MN	JAMES H	-92.924	44.829	0	10 46 6	-2	29	180	26N	322	333	+2.5	-2.2	9 7 14	9 7 23	25	154	29N	319	329	+1.7	-0.9
ROLLA	MO	JOSEPH	-91.767	37.950	0	10 59 42	-1	35	185	49N	299	309	+2.5	-1.1	9 13 19	9 13 29	32	155	48N	300	310	+2.0	-0.3
ROLLA	MO	JOSEPH	-91.767	37.950	0	10 59 42	-1	35	185	49N	299	309	+2.5	-1.1	9 13 19	9 13 29	32	155	48N	300	310	+2.0	-0.3
CEDAR RA	IA	FRANK O	-91.659	42.049	261	10 54 24	-1	31	183	37N	311	321	+2.5	-1.6	9 11 34	9 11 43	28	156	38N	311	321	+1.9	-0.6
JONESBOR	AR	PAUL QU	-90.717	35.827	99	11 4 25	-1	37	188	56N	292	302	+2.5	-0.9	9 16 0	9 16 11	34	157	54N	294	304	+2.1	-0.2
ST LOUI	MO	WAYNE E	-90.341	38.585	0	11 2 29	0	34	187	49N	299	309	+2.4	-1.2	9 15 58	9 16 8	32	158	47N	301	311	+2.0	-0.4
MIDDLETO	WI	GILBERT	-89.470	43.117	288	10 58 2	2	30	187	36N	312	322	+2.5	-1.7	9 15 1	9 15 10	28	159	35N	313	323	+1.9	-0.8
MADISON	WI	THOMAS	-89.457	43.040	305	10 58 11	2	30	187	37N	311	322	+2.5	-1.7	9 15 6	9 15 15	28	159	36N	313	323	+1.9	-0.8
MADISON	WI	MADISON	-89.438	42.791	307	10 58 40	2	30	187	38N	311	321	+2.4	-1.7	9 15 17	9 15 26	28	159	36N	312	322	+1.9	-0.8
MADISON	WI	DAVID D	-89.305	43.095	282	10 58 27	2	30	187	37N	311	322	+2.4	-1.7	9 15 21	9 15 30	28	160	35N	313	323	+1.9	-0.8
STREATOR	IL	ROBERT	-88.833	41.125	212	11 2 50	2	32	189	43N	305	315	+2.4	-1.5	9 17 43	9 17 52	30	160	41N	307	317	+2.0	-0.6
ROLLING	IL	BERTON	-88.008	42.074	216	11 3 23	3	31	190	42N	307	317	+2.4	-1.6	9 18 36	9 18 46	29	162	39N	310	320	+2.0	-0.7
GREENFIE	WI	MILWAUK	-88.000	43.000	274	11 1 48	3	30	189	39N	309	320	+2.4	-1.7	9 17 57	9 18 6	28	162	36N	312	322	+2.0	-0.8
WORTH	IL	ROBERT	-87.802	41.685	185	11 4 30	4	31	191	43N	305	316	+2.4	-1.5	9 19 23	9 19 32	30	162	40N	308	319	+2.0	-0.7
FORT WAY	IN	LAURA A	-85.240	41.019	234	11 11 31	6	31	195	48N	300	310	+2.3	-1.4	9 25 18	9 25 28	31	166	43N	305	316	+2.2	-0.7

Lunar Occultation of 7.5-mag. Comet Hale-Bopp and two stars on 1996 May 8 Reappearance, Moon 70- % sunlit, Solar elongation 113
Large observatories not in other lists

Location	E. Long.	Lat.	h,m	Univ. T. h	m	s	Sun Alt	Moon Alt	Moon Az	Cusp Ang	Pos Ang	W. Ang	a m/o	b m/o	ZC 2870 h	m	s	ZC 2871 h	m	s	Moon Alt	Moon Az	Cusp Ang	Pos Ang	W. Ang	a m/o	b m/o
LEUSCHNER OBS LAFAYE	-122.157	37.918	304	9	58	55		23	136	40N	308	319	+1.2	-0.2	8	34	35	8	34	43	10	121	59N	290	300	+0.7	+0.7
UNIV OF CALIF DAVIS	-121.753	38.541	38	9	59	13		23	137	38N	310	321	+1.2	-0.3	8	35	16	8	35	23	10	121	57N	291	302	+0.7	+0.6
MIRA Oliver Observin	-121.570	36.305	1525	9	59	56		25	137	44N	304	314	+1.3	-0.1	8	33	52	8	34	0	11	121	62N	286	296	+0.7	+0.7
Goldendale WA visual	-120.817	45.833	0	9	52	55		17	138	9N	340	350	+0.6	-3.1													
/MT WILSON OBSY CA	-118.060	34.213	1625	10	5	17		29	140	49N	299	309	+1.6	-0.1	8	35	12	8	35	20	15	123	65N	283	293	+0.9	+0.7
76CM STONEY RIDGE CA	-117.996	34.299	1729	10	5	23		29	140	49N	299	310	+1.6	-0.1	8	35	19	8	35	27	15	123	65N	283	293	+0.9	+0.7
TABLE MTN OBSY WRIGH	-117.681	34.382	2286	10	5	52		29	141	49N	299	310	+1.6	-0.1	8	35	38	8	35	47	15	124	65N	284	294	+0.9	+0.7
PALOMAR OBSY PALOMAR	-116.864	33.356	1706	10	7	21		30	142	51N	297	307	+1.7	-0.1	8	35	43	8	35	52	17	124	67N	282	292	+1.0	+0.7
Anza OCAS Obs Calif	-116.717	33.467	1371	10	7	36		30	142	51N	297	307	+1.7	-0.1	8	35	56	8	36	5	17	124	66N	282	292	+1.0	+0.7
Mount Laguna Obs CA	-116.427	32.840	1859	10	8	6		31	142	53N	295	306	+1.7	-0.1	8	35	46	8	35	55	17	124	68N	281	291	+1.0	+0.7
San Pedro Martir Baj	-115.467	31.045	2790	10	9	50		33	143	57N	291	301	+1.8	+0.0	8	35	24	8	35	33	19	124	72N	277	287	+1.1	+0.8
West Mt Obs Provo UT	-111.817	40.083	0	10	12	40		28	150	31N	317	327	+1.7	-1.0	8	43	59	8	44	8	17	131	47N	301	312	+1.0	+0.3
U S N O Flagstaff AZ	-111.740	35.184	2293	10	16	8		32	149	46N	302	313	+1.9	-0.4	8	42	6	8	42	15	20	129	59N	289	299	+1.1	+0.5
NO 1/KPNO KITT PEAK	-111.600	31.958	2091	10	17	15		35	149	55N	293	304	+2.0	-0.2	8	40	27	8	40	38	22	128	67N	281	291	+1.2	+0.6
LOWELL STA ANDERSON	-111.536	35.097	2181	10	16	34		33	150	46N	302	312	+1.9	-0.4	8	42	17	8	42	26	20	129	59N	289	299	+1.1	+0.5
MMT/MT HPKNS Obs AZ	-110.884	31.689	2607	10	18	45		36	150	56N	292	303	+2.1	-0.2	8	41	10	8	41	20	23	129	68N	281	291	+1.3	+0.6
150-CM MT LEMMON ARI	-110.791	32.441	2776	10	18	48		35	150	54N	295	305	+2.1	-0.2	8	41	44	8	41	53	22	129	66N	283	293	+1.2	+0.6
Steward Obs Catalina	-110.732	32.417	2510	10	18	56		35	150	54N	294	305	+2.1	-0.2	8	41	48	8	41	57	22	129	66N	283	293	+1.2	+0.6
CANANEA APH O Sonora	-110.305	30.985	1642	10	20	6		37	150	58N	290	301	+2.1	-0.1	8	41	27	8	41	37	23	129	69N	279	289	+1.3	+0.6
Mt Graham Vatican Ob	-109.892	32.702	3181	10	20	37		36	152	53N	295	306	+2.1	-0.3	8	42	59	8	43	9	23	130	65N	284	294	+1.3	+0.5
WNMU Silver City NM	-107.867	32.767	0	10	24	58		37	155	53N	295	305	+2.2	-0.3	8	45	45	8	45	55	25	132	64N	285	295	+1.4	+0.5
Blue Mesa Obs NMSU	-107.166	32.491	2842	10	26	33		37	156	54N	294	304	+2.2	-0.3	8	46	33	8	46	42	25	133	64N	284	295	+1.4	+0.5
EtscornO NMIMT SOCOR	-106.915	34.071	1524	10	26	32		36	157	50N	298	309	+2.2	-0.5	8	47	37	8	47	46	25	134	60N	288	299	+1.4	+0.4
U OF NM Capilla Peak	-106.405	34.697	2842	10	27	19		36	158	48N	300	310	+2.2	-0.5	8	48	31	8	48	41	25	135	58N	290	300	+1.4	+0.3
Jelm Mt 92I IR OB WY	-105.977	41.097	2943	10	22	21		30	159	29N	320	330	+2.0	-1.4	8	50	19	8	50	27	20	137	42N	307	317	+1.2	+0.0
Mount Evans Obs Colo	-105.640	39.587	4313	10	24	53		31	159	34N	314	325	+2.1	-1.1	8	50	37	8	50	45	22	137	45N	303	313	+1.2	+0.1
Tiara Obs S Park CO	-105.517	38.970	2679	10	25	58		32	160	36N	312	323	+2.1	-1.0	8	50	45	8	50	54	22	137	47N	301	312	+1.3	+0.1
SOMMERS-B Boulder CO	-105.263	40.004	1652	10	25	15		31	160	33N	315	326	+2.1	-1.2	8	51	11	8	51	19	22	138	44N	304	314	+1.3	+0.0
U TEX /MCDONALD FORT	-104.021	30.671	2053	10	34	26		41	162	60N	288	298	+2.4	-0.3	8	50	25	8	50	35	29	136	67N	281	291	+1.6	+0.5
CER VIRG OB Zacateca	-102.541	22.732	2714	10	37	44		49	162	82N	266	276	+2.6	+0.4	8	47	22	8	47	33	35	133	88N	260	270	+1.9	+1.0
Chapa de Mota Mexico	-99.523	19.790	3070	10	44	8		53	168	88S	256	266	+2.6	+0.7	8	50	23	8	50	35	40	134	84S	253	263	+2.1	+1.2
Limber Obs Pipe CrTX	-98.888	29.674	549	10	47	32		43	172	66N	282	293	+2.6	-0.3	8	59	0	8	59	10	34	142	69N	279	289	+1.9	+0.4
Tonantzintla Mex OAN	-98.314	19.033	2160	10	46	48		54	171	85S	253	263	+2.6	+0.8	8	52	9	8	52	21	41	135	82S	251	261	+2.2	+1.2
Norman U OK Herczeg	-97.444	35.202	363	10	48	14	-9	38	175	52N	296	307	+2.5	-0.8	9	2	54	9	3	4	31	146	55N	293	303	+1.8	+0.0
J RUSSELL SMITH WACO	-97.204	31.377	182	10	51	11	-10	42	176	63N	286	296	+2.5	-0.5	9	2	47	9	2	58	34	145	65N	284	294	+1.9	+0.2
Denton U North Texas	-97.133	33.300	0	10	50	20	-9	40	176	57N	291	301	+2.5	-0.6	9	3	19	9	3	29	33	146	60N	289	299	+1.9	+0.1
AST OBS OAXACA Mex	-96.732	17.069	1702	10	49	9		56	174	78S	246	256	+2.6	+1.1	8	53	3	8	53	15	44	136	77S	245	255	+2.3	+1.4
Yutan Univ Nebr 40in	-96.447	41.172	355	10	44	3	-6	32	175	35N	313	323	+2.4	-1.5	9	3	39	9	3	48	26	149	40N	309	319	+1.6	-0.4
College Sta TX TAMUO	-96.300	30.600	0	10	53	50	-9	43	178	65N	283	293	+2.6	-0.4	9	4	24	9	4	35	35	146	67N	282	292	+2.0	+0.3
Bartlesville OK Will	-95.898	36.664	215	10	50	47	-7	37	177	49N	299	309	+2.5	-1.0	9	5	43	9	5	52	30	149	51N	297	307	+1.8	-0.1
Danciger Obs Houston	-95.865	29.262	0	10	55	24	-9	44	179	69N	279	289	+2.6	-0.3	9	4	51	9	5	2	37	146	70N	278	289	+2.1	+0.3
Nacogdoches TX SFASU	-94.662	31.760	140	10	57	28	-7	42	181	64N	284	295	+2.5	-0.5	9	7	57	9	8	8	35	149	64N	285	295	+2.1	+0.1



OCCULTATION OF SAO 187526 BY EUROPA

Reinhold Büchner, Martin Federspiel, Wolfgang Beisker, and David Dunham

On 1996 June 28 the Jupiter system moves across SAO 187526. The occultation of the star by Jupiter itself has been calculated by Doug Mink and by Edwin Goffin. Goffin's world view shows that the occultation by Jupiter will be visible from Africa, Europe, western Asia, South America except the northwestern part, and Antarctica.

During further analysis we found, that on the same day an occultation by Europa can be observed from western North America, most of the Pacific Ocean, Japan, and parts of far eastern Asia. Information about the star are as follows:

PPM 269153 = SAO 187526 = HD 175947 =
XZ 26188 = ZZ 34988
Spectral type = K0, Vmag. = 8.7, Pmag = 9.5
J2000 R.A. = $18^h 58^m 44.131^s$, Decl. = $-22° 48' 26''.03$

Because Europa will be 5th magnitude, its light will overwhelm that of the star for visual observers. Photoelectric or good CCD systems will be needed to detect this event. Since the solar elongation is 174°, the event will occur in a dark sky in nearly all locations where it will occur. By coincidence, Ron Ballke of the Jet Propulsion Laboratory's Galileo outreach program points out that the Galileo spacecraft will be near Europa and observing it on June 28th.

Approximate coordinates of the occultation path are as follows:

<u>Northern Limit:</u>

W. Long.	231	230	220	210	200	190	180	170	160
Lat.	45	45	40	37	35	34	34	36	38
W. Long.	150	140	130	120	115				
Lat.	41	45	50	55	58				

<u>Central Line:</u>

W. Long.	245	240	230	220	210	200	190	180	170
Lat.	27	25	21	18	15	14	13	13	14
W. Long.	160	150	140	130	120	110	100	95	
Lat.	16	18	21	25	29	34	39	41	

<u>Southern Limit:</u>

W. Long.	252	250	240	230	220	210	200	190	180	
Lat.	12	11	7	4	1	-1	-3	-3	-3	
W. Long	170	160	150	140	130	120	110	100	90	85
Lat.	-2	-1	1	4	8	11	16	20	25	27

<u>Star rises:</u>

Lat	40	30	20
W. Long	236	243	248

<u>Star sets:</u>

Lat	50	40	30
W. Long	104	94	87

Local circumstances are given in the next column, with minimum star alt. +6° and maximum Sun alt. -6°.

L = western geographic Longitude
B = geographic latitude
TA = Disappearance, minutes after 11^h UTC
PA = Position angle of disappearence
H = Altitude of the star
S = Altitude of the Sun
TB = Reappearance, minutes after 11^h UTC
PB = Position angle of reappearence

	L	B	TA	PA	H	S	TB	PB
Tampico	97.8	22.2	23.9	192	12	-6	25.2	153
Monterrey	100.3	25.7	23.4	220	12	-6	26.3	125
San Luis Potosi	101.0	22.2	23.7	204	14	-9	25.8	142
Guadalajara	103.3	20.7	23.9	200	17	-11	25.8	145
Torreon	103.4	25.6	23.4	226	14	-9	26.6	120
Chihuahua	106.1	28.6	23.4	241	14	-9	27.1	104
Mazatlan	106.4	23.2	23.6	221	18	-12	26.6	124
El Paso	106.5	31.8	23.5	251	13	-8	27.4	94
Albuquerque	106.7	35.1	23.6	261	11	-6	27.6	84
Tucson	111.0	32.2	23.8	259	15	-11	27.7	87
Revillagigedo Is.	111.5	19.0	24.1	212	24	-19	26.6	133
Flagstaff	111.6	35.2	24.0	268	14	-9	27.9	77
Phoenix	112.1	33.4	23.9	263	15	-11	27.9	82
Las Vegas	115.1	36.2	24.3	275	15	-11	28.2	70
Boise	116.2	43.6	25.1	296	10	-6	28.4	49
San Diego	117.2	32.7	24.3	268	19	-14	28.2	77
Los Angeles	118.2	34.0	24.4	273	19	-14	28.3	72
Guadalupe I.	118.3	29.0	24.2	259	22	-17	28.1	86
Reno	119.8	39.5	25.0	289	15	-11	28.5	55
Salt Lake City	119.9	40.8	24.4	283	10	-6	28.1	62
Seattle	122.3	47.6	26.2	316	10	-7	28.6	29
San Francisco	122.4	37.8	25.1	288	18	-14	28.6	57
Portland	122.6	45.6	25.9	310	12	-8	28.6	35
Vancouver	123.1	49.3	26.6	323	9	-6	28.5	22
Mauna Kea	155.5	19.8	28.1	272	46	-44	32.0	73
Maui I.	156.3	20.8	28.2	275	46	-43	32.0	69
Christmas I.	157.5	2.0	29.5	140	64	-61	31.5	140
Honolulu	157.8	21.3	28.4	278	45	-43	32.2	67
Fanning I.	159.4	3.9	29.3	217	63	-60	32.1	127
Kauai I.	159.5	22.0	28.7	281	45	-43	32.4	63
Jarvis I.	160.0	-0.4	30.4	186	67	-64	31.3	158
Palmyra I.	162.1	5.9	29.4	229	61	-59	32.7	116
Johnston I.	169.5	17.0	29.9	271	50	-50	33.8	73
Baker I.	176.5	0.2	31.9	209	65	-66	34.3	135
Howland I.	176.6	0.8	31.9	213	64	-66	34.4	131
Midway IS.	177.4	28.2	31.3	310	38	-38	33.9	34
Gilbert Is.	185.0	-1.0	33.3	203	61	-65	35.3	140
Banaba	191.4	-0.9	34.1	203	57	-61	36.1	140
Marshall I.	192.5	9.0	33.1	248	49	-52	36.9	96
Nauru	193.1	-0.5	34.2	205	56	-60	36.4	138
Wake I.	193.4	19.3	33.0	281	40	-43	36.7	63
Guam I.	215.2	13.5	35.5	252	30	-35	39.4	91
Tokyo	220.2	35.7	35.4	317	12	-16	37.6	26
Osaka	224.5	34.7	35.5	308	10	-14	38.2	35
Palau Is.	225.5	7.5	37.1	219	25	-31	40.0	124
Kagoshima	229.4	31.6	35.7	293	9	-13	39.1	50
Pusan	231.0	35.1	35.7	302	6	-10	38.8	41
Naha	232.3	26.2	36.1	274	10	-15	40.0	68
Taipei	238.5	25.0	36.4	264	6	-11	40.4	79
Davao	234.4	7.1	38.2	200	18	-24	40.1	142
Manila	239.0	14.6	37.4	229	10	-16	40.8	113

We hope to encourage observers all over the visibility area to observe this event. Please inform us about your plans, maybe we can help to coordinate this. A specific letter for the scientific rational will be published in the next issue of **ON**. We would be very thankful for any further corrections or more predictions. Our e-mail Adresses are R.Buechner@abbs.heide.de, Beisker@gsf.de, and dunham@erols.com

DERIVING A NEW LUNAR LIMB PROFILE FROM OCCULTATION OBSERVATIONS

Dietmar Büttner

In 1993 the ILOC published lunar occultation observations made from 1981 to 1990 together with their reduction results on diskette. These data have been provided to the author by ILOC last year. The author believes that the data should not just lie in a "data cemetery" but should be used for new investigations. They are the result of very busy work by hundreds of observers around the world as well as of the ILOC in collecting the observations diligently.

A general analysis by an amateur astronomer at first would seem too difficult. Such a complex investigation requires detailed knowledge in astrometry and celestial mechanics. However, with tools now widely available, amateurs can made useful contributions in this area.

Today the LE200 and the PPM provide modern lunar ephemerides and star positions, respectively, to good accuracy, so that the Watts' charts for lunar limb corrections are the largest uncertainty source both in reducing lunar occultation and solar eclipse observations, and in predicting grazing occultations. An improvement of the lunar limb corrections may be performed by modernizing the Watts charts or by creating a totally new derived limb correction data set. The author decided on the second approach because empirical corrections in the Watts' data are a rather complicated task with many pitfalls.

The used method is to ignore the Watts charts totally in reducing the observations and to consider the residuals with respect to the smooth circular lunar limb as the newly derived limb corrections. This, of course, is an approximation because the lunar ephemerides and the star positions are assumed to be correct absolutely and no other systematic errors are considered. Anyway, the new limb corrections provide a well defined relation to the modern lunar ephemerides and star catalogues.

A limb profile reconstruction requires the topocentric physical ephemerides of the Moon which are, however, not included in the ILOC files provided on diskette. So the whole set of observations was to be reduced anew by the author. This provides the advantage that all observations are reduced by the same method using the same data base under known circumstances.

Besides a detailed knowledge in astronomical computing, the reduction of about 100.000 observations requires a suitably designed data management in order to attain reasonable processing times. Before a reduction is possible the data in the files provided by the ILOC need to be completed by the the following input data:

- ΔT to convert UTC given in the observation into TDT for entering the lunar ephemerides
- the PPM number corresponding to the star number given in the observation
- the star position in the PPM using the PPM number to locate the star in the PPM
- the station coordinates using the station code given in the observation
- the lunar position for the time given in the observation, but converted to TDT

The LE200 lunar ephemerides have been taken from the ICE using a self designed system to develope and evaluate polynomical coefficients. The whole work for the data management and for the reduction calculations itself has been performed by the author with software that he developed with a combination of dBASE and Turbo Pascal on a 486 DX2 PC.

From the whole set of 98,958 observations a number of observations was rejected for various reasons, leaving 93,028 observations for the profile reconstruction. For a first qualitative evaluation of the results, the author wrote a program to display the newly derived limb corrections around the lunar disk graphically. The display is performed for a presetable zone centered on the selected longitude and latitude librations. Two of these profiles are shown, one with a large number of observations and one with relatively few observations. Visual inspection shows how the lunar limb profile can be reconstructed using occultation observations. Depending on the distribution of the observations around the limb and over the librations, there are many sections which show clearly the typical lunar limb profile pattern with peaks and valleys. Frequently, the observations at the same region of the limb confirm each other very well. The relative flatness of the north pole is evident as well as the roughness of the south pole, which is already known from predicted and observed grazing occultation profiles. Also, the larger numer of disappearance observations at the preceding dark lunar limb from evening observations during waxing Moon phases is evident.

A program was also written to determine the distribution of the observations over the various combinations of longitude/latitude librations. The results show very clearly accumulation peaks between latitude libration -4° and -6° which is apparently caused by the large numbers of observations during the favorable Pleiades passages of the Moon. Compare the profile figures on the next page.

The author is indebted to the ILOC for providing the observation and station files. Thanks are also to Wolfgang Zimmermann who provided the cross reference catalogues from ZC, XZ, SAO and Eichhorn Pleiades catalogs to PPM numbers. Finally, the author thanks the many hundred amateur astronomers who spent their spare time observing and reporting their results to the ILOC.

The International Occultation Timing Association was established to encourage and facilitate the observation of occultations and eclipses. It provides predictions for grazing occultations of stars by the Moon and predictions for occultations of stars by asteroids and planets, information on observing equipment and techniques, and reports to the members of observations made. IOTA is a tax-exempt organization under sections 501(c)(3) and 509(a)(2) of the (USA) Internal Revenue Code, and is incorporated in the state of Texas.

The ON is the IOTA newsletter and is published approximately four times a year. It is also available separately to non-members.

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Addresses, membership and subscription rates, and information on where to write for predictions are found on the front page.

The Dunhams maintain the occultation information line at 301-474-4945. Messages may also be left at that number.

Observers from Europe and the British isles should join IOTA/ES, sending DM 40.-- to the account IOTA/ES; Bartold-Knaust Strasse 8; D-30459 Hannover; 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) and minor planet occultation data, including last-minute predictions, when available.

The addresses for IOTA/ES are:

Eberhard Bredner	Hans-Joachim Bode
Ginsterweg 14	Bartold-Knaust-Str. 8
D-59229 Ahlen 4 (Dolberg)	D-30459 Hannover 91
Germany	Germany

Telephones (49- for Germany, or 0- within Germany)

-2388-3658	-511-424696
Fax -2381-36770	-511-233112

ON Editor: Joan Bixby Dunham
7006 Megan Lane
Greenbelt, Maryland 20770-3012
U. S. A.

e-mail: dunham@erols.com

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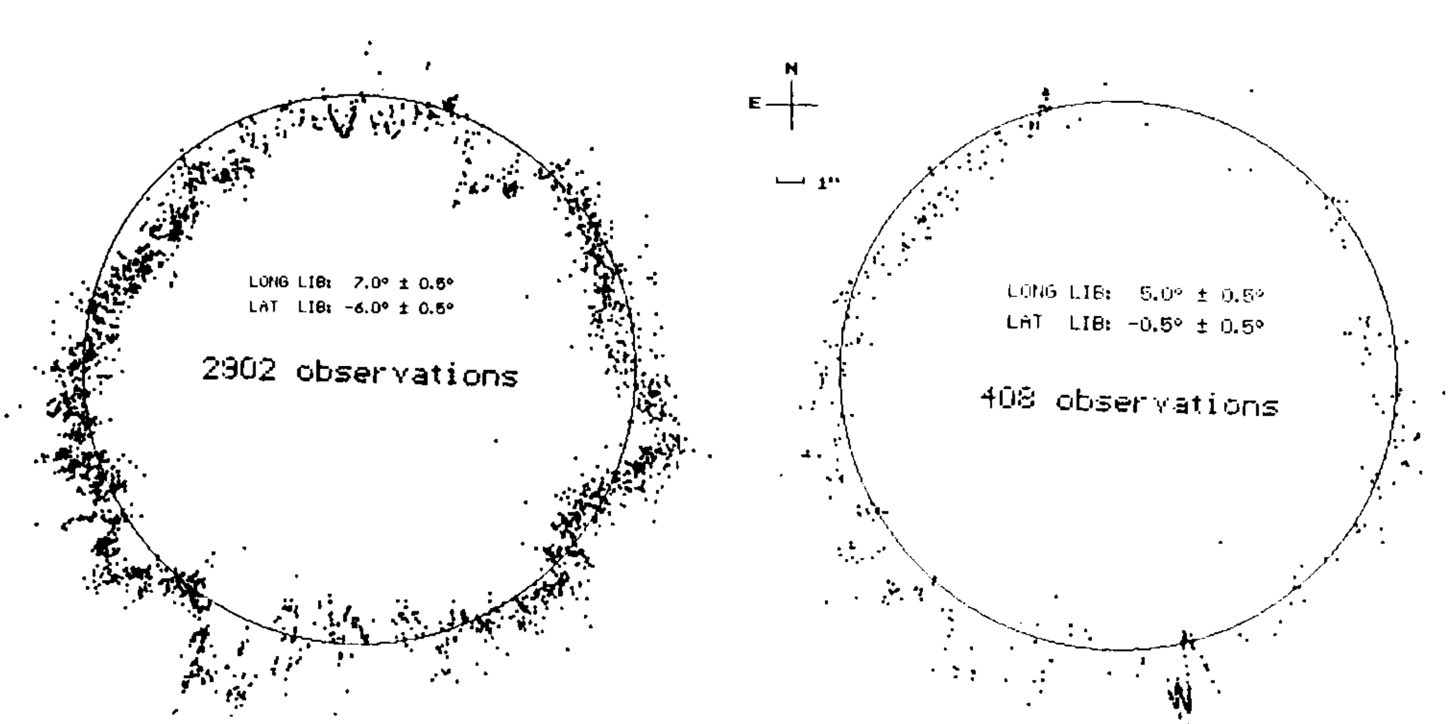
LUNAR LIMB PROFILE FROM RESIDUALS OF LUNAR OCCULTATION OBSERVATIONS



Observations collected by ILOC, Japan. Residuals computed and plotted by D. Büttner, Germany, IOTA/ES