Occultation Newsletter

International Occultation Timing Association

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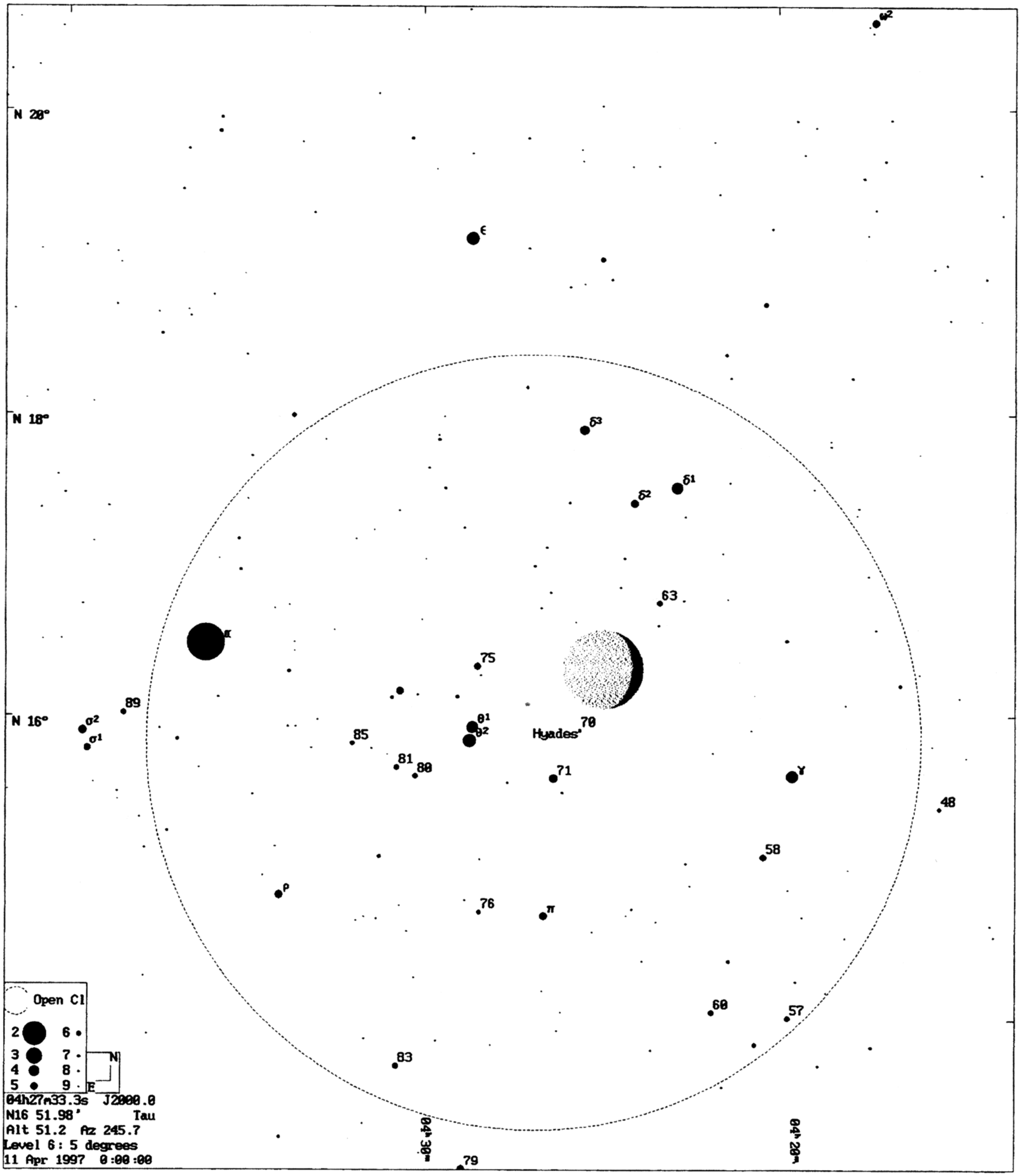

In This Issue

For subscription purposes, this the fourth issue of 1996. **The deadline for submissions to the next issue is 1997 April 1.**

On the cover: The approaching graze of Aldebaran on 1997 April 11. This star field was printed from Guide v. 5.01 from Project Pluto.

What to Send to Whom

Send new and renewal memberships and subscriptions, back issue requests, address changes, e-mail address changes, graze prediction requests, reimbursement requests, special requests, and other IOTA business, **but not observation reports**, to:

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International Lunar Occultation Centre (ILOC)
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All payments made to IOTA must be in United States funds and drawn on a US bank, or by credit card charge to VISA or MasterCard. If you use VISA or MasterCard, include your account number, expiration date, and signature. (Do not send credit card information through e-mail. It is not secure nor safe to do so.) Make all payments to **IOTA** and send them to the Secretary & Treasurer at the address on the left. Memberships and subscriptions may be made for one or two years, only.

Occultation Newsletter subscriptions (1 year = 4 issues) are US$20.00 per year for USA, Canada, and Mexico; and US$25.00 per year for all others. Single issues, including back issues, are 1/4 of the subscription price.

Memberships include the *Occultation Newsletter* and annual predictions and supplements. Memberships are US$30.00 per year for USA, Canada, and Mexico; and US$35.00 per year for all others. Observers from Europe and the British Isles should join the European Service (IOTA/ES). See the inside back cover for more information.

IOTA Publications

Although the following are included in membership, nonmembers will be charged for:

- Local Circumstances for Appulses of Solar System Objects with Stars predictions US$1.00
- Graze Limit and Profile predictions US$1.50 per graze.
- Papers explaining the use of the above predictions US$2.50
- IOTA Observer's Manual US$5.00

Asteroidal Occultation Supplements will be available for US$2.50 from the following regional coordinators:

- **South America**--Orlando A. Naranjo; Universidad de los Andes; Dept. de Fisica; Mérida, Venezuela
- **Europe**--Roland Boninsegna; Rue de Mariembourg, 33; B-6381 DOURBES; Belgium or IOTA/ES (see back cover)
- **Southern Africa**--M. D. Overbeek; Box 212; Edenvale 1610; Republic of South Africa
- **Australia and New Zealand**--Graham Blow; P.O. Box 2241; Wellington, New Zealand
- **Japan**--Toshiro Hirose; 1-13 Shimomaruko 1-chome; Ota-ku, Tokyo 146, Japan
- **All other areas**--Jim Stamm; (see address at lower left)

ON Publication Information

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IOTA News

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E-Mail Updates: Please note that the e-mail addresses have changed for IOTA and the Editor. See the "What to Send to Whom" column for the current addresses.

IOTA Meetings: The 14th annual meeting of the International Occultation Timing Association was held at the Lunar and Planetary Institute in Houston, Texas, on Saturday, December 7th (not the 6th, as mentioned on p. 278 of the last issue); see Rocky Harper's account following this article. Now we need to decide on when and where to hold the 15th annual (1997) meeting, hopefully at a time and location that will encourage higher attendance than we've had during the past few years. Richard Nugent looked into the Texas laws recently and found that the annual meetings are **not** required to be in Texas. There is already a consensus that the meeting should be held during the northern summer months to encourage attendance. We would like to decide by the end of March where and when to hold the meeting, so that it can be publicized better than it has been in the past. We want your help to decide. Which of the possibilities described below would entice you to come to the meeting? Please give your thoughts either by e-mail, telephone (+1-301-474-4722), or post (7006 Megan Lane; Greenbelt, MD 20770-3012; USA).

1. Hold the meeting in conjunction with the Astronomical League's meeting at Copper Mountain Resort the first week of July. An IOTA session is already tentatively planned, and there will be some IOTA attendance. However, the president needs to attend the meeting, and he can not at that time due to critical work that he must do for the Near Earth Asteroid Rendezvous mission around that time (asteroid 253 Mathilde flyby on June 27 and large delta-V maneuver on July 3). I will provide some video and view graphs to be shown by others at the meeting, but it can't be the official annual IOTA meeting.

2. Look at the map on p. 293 of the last issue and hold the meeting near the best 1997 graze of Aldebaran shown on the map, preferably in a location with a high probability of clear sky. The July 29th dark-limb northern-limit graze by the 23% sunlit waning crescent Moon is clearly the winner. This is a Tuesday morning (around 10h U.T.), so the IOTA meeting would be held on Sunday, July 27th, and possibly also the morning of the 28th (that might be devoted mainly to preparation for the graze). The largest city near the path is Salt Lake City, Utah, and we have an IOTA member in the area. The city is at the edge of a desert with a good chance of clear sky that time of the morning. If clouds did threaten, attendees could travel to eastern Nevada (more into the desert) or to Wyoming. Another possibility would be the Central Valley in California, with virtually guaranteed clear sky. However, it is often quite hazy there due to agricultural activity, and the altitude above the horizon is very low at the time of the graze; the view should be significantly better in Utah.

3. Hold the meeting in Topeka, KS, where three of the IOTA officers live. Or it could be in nearby Kansas City, which has better airline connections with its major airport. In any case, this is a good central-USA location. One suggestion was to hold the meeting there in late June, but that is not possible in 1997 for the same reason as (1) above, and it would also conflict with the Astronomical Society of the Pacific's "Universe" meeting. Since some IOTA officers in any case want to try the July 29th graze, late July might also be avoided (or maybe not; the meeting could be held there on Saturday, July 26th, allowing enough time for those who wanted to travel to the Aldebaran path in Wyoming or near Salt Lake City).

My own preference is for 2. Also, we might consider that a very good Aldebaran graze will cross Kansas on 1999 April 19th (Moon 12% waning), so that might be a better time to have the meeting there (in that year, observers may want to save their northern summer travel for the August total solar eclipse in Europe, which will be combined somehow with the IOTA/ES European Symposium on Occultation Projects meeting). At some time in the future, we might set up the IOTA meeting around good asteroidal occultation events, but until the accurate Hipparcos data become widely available and used to refine many of the asteroidal orbits, those events can not be predicted well enough to target meetings.

ESOP XVI: The 16th European Symposium on Occultation Projects will be held on 1997 Aug. 28-Sept. 3 in Welling, Kent, U.K. Those interested should contact Hans-Joachim Bode at bode@kphunix.han.de; when available, more details will appear on **http://www.uni-siegen.de/~uastro/occ/esop16.htm**.

Attached files: Virtually all e-mail systems can handle either uuencoded or mime-encoded attached files of any format, including binary and compressed ".zip" files, up to about 700 kilobytes (and many can handle 1.4 to 2.0 megabyte files). ILOC can receive uuencoded attached files, whereas I think that Richard Wilds' e-mail uses mime-encoding. So observers are now encouraged to send their observation reports in the original 80-column format as attached files rather than in the e-mail76 format as included in the message (but that can still be done if you can't get the attached files to work). Tom Campbell has gathered together programs for creating (encoding) or decoding both mime-encoded and uuencoded files, and has put them, along with descriptions for using them, in a compressed file called codeutil.zip that can now be downloaded from our lunar (sky.net) Web site. Please supply your e-mail address to IOTA and to the computor and prediction coordinator for your region, if you have not already done so. It saves us much postal expense if we can send your predictions to you as attached .zip files. It also saves time; you can receive your predictions much more quickly. Having your e-mail address also allows us to send you reminders for important events, and time-critical updates for asteroidal occultations. If you don't have e-mail yourself, perhaps you could supply the e-mail address of a nearby friend who could pass information (including large files on a diskette) on to you.

1997 Predictions: IOTA members should by now have all of their

1997 predictions of grazing and total lunar occultations that they want, and of asteroidal/planetary occultations (both the charts by Edwin Goffin and the local circumstance/appulse predictions). If this is not the case, please let us know so you can be provided with your predictions. The graze computors and total occultation coordinators had the files and information to distribute preliminary predictions for 1997 in late December. Unfortunately, observers in some regions did not receive predictions until February. In late January, software to correct some errors in XZ94E designations and double star codes in the PC-Evans predictions was distributed so that regional coordinators could generate and distribute corrected predictions. These errors remain in OCCULT-produced predictions, and in those generated with PC-Evans late in 1996, especially for many European observers, so they will be documented in the next issue. Since some star designations are wrong, incorrect star numbers might be reported to ILOC, causing the observation to be rejected when the timing is all right. Only a few stars are involved that are occulted anywhere in the world during 1997, and it happened that none of them are occulted at my site under observable conditions this year (that may also be the case for most temperate-zone Northern-Hemisphere stations). Some of these errors were probably also present in the 1996 and possibly 1995 predictions. The PC-Evans IOTA predictions do not include lunar occultation predictions of Saturn and other major planets. These will be computed with the Occult program after I have completed and distributed software to generate Occult-program format input station data from the PC-Evans station files.

The original R.A. and Dec. given at the top of Edwin Goffin's charts for asteroidal occultations of GSC stars, and of one PPM star to be occulted by the Kuiper-belt object 1994 JR1, are all wrong for 1997. The correct coordinates were in a ".u10" file distributed with the local circumstance appulse predictions near the beginning of January, and they were also hand-written on the charts distributed with the *ON* 1997 planetary occultation supplement for North American observers, but apparently the coordinators for some parts of the world did not correct the charts before distributing them. Fortunately, the detailed finder charts are all right; it's just the coordinates of the star in the upper right corner that are wrong by a small amount. Data for computing revised local circumstance appulse predictions will be distributed to the graze computors for computation and distribution in late February; the revisions include some updated star positions from accurate Carlsberg Automated Meridian Circle (CAMC) observations, additional SAO numbers and spectral types, and better double star information, including, where appropriate, predictions for the separate components of relatively close double stars.

There are some substantial changes regarding grazing occultation predictions. These are described in the Eastern and Western Hemisphere Grazing Occultation Supplement for 1997 that is being distributed with this issue.

Tax Form: The USA income tax form can be downloaded from our lunar (sky.net) Web site, if you want to deduct as an IOTA contribution the cost of expeditions that you undertook in 1996.

Hipparcos Project: The reduction of asteroidal occultation observations and occultation star catalog work relative to the Hipparcos catalog was mentioned on p. 278 of the last issue. The asteroidal occultation observations will be used to define where the asteroid was relative to the occulted star to a precision much better than other ground-based astrometric observations of the asteroid. Then, good early-epoch positions [relative to Hipparcos direct (for a few asteroids) and later planned radar observations] of the asteroids can be derived from comparison with the Hipparcos data for the occulted stars to determine much better orbits for the asteroids involved, and that will in turn help in determining the masses of more asteroids. I now have some help with this project from Doug Faust, a high school senior in a mentor program at the Johns Hopkins University Applied Physics Laboratory where I work. ι

OCCULT Version 4.01

David Herald

Version 4.01 of OCCULT was received in the U.S.A. on February 3rd and made available to IOTA via Kent Okasaki and ftp.anomalies.com shortly after that. It consists of 4 revised .EXE files and 10 new documentation files, all to be placed in the \OCCULT\ directory. The principal changes from version 4.0 are as follows:

- An option that displays the documentation files directly from within the program. The information previously was in a separate read.me file.
- A linear rate of change in osculating elements of asteroids between the computed points is now used to calculate more accurate asteroidal occultation predictions, especially for updating the predictions with astrometric observations. Coordinates of the central line of the occultation path is now generated. Also, there is output for occultations of stars by major planets (both graphical and local circumstances).
- The eclipse routines have been modified to allow output to a disk file, and calculations of transits of Mercury and Venus are now included.
- A rare error that can cause the program to crash for photoelectric option calculations, and one that sometimes caused wrapping of occultation region maps, have been corrected.

A problem in both versions 4.0 and 4.01 was recently identified: These versions can only run from the C: drive due to a specification of that drive in one of the updated subroutines. That has recently been corrected, and a listing of the runtime error codes is now provided. A plot of the Sun showing the path of a planet during a transit has also been added. These changes will be in version 4.02, which will be available through IOTA's channels by the time this issue of the *ON* is distributed.

Planned future changes include improvement of the double star data and the Cassini region profile based largely on the new reductions of many observed grazes by Mitsuru Sôma that are now used by the ACLPPP program. ι

Spectacular Aldebaran and Hyades Occultation April 10-11

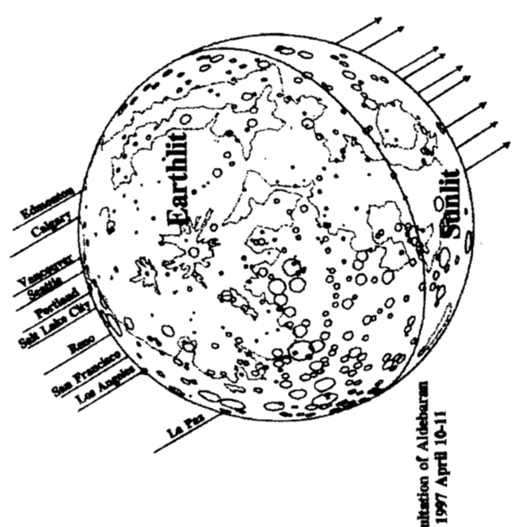
David W. Dunham

On Thursday evening, April 10th (local time; April 11th, U.T.), the thin (17% sunlit) waxing crescent Moon will cover 1st-magnitude Aldebaran in what will be the best occultation of 1997 for observers along the Pacific coast of North America. Astronomical societies west of the Rocky Mountains and in the northern plains should use this opportunity to publicize an astronomical phenomenon that the general public can watch since the disappearance on the Moon's Earthlit dark side will be visible without optical aid. Moreover, anyone with a camcorder can video record the event to less than 0.05 second. If hundreds of people (including many who are not normally amateur astronomers) could video record this event, the lunar profile could be mapped in unprecedented detail, information that would be valuable for refining the analysis of other occultation events. This includes solar eclipses, the study of careful observations of which have revealed small variations of the solar radius that could have ramifications on questions about the Earth's short-term climate, such as global warming rates. Many similar occultations of Aldebaran, and of other first-magnitude stars, were seen and noted by ancient Greek, Roman, Arabian, Chinese, and Japanese astronomers. But only now can we video record for posterity occultations of this brightest star (excluding the Sun) that is covered by the Moon.

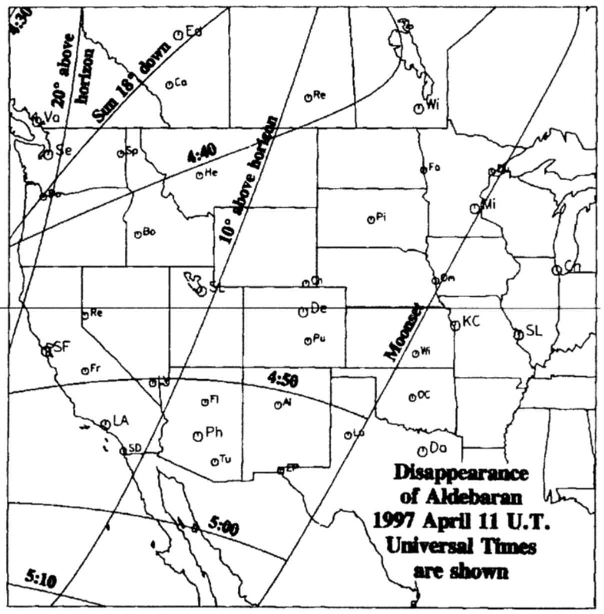
In addition, the reappearance might be timed using binoculars or, better, small telescopes, with which the event could even be video recorded by holding a camcorder up to the eyepiece. Such observations, although fewer than the disappearance ones, would be valuable for refining our knowledge of the lunar profile around the Moon's full circumference. Unfortunately, the northern limit of this occultation crosses thinly-populated parts of northern Canada, including just north of Ft. Good Hope, Northwest Territories; the south shore of Great Bear Lake; the northern part of Great Slave Lake; just north of Lake Athabaska; a little south of Churchill, Manitoba, and also near Port Nelson on the shore of Hudson Bay (but very low there). The northern limit also crosses Siberia, including Lake Baikal and just south of Wrangel Island, then over the North Slope of Alaska starting just south of Point Barrow, but a telescope would be needed to see the graze in daylight in those areas. The southern limit only crosses the Pacific Ocean, so there are no reasonable chances to observe a grazing occultation this time.

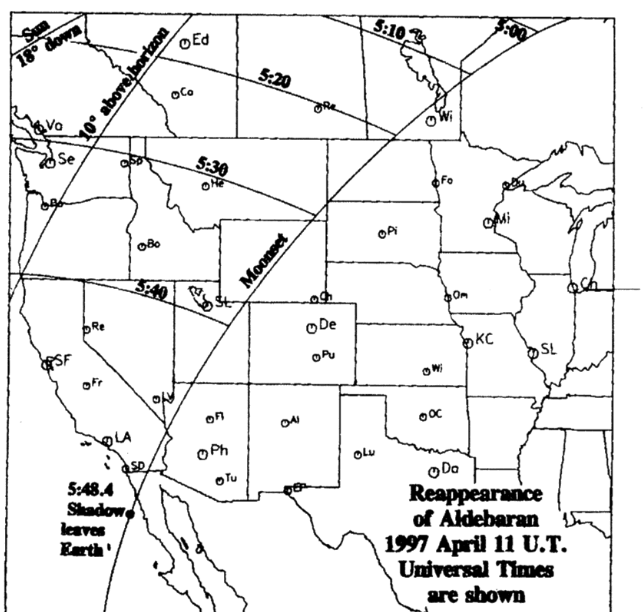
Although Aldebaran will be a Western show, most of the rest of the U.S.A. and Canada will be treated to occultations of a few bright Hyades cluster members that might be seen with binoculars and even recorded with camcorders, like Aldebaran. Times for the disappearance of 4.8-mag. Z.C. 677 are given for several cities in the table on p. 91 of the January issue of *Sky & Telescope*, in addition, occultations of 5.3-mag. 75 Tauri (Z.C. 667) and a couple of 6th-mag. stars can also be seen across much of North America. A spectacular southern-limit graze of the 4.0-mag. close double θ^1 Tauri can be seen north of Winnipeg, and with more difficulty on the bright side north of Montreal and across Maine and southern Nova Scotia. An occultation of 3rd-mag. γ Tauri will occur in northern Quebec and Labrador. The southern limits for these Hyades occultations are shown in the **RASC Observer's Handbook 1997** and are also displayed on our sky.net Web page. Tables and Moon views, and perhaps maps, for some of the better Hyades occultations of April 10-11 will be placed on our Web page in early April. Telescopic observers will be able to time many other occultations, and some grazes, of fainter stars; at this phase, occultations of even 10th and 11th-mag. stars might be timed with mid-sized and large telescopes.

For timing an occultation in a given metropolitan area, camcorder users can be asked to video record (before and after the occultation, while the camcorder is kept running) the time given in the local broadcast parts of The Weather Channel (and/or telephone time, or any television or radio broadcast that can be received throughout the area), but one including a video display of the time will be easiest to reduce. However, like local telephone time, The Weather Channel local time is not normally accurately set to UTC, so all of these must be calibrated with a video recording by the local coordinator that includes WWV or CHU time signals in the background (WWV is preferred, since we have time inserters that automatically trigger a video time display from the WWV minute mark).



The view of the Moon shows the paths behind it as seen from several cities. I produced it with OCCULT 4.0 for the disappearance at Los Angeles, then added the paths for the different cities and oriented it relative to the horizon at Los Angeles (the up direction will not be much different at other locations in western North America). The paths for some major cities, mostly where only the disappearance will occur above the horizon, could not be shown due to crowding. The path for Winnipeg is a little north of that for Edmonton; Denver's path is between Portland's and Salt Lake City's; Albuquerque's is just south of Reno's; Phoenix's and El Paso's is between Los Angeles' and San Francisco's; Tucson's is almost the same as Los Angeles'; and San Diego's is just south of Los Angeles'. The Moon is just setting when the star disappears at La Paz, southern Baja California.





The Universal Times and altitudes above the west-northwestern horizon can be estimated for any location shown on the two maps, one for the disappearance and the other for the reappearance. The sky will be dark in most areas of the map. In the northwest corner of the maps, there will be some twilight (Sun 18° down marks the end of astronomical twilight), but it will be rather faint by then, not strong enough to interfere with observation. Observers need to select a location where trees or other high obstructions will not block the view of the Moon, especially where the Moon is 10° or less above the horizon, where a very clear sky will also be needed to see the event. The Moonset line is where the star's geometric altitude is -0°.6, so it takes into account atmospheric refraction to represent the true location where the star will disappear or reappear when it is on the astronomical horizon. It will be interesting to see the lowest altitude above the horizon at which the disappearance can be video recorded.

The bend in the 4:40 U.T. disappearance curve in Manitoba is real and is caused by the proximity to the northern limit, which actually ends at Moonset near the northeast corner of the maps.

For those without camcorders, the disappearance can be seen directly with the naked eye. It will help to block the bright part of the Moon with an outstretched finger, or position yourself so that it is blocked by a telephone pole, building, or other obstruction, while Aldebaran and the dark side of the Moon (illuminated by Earthshine) remain visible. Of course, binoculars or opera glasses will give a better view, if they are available, and they will probably be necessary where the Moon is only a few degrees above the horizon at the time of disappearance.

The Moon view and maps like the ones shown here are normally published in *Sky & Telescope*, but other pressing needs, mainly to get detailed 1997 IOTA prediction information to regional coordinators, prevented me from meeting their deadline. A short note about the occultation, and its significance as an event in which the general public can participate, will appear in their May issue, with a reference to our sky.net.. Web site for details (this article, including the charts, will be placed on the Web site shortly after this issue is distributed).

The table below gives the predicted times and circumstances for the occultation at most of the cities whose first (or major) two letters are given on the maps, as well as for Juneau and Anchorage, Alaska. They are effectively a continuation of the tables that end on p. 300 of the last issue, where they are explained. For April 11th, Tacoma, WA (very close to Seattle) has been replaced by Spokane, WA (E. Long. -117°.41, Lat. +47°.67).

Lunar Occultation of 1.1-mag. Aldebaran on 1997 April 11
Disappearance, Moon 17+ % sunlit, Solar elongation 48

Location	Univ. h	T. m	s	Sun Alt	Moon Alt	Az	Cusp Ang	Pos Ang	W. Ang	a m/o	b m/o
Anchorage AK	4	9	14	6	36	234	47N	43	52	+0.9	+0.2
Juneau AK	4	22	10	-4	29	254	49N	46	55	+0.7	-0.3
Vancouver BC	4	34	33		21	271	69N	66	75	+0.5	-0.8
Portland OR	4	38	11		20	273	79N	76	85	+0.4	-1.0
San Francisco CA	4	47	24		18	277	79S	98	107	+0.2	-1.4
Seattle WA	4	36	20		21	272	73N	70	79	+0.4	-0.9
Reno NV	4	45	40		16	278	86S	90	99	+0.2	-1.2
Fresno CA	4	49	10		15	279	78S	98	107	+0.1	-1.3
Los Angeles CA	4	53	1		13	281	71S	105	114	+0.0	-1.5

Location	h	m	s	Sun Alt	Moon Alt	Moon Az	Cusp Ang	Pos Ang	W. Ang	a m/o	b m/o
San Diego CA	4	54	55		11	283	68S	108	117	-0.1	-1.5
Spokane WA	4	38	7		17	276	69N	66	75	+0.3	-0.8
Boise ID	4	42	2		15	279	80N	76	85	+0.2	-0.9
Las Vegas NV	4	50	15		11	282	80S	96	105	+0.0	-1.2
Calgary AB	4	36	50		15	277	57N	54	63	+0.3	-0.6
Edmonton AB	4	35	46		16	277	49N	46	55	+0.4	-0.4
Phoenix AZ	4	53	24		8	285	75S	101	110	-0.1	-1.3
Helena MT	4	40	22		13	281	68N	65	74	+0.2	-0.7
Salt Lake City UT	4	45	23		11	283	84N	81	90	+0.1	-1.0
Flagstaff AZ	4	51	18		8	285	81S	96	105	-0.1	-1.2
Tucson AZ	4	54	52		6	286	72S	104	113	-0.2	-1.3
La Paz Mexico	5	7	21		0	288	45S	131	140	-0.6	-2.0
Albuquerque NM	4	50	46		4	287	85S	92	101	-0.2	-1.0
El Paso TX	4	54	20		2	288	75S	101	110	-0.3	-1.2
Denver CO	4	46	15		5	287	81N	78	87	-0.1	-0.8
Cheyenne WY	4	45	6		6	287	77N	74	83	-0.1	-0.8
Regina SK	4	39	25		9	285	51N	48	57	+0.2	-0.4
Pueblo CO	4	47	26		4	288	85N	81	90	-0.1	-0.9
Pierre SD	4	42	40		4	289	65N	61	70	-0.0	-0.6
Winnipeg MB	4	40	30		4	291	46N	43	52	+0.1	-0.2
Fargo ND	4	41	24		3	291	55N	51	60	-0.0	-0.4

Lunar Occultation of 1.1-mag. Aldebaran on 1997 April 11
Reappearance, Moon 17+ % sunlit, Solar elongation 49

Location	Univ. T. h	m	s	Sun Alt	Moon Alt	Moon Az	Cusp Ang	Pos Ang	W. Ang	a m/o	b m/o
Anchorage AK	4	58	14	0	31	247	-49N	308	317	+0.4	-2.6
Juneau AK	5	9	36	-9	23	265	-50N	307	316	+0.1	-2.5
Vancouver BC	5	29	3		13	281	-66N	291	299	-0.1	-1.8
Portland OR	5	35	17		10	283	-75N	281	290	-0.1	-1.5
San Francisco CA	5	44	40		7	286	-84S	261	270	-0.0	-0.9
Seattle WA	5	31	50		11	282	-70N	287	296	-0.1	-1.7
Reno NV	5	42	42		6	287	-89N	268	277	-0.1	-1.1
Fresno CA	5	45	18		4	287	-84S	260	269	-0.1	-0.8
Los Angeles CA	5	47	00		2	289	-77S	254	263	-0.1	-0.6
San Diego CA	5	47	33		0	289	-74S	251	260	-0.1	-0.4
Spokane WA	5	30	50		8	285	-66N	291	300	-0.3	-1.7
Boise ID	5	36	54		5	288	-75N	281	290	-0.3	-1.4
Las Vegas NV	5	45	00		1	290	-86S	263	271	-0.2	-0.8
Calgary AB	5	23	31		8	286	-55N	302	311	-0.3	-2.0
Edmonton AB	5	17	57		9	285	-47N	309	318	-0.4	-2.3
Helena MT	5	31	0		4	289	-65N	292	301	-0.4	-1.7
Salt Lake City UT	5	39	22		1	291	-79N	277	286	-0.3	-1.2
Regina SK	5	20	38		3	293	-49N	308	317	-0.5	-2.0

Lunar Occultation of 0.3-mag. Saturn on 1997 May 4
Disappearance, Moon 7- % sunlit, Solar elongation 30

Location	Univ. T. h	m	s	Sun Alt	Moon Alt	Moon Az	Cusp Ang	Pos Ang	W. Ang	a m/o	b m/o
Anchorage AK	14	36	5	5	7	95	-48N	21	45	-0.0	+2.1
Juneau AK	14	30	58	11	14	107	-57N	30	54	+0.2	+2.1
Vancouver BC	14	15	22	13	21	110	-74N	48	72	+0.4	+2.0
Portland OR	14	8	11	11	22	108	-81N	54	78	+0.5	+1.9
Tacoma WA	14	11	40	13	22	109	-78N	51	76	+0.5	+2.0
San Francisco CA	13	54	19	7	21	102	-85S	68	92	+0.6	+1.6
Seattle WA	14	12	28	13	22	110	-77N	51	75	+0.5	+2.0
Reno NV	13	58	51	11	24	106	-87S	66	91	+0.6	+1.7
Fresno CA	13	54	24	9	24	104	-82S	72	96	+0.7	+1.6
Los Angeles CA	13	51	30	9	25	103	-75S	78	103	+0.8	+1.4
San Diego CA	13	50	45	10	26	103	-71S	82	107	+0.9	+1.3
Boise ID	14	8	27	16	27	112	-88N	61	86	+0.7	+1.8
Las Vegas NV	13	57	3	13	28	107	-77S	76	101	+0.9	+1.4
Calgary AB	14	23	49	20	27	121	-78N	51	75	+0.6	+1.9
Edmonton AB	14	28	59	21	27	124	-74N	48	72	+0.6	+1.9
Phoenix AZ	13	56	33	15	31	108	-69S	85	109	+1.1	+1.2
Helena MT	14	16	58	20	30	119	-86N	59	84	+0.8	+1.8
Salt Lake City UT	14	7	6	18	31	114	-84S	70	94	+0.9	+1.6
Flagstaff AZ	13	59	8	16	31	110	-72S	81	106	+1.1	+1.3
Tucson AZ	13	56	24	16	32	108	-65S	89	113	+1.2	+1.1
La Paz Mexico	13	53	0	14	34	103	-40S	114	138	+1.7	-0.2
Albuquerque NM	14	4	53	22	36	115	-67S	86	111	+1.3	+1.1
El Paso TX	14	1	59	21	37	112	-59S	95	119	+1.5	+0.8
Denver CO	14	12	54	25	37	121	-76S	78	102	+1.2	+1.4
Cheyenne WY	14	15	8	25	37	123	-78S	75	100	+1.2	+1.4
Regina SK	14	29	57	27	33	132	-86N	59	83	+0.9	+1.7
Pueblo CO	14	11	27	25	37	120	-72S	81	106	+1.3	+1.3
Lubbock TX	14	10	44	27	42	119	-58S	95	120	+1.7	+0.7
Pierre SD	14	25	14	30	39	132	-80S	73	98	+1.3	+1.4
Monterrey Mexico	14	14	47	28	47	114	-27S	127	151	+3.2	-1.8
San Antonio TX	14	16	23	31	47	120	-40S	114	138	+2.5	-0.4
Austin TX	14	17	59	32	48	122	-42S	112	136	+2.4	-0.2
Oklahoma City OK	14	19	55	32	45	127	-57S	96	121	+1.9	+0.7
Brownsville TX	14	24	38	33	51	119	-19S	135	159	+4.5	-3.9
Wichita KS	14	21	58	33	44	130	-63S	91	115	+1.8	+0.9
Winnipeg MB	14	36	48	33	37	141	-87S	66	91	+1.1	+1.4
Dallas TX	14	20	6	33	47	126	-49S	105	130	+2.2	+0.2
Fargo ND	14	33	7	34	40	139	-81S	72	96	+1.3	+1.3
Omaha NE	14	27	43	34	43	135	-69S	84	109	+1.6	+1.0
Tulsa OK	14	23	24	34	46	130	-57S	97	121	+2.0	+0.6
Topeka KS	14	25	59	34	45	134	-64S	90	114	+1.8	+0.9
Houston TX	14	24	31	35	51	126	-35S	119	143	+2.9	-0.9
Kansas City MO	14	28	1	36	46	136	-63S	91	115	+1.8	+0.8
Des Moines IA	14	31	48	37	45	140	-67S	86	111	+1.7	+0.9
Minneapolis MN	14	35	44	37	43	143	-74S	79	104	+1.5	+1.1
Little Rock AR	14	30	41	39	51	136	-47S	107	131	+2.4	-0.0
Duluth MN	14	39	24	38	42	147	-77S	77	101	+1.4	+1.1
Saint Louis MO	14	36	17	41	49	143	-55S	98	123	+2.1	+0.4
Jackson MS	14	37	54	42	55	139	-34S	120	145	+3.2	-1.2
New Orleans LA	14	43	41	44	57	139	-19S	135	159	+5.0	-4.3
Memphis TN	14	36	33	42	52	141	-44S	109	134	+2.6	-0.3
Mobile AL	14	50	54	47	59	146	-15S	138	163	+6.1	-6.2
Milwaukee WI	14	43	2	42	47	152	-64S	90	114	+1.9	+0.6
Chicago IL	14	42	52	43	48	151	-60S	93	118	+2.0	+0.5
Montgomery AL	14	52	25	48	58	151	-21S	132	157	+4.6	-3.7
Indianapolis IN	14	45	31	45	51	153	-53S	101	126	+2.3	+0.1
Louisville KY	14	46	34	46	53	153	-47S	107	131	+2.5	-0.3
Cincinnati OH	14	49	25	47	52	157	-48S	106	130	+2.5	-0.3
Atlanta GA	14	56	10	50	58	157	-24S	130	154	+4.2	-3.1
Knoxville TN	14	53	21	49	56	158	-35S	119	143	+3.2	-1.4
Detroit MI	14	52	31	47	50	162	-55S	98	123	+2.1	+0.1
Cleveland OH	14	55	45	49	51	165	-51S	103	127	+2.3	-0.2
Charleston WV	14	57	39	51	54	165	-40S	114	139	+2.9	-1.0
Sudbury ON	14	57	25	48	47	168	-63S	90	115	+1.8	+0.3
Charlotte NC	15	6	37	55	58	169	-21S	133	157	+4.6	-4.1
Pittsburgh PA	15	0	21	52	53	169	-44S	109	134	+2.6	-0.7
Toronto ON	15	0	24	50	50	171	-54S	100	124	+2.2	-0.2
Buffalo NY	15	1	47	51	51	172	-51S	103	127	+2.3	-0.4
Raleigh NC	15	14	41	57	58	177	-16S	138	162	+5.4	-6.1
Richmond VA	15	12	32	57	56	178	-25S	128	153	+3.8	-3.1
Washington DC	15	10	53	56	55	178	-32S	122	146	+3.2	-2.1
Baltimore MD	15	11	18	56	54	179	-33S	121	145	+3.1	-1.9
Norfolk VA	15	20	33	59	57	184	-16S	138	163	+5.3	-6.4
Dover DE	15	14	58	58	55	183	-29S	124	149	+3.3	-2.5
Philadelphia PA	15	14	30	57	54	183	-33S	121	145	+3.1	-2.0
New York NY	15	16	43	58	53	186	-34S	120	144	+3.0	-2.0
Albany NY	15	14	7	56	51	185	-42S	112	136	+2.5	-1.2
Montreal PQ	15	12	7	54	48	184	-51S	102	127	+2.1	-0.6
Burlington VT	15	13	33	55	49	185	-47S	106	131	+2.3	-0.8
Hartford CT	15	18	21	58	52	189	-36S	118	142	+2.8	-1.8
Manchester NH	15	19	35	58	50	191	-39S	115	139	+2.6	-1.5
Providence RI	15	21	43	59	51	192	-34S	120	144	+2.8	-2.1
Quebec City PQ	15	16	5	55	47	189	-52S	101	126	+2.0	-0.7
Boston MA	15	21	41	59	51	192	-35S	118	143	+2.7	-1.9
Bangor ME	15	23	25	58	48	196	-42S	112	136	+2.3	-1.4
Halifax NS	15	35	58	61	46	208	-33S	121	145	+2.4	-2.5
St Johns NF	15	51	23	58	38	224	-32S	122	146	+1.8	-2.8

Lunar Occultation of 0.3-mag. Saturn on 1997 May 4
Reappearance, Moon 6- % sunlit, Solar elongation 30

Location	Univ. T. h	m	s	Sun Alt	Moon Alt	Moon Az	Cusp Ang	Pos Ang	W. Ang	a m/o	b m/o
Anchorage AK	15	12	28	9	11	103	32N	301	325	+0.4	+1.3
Juneau AK	15	17	18	17	20	117	44N	289	314	+0.7	+1.3
Vancouver BC	15	15	52	23	30	124	65N	268	292	+1.0	+1.3
Portland OR	15	11	19	23	32	122	72N	261	286	+1.1	+1.4
Tacoma WA	15	13	52	23	31	123	69N	264	288	+1.1	+1.3
San Francisco CA	14	59	47	20	34	115	87N	246	271	+1.0	+1.6
Seattle WA	15	14	32	23	31	124	69N	265	289	+1.1	+1.3
Reno NV	15	5	25	23	36	119	86N	247	272	+1.1	+1.6
Fresno CA	15	0	55	22	36	117	88S	242	266	+1.1	+1.7
Los Angeles CA	14	57	34	23	38	115	81S	234	259	+1.0	+1.9
San Diego CA	14	56	17	23	39	115	77S	230	254	+1.0	+2.0
Boise ID	15	15	50	28	37	128	81N	252	276	+1.2	+1.5
Las Vegas NV	15	5	0	27	41	121	82S	236	260	+1.1	+1.8
Calgary AB	15	28	14	30	35	137	70N	263	288	+1.2	+1.2
Edmonton AB	15	31	45	31	34	140	66N	267	291	+1.2	+1.1
Phoenix AZ	15	3	16	29	44	122	73S	226	250	+1.1	+2.1
Helena MT	15	25	12	32	39	137	80N	254	278	+1.3	+1.3
Salt Lake City UT	15	16	52	32	42	131	89S	242	266	+1.3	+1.6

Flagstaff AZ	15	7	17	30	44	125	76S	230	254	+1.2	+2.0
Tucson AZ	15	1	48	30	45	121	68S	221	246	+1.1	+2.2
La Paz Mexico	14	40	22	25	45	110	42S	196	220	+0.5	+3.5
Albuquerque NM	15	12	55	35	48	131	70S	223	247	+1.2	+2.1
El Paso TX	15	5	40	34	49	127	61S	214	238	+1.1	+2.5
Denver CO	15	24	4	38	47	140	78S	232	256	+1.3	+1.8
Cheyenne WY	15	26	46	39	46	143	81S	235	259	+1.3	+1.7
Regina SK	15	39	24	38	40	152	80N	254	278	+1.3	+1.1
Pueblo CO	15	21	56	38	48	139	75S	228	253	+1.3	+1.9
Lubbock TX	15	15	8	40	52	137	59S	212	237	+1.1	+2.5
Pierre SD	15	37	51	43	47	154	83S	237	261	+1.4	+1.4
Monterrey Mexico	14	49	20	36	54	123	25S	179	204	-0.2	+5.2
San Antonio TX	15	5	58	41	56	134	39S	192	217	+0.6	+3.7
Austin TX	15	9	28	43	56	138	40S	194	218	+0.7	+3.5
Oklahoma City OK	15	24	44	45	54	148	57S	211	235	+1.2	+2.5
Brownsville TX	14	49	0	39	56	126	16S	170	195	-1.3	+7.3
Wichita KS	15	30	3	46	53	152	63S	217	241	+1.2	+2.2
Winnipeg MB	15	48	49	44	43	164	88N	245	269	+1.3	+1.0
Dallas TX	15	18	17	45	56	145	48S	201	226	+0.9	+3.0
Fargo ND	15	46	0	45	46	163	85S	238	263	+1.4	+1.2
Omaha NE	15	38	55	47	51	159	71S	224	249	+1.3	+1.8
Tulsa OK	15	28	11	47	55	152	57S	210	235	+1.2	+2.4
Topeka KS	15	34	56	47	53	157	64S	218	242	+1.3	+2.0
Houston TX	15	8	36	45	58	140	33S	186	211	+0.3	+4.2
Kansas City MO	15	36	27	48	53	160	63S	217	241	+1.3	+2.1
Des Moines IA	15	42	32	49	51	164	68S	222	246	+1.3	+1.8
Minneapolis MN	15	48	19	49	48	168	76S	230	254	+1.3	+1.4
Little Rock AR	15	28	19	50	57	158	46S	200	224	+0.9	+3.0
Duluth MN	15	52	14	49	47	172	80S	233	257	+1.3	+1.2
Saint Louis MO	15	40	39	52	55	168	55S	209	233	+1.1	+2.3
Jackson MS	15	21	8	51	59	157	31S	185	209	+0.3	+4.3
New Orleans LA	15	8	21	49	60	149	16S	170	194	-1.4	+7.5
Memphis TN	15	31	30	52	58	163	43S	196	221	+0.8	+3.2
Mobile AL	15	10	49	51	61	155	12S	166	190	-2.4	+9.3
Milwaukee WI	15	52	16	53	51	178	65S	219	243	+1.3	+1.7
Chicago IL	15	50	29	54	52	177	61S	215	239	+1.2	+1.9
Montgomery AL	15	20	48	54	60	164	18S	172	197	-0.9	+6.6
Indianapolis IN	15	47	57	56	54	179	52S	206	230	+1.1	+2.3
Louisville KY	15	44	26	56	55	178	46S	200	224	+0.9	+2.8
Cincinnati OH	15	48	2	57	55	182	47S	201	225	+1.0	+2.6
Atlanta GA	15	28	6	57	60	172	22S	175	200	-0.5	+5.8
Knoxville TN	15	38	26	58	58	178	33S	187	211	+0.4	+3.9
Detroit MI	15	56	50	57	51	187	56S	210	234	+1.1	+2.0
Cleveland OH	15	56	33	58	52	190	51S	205	229	+1.0	+2.2
Charleston WV	15	48	18	60	55	187	39S	193	217	+0.7	+3.2
Sudbury ON	16	5	58	56	47	193	66S	220	244	+1.2	+1.3
Charlotte NC	15	34	53	60	58	182	19S	173	197	-0.8	+6.5
Pittsburgh PA	15	55	41	60	53	192	45S	198	223	+0.9	+2.7
Toronto ON	16	3	20	59	49	195	55S	209	233	+1.1	+1.9
Buffalo NY	16	2	29	59	50	196	52S	206	230	+1.0	+2.1
Raleigh NC	15	36	23	61	58	187	14S	168	193	-1.6	+8.3
Richmond VA	15	46	43	62	55	193	25S	178	203	-0.1	+5.1
Washington DC	15	52	43	62	54	196	32S	185	210	+0.4	+3.9
Baltimore MD	15	54	29	62	53	198	33S	187	211	+0.5	+3.7
Norfolk VA	15	41	54	63	56	194	15S	169	193	-1.5	+8.3
Dover DE	15	54	18	63	53	199	30S	183	208	+0.3	+4.2
Philadelphia PA	15	57	44	63	52	201	33S	187	212	+0.5	+3.6
New York NY	16	0	56	63	51	204	35S	189	213	+0.5	+3.4
Albany NY	16	6	38	62	48	205	44S	197	222	+0.8	+2.5
Montreal PQ	16	12	39	60	45	206	54S	208	232	+1.0	+1.7
Burlington VT	16	11	9	60	46	207	50S	204	228	+0.9	+2.0
Hartford CT	16	4	59	63	49	206	38S	191	216	+0.6	+3.1
Manchester NH	16	9	18	62	47	209	41S	195	219	+0.7	+2.6
Providence RI	16	5	56	63	48	209	36S	189	214	+0.6	+3.2
Quebec City PQ	16	16	59	59	43	210	56S	210	234	+1.0	+1.5
Boston MA	16	7	43	63	48	209	38S	191	216	+0.6	+3.0
Bangor ME	16	15	42	61	44	214	45S	199	223	+0.8	+2.2
Halifax NS	16	19	0	61	42	221	38S	191	216	+0.6	+2.8
St Johns NF	16	32	26	56	32	235	40S	194	218	+0.6	+2.1

Lunar Occultation of 1.1-mag. Aldebaran on 1997 May 8
Disappearance, Moon 4+ % sunlit, Solar elongation 22

Location	Univ. T. h	m	s	Sun Alt	Moon Alt	Moon Az	Cusp Ang	Pos Ang	W. Ang	a m/o	b m/o
Albany NY	12	0	23	24	7	74	48N	54	63	-0.4	+1.8
Montreal PQ	12	5	34	25	8	75	42N	48	57	-0.4	+1.9
Burlington VT	12	3	30	25	8	75	45N	51	60	-0.3	+1.9
Hartford CT	11	58	26	24	7	74	51N	57	66	-0.3	+1.7
Manchester NH	12	0	13	26	8	75	50N	55	64	-0.3	+1.8
Providence RI	11	58	7	25	8	75	52N	58	67	-0.3	+1.7
Quebec City PQ	12	7	21	27	11	77	42N	47	56	-0.3	+2.0
Boston MA	11	58	54	26	8	75	51N	57	66	-0.3	+1.7
Bangor ME	12	2	45	28	11	78	48N	53	62	-0.2	+1.9
Hamilton Bermuda	11	43	20	27	7	75	79N	85	94	-0.1	+1.1
Halifax NS	12	1	31	32	14	81	52N	58	67	-0.1	+1.9
St Johns NF	12	7	14	39	23	91	55N	61	70	+0.2	+1.9

Lunar Occultation of 1.1-mag. Aldebaran on 1997 May 8
Reappearance, Moon 4+ % sunlit, Solar elongation 23

Location	Univ. T. h	m	s	Sun Alt	Moon Alt	Moon Az	Cusp Ang	Pos Ang	W. Ang	a m/o	b m/o
Detroit MI	12	49	3	26	9	75	-76N	289	298	+0.1	+0.8
Cleveland OH	12	48	22	27	9	76	-79N	286	295	+0.1	+0.9
Charleston WV	12	45	34	27	8	75	-86N	279	288	-0.0	+0.9
Sudbury ON	12	52	36	28	12	78	-68N	297	306	+0.2	+0.8
Pittsburgh PA	12	47	33	28	10	77	-83N	282	291	+0.1	+0.9
Toronto ON	12	50	31	29	12	78	-76N	289	298	+0.2	+0.9
Buffalo NY	12	49	56	29	12	78	-78N	287	296	+0.2	+0.9
Raleigh NC	12	43	3	28	9	76	-85S	270	279	-0.0	+1.0
Richmond VA	12	44	54	30	11	77	-88S	273	282	+0.1	+1.0
Washington DC	12	46	17	30	12	78	-89N	276	285	+0.1	+1.0
Baltimore MD	12	46	46	31	12	79	-88N	277	286	+0.1	+1.0
Norfolk VA	12	44	18	31	12	78	-86S	271	280	+0.1	+1.1
Dover DE	12	46	45	32	13	79	-90N	276	284	+0.1	+1.0
Philadelphia PA	12	47	41	32	14	80	-88N	277	286	+0.2	+1.0
New York NY	12	48	40	33	15	81	-88N	278	287	+0.2	+1.0
Albany NY	12	50	41	33	16	82	-83N	282	291	+0.2	+1.0
Montreal PQ	12	53	36	34	17	83	-77N	288	297	+0.3	+1.0
Burlington VT	12	52	41	34	17	83	-80N	286	294	+0.3	+1.0
Hartford CT	12	50	2	34	16	82	-86N	279	288	+0.3	+1.1
Manchester NH	12	51	41	35	18	84	-85N	281	290	+0.3	+1.1
Providence RI	12	50	26	35	17	83	-87N	278	287	+0.3	+1.1
Quebec City PQ	12	55	42	35	19	86	-76N	289	298	+0.4	+1.0
Boston MA	12	51	4	35	18	83	-86N	279	288	+0.3	+1.1
Bangor ME	12	54	32	37	20	86	-83N	282	291	+0.4	+1.1
San Juan PR	12	13	33	31	9	76	-22S	206	215	-0.6	+2.7
Hamilton Bermuda	12	39	48	39	19	82	-64S	249	258	+0.2	+1.5
Halifax NS	12	56	43	41	24	90	-88N	277	286	+0.5	+1.2
St Johns NF	13	7	25	48	33	102	-89S	274	283	+0.8	+1.3

Videotaping Grazes with Hand-held Camcorders

David W. Dunham

My experience with the January 19th grazing occultation of Aldebaran shows that anyone with a telescope and a camcorder can video record grazes of relatively bright stars. Many amateur astronomers now have camcorders, perhaps even more than those who have audio tape recorders, and they should be encouraged to video record good grazes in their area. Unfortunately, nearly all camcorders, including mine, do not have removable lenses or a proper front-end for connection to a C-mount or other telescope adaptor. But they can be held up to an eyepiece, and for a bright source like the Moon, a blurry blob of light can be located in the viewer without too much difficulty. Then, the image must be brought into focus, which with ordinary scenes is easiest in the widest-field mode. I found this usually doesn't work; instead, once the blob of light is in view, zoom in on it. That quickly brought craters into view on January 19th, and then the image could easily be kept in focus. Although it's better to use a video camera connected directly to the telescope when possible, the hand-held camcorder technique is easier to set up and available to many more observers. It also has an advantage that if any troubles develop with the video and the star can't be reliably imaged, the camcorder can just be set down, still running to act as an audio recorder, and the observer can quickly put his or her eye to the telescope eyepiece and call out the events visually.

I didn't understand this technique last September 26-27th, when I wanted to video record the graze of 6.1-mag. Z.C. 35 during the total lunar eclipse. I had with me my image intensifier and black-and-white Panasonic camera, my usual system for occultations, and planned to use my camcorder only in VCR-mode as a recording system. But after setting up and getting the Moon in view, I discovered that I had left behind a critical component needed for audio, and without that, no timings. So I took the camera off, put in an eyepiece, and observed the graze visually, using a backup portable tape recorder for timings (I could have used the camcorder as an audio recorder, but didn't think of that at the time). After the graze, I put the camcorder up to the eyepiece of the C-8 (loaned to me by Steve Edberg), and after some difficulty, was able to video record the red eclipsed Moon and Z.C. 35. Many camcorders have good dynamic range and are rather sensitive, so I believe that they could be used to record grazes of 5th and maybe 6th-mag. stars on the dark limb of the crescent or quarter-phase Moon. Hand-held camcorders might not be so useful for recording total occultations well on the dark side of the Moon, since the lunar cusp serves as a good reference for the camcorder's focus during a graze, but maybe some experimenting will show some success for such total occultations as well (focus first on the Moon, then move over to the star, more difficult for reappearances).

The Aldebaran graze on Jan. 19th was featured on the front cover of the last issue. In New England, it was 12° from the south cusp on the sunlit side of the 82% sunlit waxing Moon. My regular video system using my black-and-white Panasonic camera is optimized for recording faint stars. It is useless for bright-limb events due to blooming and its limited dynamic range. Besides, I wanted to record the graze in color, to show Aldebaran's orange color relative to the Moon. So I planned to use my camcorder with my 5-inch Celestron telescope (no need to use my C-8 with a star that bright), and would just hold it with my hands to the eyepiece, since I could not connect it to the telescope directly. This also vastly simplifies my usual setup since there are no cables to connect. But when I set up the telescope, I discovered that I had left with my C-8 at home the screws to connect the equatorial wedge to the tripod. I ended up resting the telescope base on its Anvil metal case and used it in alt-az mode. Since my hands held the camcorder, I could not track the Moon. I knew approximately when the graze events would occur, so I watched the Moon drift across the field, and set Aldebaran where it would have a maximum track (a little less than 2 minutes) across the field about a minute before the first disappearance. After recording the disappearance and making sure that it did not reappear against the steep mountain on the profile, I set the camcorder (still running) down and adjusted the telescope as the star was behind the large mountain near the time of central graze. When I sighted the Moon again in the camcorder viewfinder, Aldebaran had already reappeared; the first reappearance had occurred a little earlier than I expected, because my location was about half a km south of where I had planned to be, as careful measurements showed later. Then I recorded 3 disappearances and 3 reappearances as the star passed over the last large mountain ridge on the profile. This was in Acton, Massachusetts, about 50 km northwest of Boston and about 725 km by highway from my home in Maryland; the temperature was about -18° C. It's not the most spectacular graze that I have video recorded, but it's my first video of one well on the bright limb, and as far as I know, it is the first video ever of a graze of Aldebaran. So it was well worth the long trip; there is only one other possibility for a graze of Aldebaran under conditions this good or better during the rest of the series (on 1998 Sept. 12) within 725 km of my home, according to the map on p. 293 of the last issue. Wayne Warren shared the travel with me and also tried to video record the graze at a site nearby. He didn't know what I was then learning, failed to focus on the Moon and the star, and set his camcorder down to audibly record his visual observations. He saw the first reappearance that I missed, but discovered afterward that his camcorder stopped soon after he had set it down. I learned later from expedition leader Phil Dombrowski that the graze was timed from two other stations in Acton, but being higher on the profile, they had fewer events. Claudio Veliz timed the graze from a site in Vermont, and John Leppert observed but was unable to time the graze in North Dakota in unseasonably warm temperatures, near freezing, for that time of year. Guy Nason reports that six stations out of nine deployed near Toronto, Ontario, successfully timed the graze; the failures at three stations were caused by the bitter cold (-26° C and windy). As far as I know, this was the first graze observed during the current series of Aldebaran occultations. The first impression was that the observations were in relatively good agreement with the ACLPPP profile, which in this case was similar as well to the GRAZEREG profile in this well-charted part of the Moon far from the Cassini region; there may have been about a 0.″1 south shift, but not more than that. ι

1997 Planetary, Cometary, and Asteroidal Occultations

David W. Dunham and Edwin Goffin

Predictions for occultations of stars by asteroids, comets, and major planets during March, April, and May are given in the tables below. Data to compute appulse local circumstance predictions for these events for all of 1997 were distributed to the graze computors at the beginning of January, and they should have distributed these "LOCM97" predictions to IOTA members later that month. As noted in IOTA News, there should have been a new distribution of these predictions in late February after more information was added to the input data, but except for some components of double stars, the events with these new predictions will be almost the same as the ones distributed earlier.

The predictions are in virtually the same format as those for 1994. However, now all events predicted by Goffin are included, rather than just those using the IOTA criteria described in *ON* vol. 6, no. 4 (Sept. 1994), p. 76. This is because the basic stellar and asteroidal/cometary/planetary ephemeris data have been supplied to IOTA in ASCII files transmitted by e-mail, saving Dunham considerable work. Changes in the 1995 to 1997 predictions from those published in 1994 include use of the H and

G magnitude parameters; a problem with interpolation near R.A. 0^h or 24^h has been corrected; and there are other changes (in the star catalog codes and IOTA selection). The star catalog codes are described in *ON* vol. 6, no. 4, pp. 84 and 85, but some new codes needed to be added for the 1997 predictions:

V: Very accurate, from the Hipparcos output catalog, accuracy a few milliarcseconds at the current epoch. This catalog will become available in the middle of 1997, and will be used to update the predictions for only a few events involving mainly the brighter stars that will occur late in the year.

6: Tycho catalog, a less precise product of the Hipparcos mission, including about a million stars. The accuracy is still better than any other ground-based catalog, generally of the order of 0″.02 at current epochs. These will also be released in the middle of 1997, and will be used to update the predictions of occultations that will occur late in the year.

8: The U. S. Naval Observatory's Twin Astrographic Catalog (TAC) with positions claimed to be accurate to about 0″.15 at current epochs. The coverage is rather complete to 11th mag., with a density about 3 times that of the PPM. Currently, it is available for the northern hemisphere, but will soon be extended to declination -18°, and farther south later in 1997. One test of a TAC position has been made, for the February 10th occultation of a 10th-mag. GSC star by (451) Patientia. According to 6 accurate recent observations of the star with the Carlsberg Automated Meridian Circle, giving a position that should be accurate to less than 0″.10, the TAC position was 0″.65 in error in declination, much worse than the claimed accuracy but still better than the GSC 1.1 positions that have an accuracy of about 1″.

9: Guide Star Catalog version 1.2 (GSC 1.2), a new PPM-based reduction of the GSC performed at the Astronomisches Rechen Institut in Heidelberg, Germany, and available for specified fields from a Web site maintained by the Space Telescope Science Institute. The accuracy, currently about 0″.3, is much better than GSC 1.1.

Stellar SAO numbers and spectral types were not suppled by Goffin. They have been inserted automatically from software written by Dunham that obtains this information from the PPM catalog, and he also added the asteroid types and B-V magnitudes from a program that reads the Jet Propulsion Laboratory's Dastcom3 file of asteroidal and cometary orbital elements and physical information. Comparison stellar data are no longer given, so those columns have been removed from Table 2. The ephemeris source has been moved from Table 1 to Table 2 to make them more nearly equal in size and fit better on the pages of *ON*.

An asterisk (*) appears between the date and U.T. hour in Table 1 and between the asteroid number and name in Table 2 if the event meets the IOTA criteria. Observers are encouraged to monitor the * events that occur under reasonable conditions at their location, especially those events with predicted closest approach distances less than 1″.2; they are IOTA's priority events for which astrometric updates might be obtained (and would be most effective). Although the nominal predictions for recent events have been rather better than in the past, thanks mainly to the improved PPM positions and to updated orbital elements for many asteroids, you should monitor these events even if the expected path is several hundred kilometers away, since there can still be astrometric error for the main event and secondary occultations by an asteroidal satellite is possible. To independently confirm observations of the latter, observers are encouraged to watch from two stations about a km apart.

Edwin Goffin's charts have been distributed to North American observers only for those events meeting the IOTA criteria, and for all events involving major planets, which are asterisked only if the occulted star is brighter than mag. 8.5. B1950 and J2000 positions of the non-asterisked stars were given in a table that was distributed to IOTA members for which we have station data along with the first LOCM97 predictions, and this table is also on IOTA's asteroidal occultation Web site at **http://www.anomalies.com/iota/splash.htm.** A few of the occultations were not in E. Goffin's coverage, but were found by Isao Sato in Japan; he provided charts to Dunham for North American events. Three of these have been included here, using ephemeris data generated by Dunham and the star positions supplied by Sato and converted to B1950 for Dunham's software. Charts for these events for the 1997 Planetary Occultation Supplement for North American observers distributed with the last *ON* were prepared by Richard Wilds using the printed data and World map from Sato, and star charts produced with the Guide 5.0 software. The world map shows the sunrise/sunset terminator, the nautical twilight (Sun alt. -12 deg.) curve, and the moonrise/moonset curve. A symbol shows the Moon approximately over the point where the Moon is in the zenith, so you can tell on which side of the moonrise/moonset curve the Moon is above the horizon; the symbol also indicates the percent of the Moon that is sunlit. David Werner has annotated the star charts in the same way that he has done for E. Goffin's charts.

Note that the positions of all of the GSC stars, and of the PPM star occulted by 1994 JR1 in July, are all incorrect as given in the upper right corner of the original charts by Edwin Goffin. The position given there is of the asteroid at the end of its plotted track, not the position of the star. The correct positions are in the file of stellar positions that was distributed to observers receiving the LOCM97 predictions, and some coordinators (but not all) have written in the correct position for the star on the charts that were distributed, including those in the 1997 North American Supplement. The detailed charts at the bottom show properly the star, and the R.A. and Dec. grid, so fortunately there is no error with them.

If you see any strange message in your local circumstance appulse (LOCM97) predictions or the data for an event seem to be grossly in error, please let me know. Some of the events use updated orbital or stellar information, so the distance given in your predictions might not agree with the charts for 1997 that have been distributed. Usually, the differences are small and not noticeable. You can tell if an orbit has been updated by comparing the ephemeris source listed in Table 1 with that given on your chart. If there are significant differences when the ephemeris source is

Table 1. Occultations of stars by major and minor planets during 1997 March, April, and May

1997 Date	Universal Time h m m	PLANET Name	m_v	d,AU	STAR SAO No	m_v	Sp	R.A.(1950) h m	Dec. ° '	Occultation dm	dur s	df	P	Possible Path Lo1La1 ° °	LoMLaM ° °	LoELaE ° °	El Sun °	MOON El °	%Snl	up °
Mar 1	8 42-43	Circe	14.3	3.453		11.5	M	19 44.6	-16 43	2.9	3	10	42	-80-40	-71-42	-59-44	45	61	63-	all
Mar 1	20 23-29	Hypatia	14.0	2.964		9.5		16 34.7	-12 12	4.5	10	21	28	70 20	104 19	139 27	92	14	58-	all
Mar 2*	20 42-45	Interamnia	11.7	2.827		10.1		3 56.5	25 53	1.9	15	14	12	-31 57	7 45	39 29	81	149	47-	none
Mar 3	21 32-35	Hale-Bopp	-3.9	1.448	71556	11.0	K0	21 36.7	35 16	0.0	2	4	21	113 15	-33 77	-17 61	46	60	35-	e 36W
Mar 5	11 8-22	Psyche	10.4	2.227		11.5		10 46.4	8 45	0.3	18	21	12	-93-19	-164 10	111 30	175	133	18-	e125W
Mar 5	22 35-52	Astarte	15.5	1.875		9.0		14 45.9	-26 40	6.5	4	33	80	62 51	76 6	95-38	117	82	14-	e 70E
Mar 6	7 48-70	Angelina	10.5	1.399		8.9	G5	10 18.9	9 20	1.9	7	26	34	-45 0	-115 24	155 39	168	152	11-	e 62W
Mar 6*	10 23-34	Comet SW-1	16.9	5.336		11.2		11 59.1	-8 57	5.7	4	27	129	-71 12	-134 20	152 41	160	130	10-	e100W
Mar 12	0 58-65	Thusnelda	14.3	2.278	95016	9.4	K5	5 53.8	11 2	4.9	3	22	77	-89-38	-56-25	-22-22	97	58	11+	w 63W
Mar 12	12 59-64	Tanete	14.1	2.953	39911	9.6	A0	4 55.5	40 12	4.5	8	22	35	89 58	134 45	164 24	86	52	15+	w123E
Mar 12	23 8-23	Iris	10.0	2.002		11.0		13 42.8	-18 3	0.4	24	34	14	95 23	48 29	-1 48	141	155	19+	none
Mar 12	23 20-21	Juno	9.6	2.364		11.5		3 12.8	6 39	0.2	7	8	12	-67 38	-52 39	-33 39	57	8	19+	all
Mar 13*	2 9-31	Egeria	10.6	1.636		10.1	F5	14 7.0	0-14	1.0	34	40	11	46-36	-12-35	-72-34	141	166	20+	w 72W
Mar 14*	11 19-19	Hygiea	11.9	4.234	92654	8.5	G0	1 47.4	14 6	3.4	11	11	14	111 50	122 49	138 47	37	40	33+	all
Mar 14*	13 5- 7	Hale-Bopp	-4.1	1.341	52542	10.4		22 55.8	42 28	0.0	1	3	19	-142 41	-154 66	146 57	46	84	34+	w147E
Mar 15*	22 37-39	Irene	11.2	2.371		10.0		18 25.8	-21 2	1.5	7	13	22	72 42	86 36	104 31	79	156	49+	none
Mar 16	8 57-60	Eurykleia	14.7	2.939	186690	9.2	K0	18 18.1	-29 53	5.5	4	16	48	-105 9	-82 -4	-52-16	81	150	53+	none
Mar 17	10 53-94	Ellicott	15.8	2.669	116073	9.1	G5	7 50.5	8 19	6.8	12	64	62	147-71	146 3	-145 67	121	16	65+	w155W
Mar 17	13 38-57	Victorplat	15.4	2.194	117590	6.6	A5	9 17.2	5 26	8.8	4	36	103	-156 13	146 31	71 55	142	35	66+	w174E
Mar 19	15 44-51	Medea	14.4	3.279	185773	9.5	F0	17 45.0	-27 26	5.0	10	25	34	129 -9	161-26	-157-38	92	130	83+	w167E
Mar 20	7 20-20	Polyxo	13.5	2.954		9.3		19 50.9	-17 3	4.3	5	11	29	-34 53	-33 53	-30 53	63	154	88+	none
Mar 21*	8 10-23	Campania	12.8	1.854	138801	8.4	F5	12 25.4	-7 17	4.4	7	21	29	-38 6	-96 24	-169 62	170	37	93+	w 60W
Mar 22	21 51-60	Hebe	9.8	1.888		11.9		11 16.3	17 31	0.2	14	21	15	103 21	70 45	22 78	158	17	99+	all
Mar 23	3 57-66	Tjilaki	15.0	1.825		9.3		16 47.4	-10 35	5.7	4	25	68	-59 27	-24 38	6 67	110	81	99+	all
Mar 24	18 33-45	Libussa	13.8	2.572		10.0		16 20.5	-21 47	3.9	14	86	70	157 53	157 35	161 14	116	59	100-	all
Mar 24	21 0-15	Hermentari	11.7	2.088		12.3		11 14.3	18 26	0.5	9	24	28	109 6	51 30	-29 42	155	28	100-	all
Mar 25	19 50-65	Miriam	14.2	2.305		9.8	G5	13 49.8	-12 23	4.4	7	25	39	144 -6	85 10	21 41	155	14	98-	all
Mar 26*	15 19-22	Herculina	10.9	2.648	162370	7.5	K0	19 12.6	-16 11	3.5	10	14	18	146-28	176-36	-144-41	78	77	95-	all
Mar 29	21 45-49	Egeria	10.2	1.543		11.6		13 54.7	0 -9	0.3	20	23	10	79 71	46 71	9 72	159	45	70-	all
Mar 30	3 23-39	Campania	12.7	1.849		9.6		12 18.4	-6 15	3.2	7	21	29	29-40	-57-14	-133 21	176	73	68-	e 73W
Apr 1	5 49-55	Anacostia	12.9	2.286	204595	9.5	F0	13 30.8	-33 15	3.4	7	24	37	-35 38	-64 33	-92 45	149	85	44-	e 80W
Apr 1	8 27-40	Melpomene	10.5	1.808		11.7		11 5.8	12 18	0.3	14	25	18	-70 9	-114 33	-179 65	151	122	42-	e118W
Apr 2	19 2- 7	Klytia	12.5	1.739		11.6	G	12 50.5	-5 53	1.3	4	22	56	139 49	112 56	83 71	178	117	26-	e102E
Apr 4	23 40-42	Elisabetha	14.4	2.667		10.0	F2	6 34.7	26 28	4.4	5	17	42	-53 60	-19 53	8 41	83	114	8-	none
Apr 5	17 17-24	Selinur	13.6	2.004		9.7		12 39.2	-20 7	3.9	3	20	65	158 32	119 36	83 59	165	153	4-	none
Apr 6*	0 1-27	Sibylla	13.7	2.853	117780	8.6	G0	9 32.2	9 54	5.1	40	88	27	-53-70	-66-35	-88 -3	126	146	3-	none
Apr 6	11 7-17	Comet SW-1	16.9	5.319		11.6		11 45.8	-7 48	5.3	3	26	129	-109 10	-166 22	127 50	162	170	1-	none
Apr 7	8 42-45	Pallas	10.3	3.361		11.0		19 41.9	12 20	0.5	24	16	9	-101-23	-75 -8	-51 11	79	80	0-	none
Apr 7*	9 44-49	Irene	11.0	2.125		10.0		18 52.4	-21 23	1.4	11	20	20	-122 27	-95 16	-67 9	95	92	0+	none
Apr 7*	22 54-74	Clorinde	14.8	1.626	140751	6.2	K0	15 44.1	-5 58	8.5	6	36	59	101 0	65 32	16 74	140	147	1+	none
Apr 8	1 36-57	Hebe	10.2	2.006		11.1		11 5.2	18 58	0.4	22	33	16	15-20	-38 7	-103 28	141	138	1+	none
Apr 8	6 10-33	Deborah	14.5	1.932	137784	8.4	K0	10 44.8	-1 28	6.1	8	35	48	-48-35	-116-11	-176 25	145	133	1+	w176W
Apr 8*	18 45-60	Helio	13.6	2.496	223916	9.5	A3	13 4.8	-40 30	4.1	11	22	25	164-29	77-32	18 19	147	136	3+	none
Apr 9	4 9	Nike	16.1	3.067		10.0		19 8.3	-21 4	6.1	4	25	77	U.K.-low,Denmark-dawn			93	112	5+	none
Apr 10	10 59-82	Lydia	12.1	1.928		9.3	G5	15 24.1	-16 20	2.9	12	36	31	-83 9	-143 8	153 24	147	162	12+	none
Apr 12*	16 29-36	Nemausa	12.0	2.022	162259	9.4	K2	19 6.8	-10 58	2.7	9	18	21	115-19	155-18	-166 -6	95	160	32+	none
Apr 14	0 28-30	Aemilia	13.5	2.617	79563	9.4	G0	7 35.3	21 35	4.1	7	18	29	-62 60	-28 51	0 40	89	23	46+	w 13W
Apr 14	5 60-66	Erigone	15.1	2.641	162924	8.9	K0	19 40.2	-16 40	6.2	5	21	50	-82-21	-45-26	-5-22	90	163	48+	none
Apr 15	6 6-19	Egeria	10.0	1.520		11.8	F	13 37.7	0-14	0.2	17	19	10	-20 33	-93 29	-167 27	171	82	58+	w 83W
Apr 16*	0 26-32	Bamberga	12.4	2.751	79765	8.8	F8	7 49.8	23 38	3.7	14	20	17	-80 31	-49 12	-18 -7	90	27	65+	all
Apr 17*	16 24-29	Pallas	10.3	3.251		10.3		19 48.2	13 50	0.8	28	19	9	127 0	152 22	167 56	86	144	79+	w148E
Apr 18*	21 51-85	Juewa	11.6	1.572		9.6	F5	10 20.3	12 45	2.2	30	46	14	-7 64	-10 2	16-59	124	16	87+	all
Apr 22	3 14-20	Pallas	10.2	3.203		11.8		19 50.4	14 28	0.2	30	20	9	-32-16	-5 6	14 40	89	95	99+	all
Apr 22	23 41-53	Turandot	14.3	2.256	161438	9.2	K0	18 21.7	-14 48	5.1	16	54	37	6 40	33 42	60 53	117	64	99-	all
Apr 24	1 41-46	Pallas	10.2	3.182		11.1		19 51.2	14 45	0.4	31	21	9	1-40	29-16	49 13	90	72	97-	all
Apr 25	3 28-35	Egeria	10.2	1.543		11.9	F	13 27.1	0-28	0.2	18	20	10	(Iceland,n.Canada)?s			164	39	93-	all
Apr 25*	23 11-12	Kalliope	11.9	3.118	58797	8.9	F5	6 6.0	31 45	3.1	6	10	24	-47 51	-28 42	-11 31	57	143	88-	e 40W
Apr 29*	6 41-53	Kleopatra	12.2	2.497		11.7		13 50.1	-12 15	1.1	8	19	26	-29-20	-100 -3	-168 37	172	91	56-	e110W
Apr 29*	6 46-55	Kleopatra	12.2	2.497		11.7		13 50.1	-12 15	1.0	8	19	26	-36 8	-87 22	-139 59	172	91	56-	e111W
Apr 29	12 3-20	Egeria	10.3	1.561		11.3	F	13 22.7	0-36	0.4	19	21	11	-119 6	167 -2	91-12	159	101	54-	e171E
Apr 29	14 53-72	Anahita	11.7	1.343		13.9		13 34.0	-12 47	0.1	5	21	37	-156-36	122-24	57 7	167	100	52-	e130E
Apr 29*	22 17-35	Juewa	11.8	1.686	99111	7.7	K0	10 22.8	11 25	4.2	20	32	15	-23 59	-1 14	36-20	114	150	49-	e 22E
Apr 30	19 13-19	Marlu	14.7	2.096		9.2		20 43.1	-39 15	5.5	4	16	41	87 0	118-22	160-36	97	40	39-	all
May 2	8 9-14	Asia	12.2	1.683		9.9		20 33.7	-11 34	2.5	3	13	41	-117-22	-78-22	-41-12	93	35	24-	e 89W
May 2*	9 2-13	Eunike	12.5	2.167	122258	8.1	A2	17 15.9	9 34	4.4	16	28	19	(Venez.,neUSA,ON)?s 16			133	84	23-	all
May 2*	9 1-17	Aletheia	11.7	1.834		9.7	A	15 21.4	-7 17	2.2	17	24	14	-43-38	-129-39	148-28	166	112	23-	e104W
May 4	6 14-32	Clorinde	14.3	1.511	140556	9.6	G8	15 25.7	-3 20	4.7	4	22	55	-3-34	-89-17	-168 4	164	137	9-	e 38W
May 5	22 4-10	Bavaria	15.0	2.269	163904	9.3	F8	20 46.3	-14 40	5.7	4	19	60	30-30	71-34	115-28	95	80	3-	e104E
May 5	23 49-59	Pallas	10.1	3.055		11.1		19 55.0	16 27	0.4	39	25	8	(wAfrica,wEurope,UK)?e			98	94	3-	none
May 6*	11 29-45	Hispania	12.0	1.920		10.2		14 19.1	-34 58	2.0	13	21	17	-93-18	-178-41	100 -8	160	145	2-	none
May 8	6 50-52	Flora	10.9	2.253		11.7		22 42.6	-10 21	0.4	5	10	23	-66 -8	-47 -9	-23 -7	69	84	5+	none
May 10	16 9-11	Ino	13.6	3.165		10.0	G	7 46.4	17 56	3.7	6	12	29	42 20	63 16	86 9	66	26	20+	w 76E
May 10	16 30-46	Charis	14.0	1.892	140487	9.2	G0	15 19.4	-8 4	4.8	5	23	47	-161-35	108-26	29 -3	170	132	20+	w 69E
May 10	19 37-56	Vinifera	14.6	1.766		9.4		12 39.3	-36 56	5.2	5	25	49	131-32	40-38	-16 15	142	90	21+	w 24E

Table 2. Occultations of stars by major and minor planets during 1997 March, April, and May

1997 Date	MINOR PLANET No.	Name	km-Diam.	-//	RSOI km	Type	Motion o/day	P.A. °	STAR SAO No	DM/ID No	D	Min. Geocentric U.T. h m	Sep. "	S	Apparent R.A. h m	Dec. ° '	Ephem. Source
Mar 1	34	Circe	118	0.05	470	C	0.361	77.9		L5 1134		8 44.7	1.11S	H	19 47.2	-16 36	MPC22200
Mar 2	704*	Interamnia	333	0.16	2224	F	0.268	97.1		18171721		20 41.3	1.73N	J	3 59.3	26 1	Goffin92
Mar 3	9701	Hale-Bopp	100	0.10	134		1.459	58.8		M 86840		21 33.5	3.98N	M	21 38.7	35 28	Goffin97
Mar 5	16	Psyche	264	0.16	1778	M	0.213	295.5		08460411		11 15.0	0.25N	J	10 48.9	8 30	MPC24219
Mar 5	672	Astarte	34	0.02	64		0.142	158.9		M 263418		22 47.7	0.82N	M	14 48.7	-26 52	MPC14758
Mar 6	64	Angelina	60	0.06	142	E	0.216	289.2		M 156746		7 59.2	1.98N	M	10 21.4	9 5	MPC25033
Mar 6	9925*	Comet SW-1	60	0.02	376		0.106	285.0		55181025		10 28.5	0.83N	J	12 1.5	-9 13	Goffin94
Mar 12	219	Thusnelda	43	0.03	94	S	0.199	68.1		M 121619		0 59.4	2.81S	M	5 56.4	11 2	MPC15528
Mar 12	772	Tanete	123	0.06	536	C	0.169	86.3		M 47560		12 57.2	0.95N	M	4 58.8	40 17	MPC13146
Mar 12	7	Iris	203	0.14	1059	S	0.138	283.5		61270738		23 15.0	3.17N	J	13 45.4	-18 17	MPC24084
Mar 12	3	Juno	284	0.17	1231	S	0.536	71.3		00620916		23 18.1	1.28N	J	3 15.3	6 50	Goffin95
Mar 13	13*	Egeria	215	0.18	1009	G	0.128	271.4		M 179237		2 17.8	3.13S	M	14 9.5	0-29	Goffin96
Mar 14	10*	Hygiea	429	0.14	3993	C	0.302	71.1	92654	M 117712	A	11 16.6	0.96N	L	1 49.9	14 20	MPC24219
Mar 14	9701*	Hale-Bopp	100	0.10	125		1.702	71.3		M 63645		13 6.0	5.89N	T	22 57.9	42 43	Yeoman48
Mar 15	14*	Irene	155	0.09	593	S	0.322	92.6		M 734054		22 40.0	2.83N	M	18 28.6	-21 0	MPC24219
Mar 16	195	Eurykleia	89	0.04	320	C	0.239	97.3		M 268286		9 2.1	0.49N	M	18 21.2	-29 51	Goffin96
Mar 17	2196	Ellicott	62	0.03	207	CFXU	0.063	10.0		M 153505		11 13.6	0.70E	L	7 53.1	8 11	MPC24550
Mar 17	3237	Victorplat	31	0.02	68		0.122	292.8	117590	F5S 2740		13 48.8	2.29N	2	9 19.7	5 13	MPC25517
Mar 19	212	Medea	140	0.06	737	DCX:	0.143	96.4		M 267322		15 51.7	0.58S	M	17 47.9	-27 27	MPC25033
Mar 20	308	Polyxo	148	0.07	614	T	0.357	76.9		M 236651		7 21.1	2.87N	M	19 53.6	-16 55	Goffin94
Mar 21	377*	Campania	94	0.07	334	PD	0.225	300.4	138801	M 195523		8 16.2	2.88N	M	12 27.9	-7 33	Goffin96
Mar 22	6	Hebe	186	0.14	927	S	0.226	301.9		14371538		21 56.0	3.50N	J	11 18.8	17 15	MPC24219
Mar 23	732	Tjilaki	39	0.03	74		0.190	60.3		M 232217		4 1.7	4.14N	M	16 50.0	-10 40	Goffin96
Mar 24	264	Libussa	53	0.03	156	S	0.047	153.1		M 265475		18 55.9	1.85N	M	16 23.3	-21 53	Goffin92
Mar 24	346	Hermentari	110	0.07	449	S	0.185	286.9		CR0 8109		21 8.6	1.34N	T	11 16.8	18 11	Goffin92
Mar 25	102	Miriam	86	0.05	332	P	0.175	295.7		M 227957		19 56.6	1.37N	M	13 52.3	-12 37	MPC25186
Mar 26	532*	Herculina	217	0.11	1082	S	0.277	88.9	162370	M 235721		15 23.4	1.47S	M	19 15.3	-16 6	Goffin88
Mar 29	13	Egeria	215	0.19	1016	G	0.233	270.9		49680307		21 46.3	5.41N	J	13 57.1	0-25	Goffin96
Mar 30	377	Campania	94	0.07	334	PD	0.231	301.8		M 195395		3 30.7	0.68S	M	12 20.9	-6 31	Goffin96
Apr 1	980	Anacostia	89	0.05	344	SU	0.180	278.3		M 291536		5 52.0	3.54N	M	13 33.6	-33 30	MPC18085
Apr 1	18	Melpomene	148	0.11	632	S	0.194	300.6		08510532		8 34.6	2.91N	J	11 8.3	12 3	MPC24085
Apr 2	73	Klytia	45	0.04	106	S	0.230	289.3		L2 335		19 4.9	4.73N	H	12 53.0	-6 9	Goffin95
Apr 4	412	Elisabetha	93	0.05	316		0.239	85.2		M 96280		23 37.8	1.89N	M	6 37.7	26 26	Goffin96
Apr 5	500	Selinur	45	0.03	116		0.228	291.7		M 730910		17 21.0	3.83N	M	12 41.7	-20 23	MPC24550
Apr 6	168*	Sibylla	154	0.07	872	C	0.044	326.9		M 155980		0 23.6	1.69S	L	9 34.7	9 41	Goffin96
Apr 6	9925	Comet SW-1	60	0.02	376		0.107	293.3		55170081		11 12.0	0.95N	J	11 48.3	-8 4	Goffin94
Apr 7	2	Pallas	533	0.22	5260	B	0.221	49.4		10650336		8 46.2	0.59N	J	19 44.1	12 27	Goffin92
Apr 7	14*	Irene	155	0.10	602	S	0.226	94.4		M 734603		9 50.2	2.07N	M	18 55.2	-21 19	MPC24219
Apr 7	282*	Clorinde	40	0.03	81	BFU:	0.141	316.7	140751	F5S 3250		23 1.2	3.01N	2	15 46.6	-6 7	Goffin95
Apr 8	6	Hebe	186	0.13	932	S	0.139	295.0		14330560		1 48.5	0.16S	J	11 7.8	18 42	MPC24219
Apr 8	541	Deborah	59	0.04	164		0.133	306.1	137784	M 178291		6 23.0	0.01S	L	10 47.2	-1 43	MPC16209
Apr 8	895*	Helio	147	0.08	775	FCB	0.186	299.7		M 318151		18 52.4	0.47N	M	13 7.5	-40 46	Goffin89
Apr 9	307	Nike	58	0.03	186	CX	0.150	87.0		M 734899		4 11.2	2.79N	M	19 11.1	-20 59	MPC16996
Apr 10	110	Lydia	89	0.06	305	M	0.130	275.0		M 230260		11 9.2	1.87N	M	15 26.8	-16 30	MPC14752
Apr 12	51*	Nemausa	137	0.09	483	CU	0.253	66.2		M 235573		16 36.1	0.40N	M	19 9.4	-10 54	Goffin94
Apr 14	159	Aemilia	131	0.07	537	C	0.228	93.1		M 97772		0 26.2	2.23N	M	7 38.1	21 28	Goffin95
Apr 14	163	Erigone	76	0.04	241	C	0.194	74.7		M 236390		6 6.5	0.22S	M	19 42.9	-16 33	Goffin90
Apr 15	13	Egeria	215	0.19	1022	G	0.273	266.8		L2 2975		6 12.5	2.91N	H	13 40.1	0-29	Goffin96
Apr 16	324*	Bamberga	228	0.11	1296	CP	0.200	114.9	79765	M 98075		0 25.7	0.67N	M	7 52.7	23 30	Goffin96
Apr 17	2*	Pallas	533	0.23	5277	B	0.194	41.2		10703543		16 27.5	1.92N	J	19 50.4	13 57	Goffin92
Apr 18	139*	Juewa	164	0.14	620	CP	0.114	171.0		M 127356		22 6.2	1.17E	M	10 22.8	12 30	Goffin93
Apr 22	2	Pallas	533	0.23	5284	B	0.182	37.0		10700897		3 18.7	1.42N	J	19 52.6	14 36	Goffin92
Apr 22	530	Turandot	89	0.05	308	F	0.080	71.5		M 234494		23 48.9	3.49N	M	18 24.4	-14 47	MPC14756
Apr 24	2	Pallas	533	0.23	5287	B	0.177	35.0		10701061		1 46.7	0.35N	J	19 53.4	14 53	Goffin92
Apr 25	13	Egeria	215	0.19	1025	G	0.260	262.6		L2 2376		3 32.7	5.91N	H	13 29.5	0-43	Goffin96
Apr 25	22*	Kalliope	187	0.08	889	M	0.359	90.1	58797	M 71275		23 9.4	1.44N	L	6 9.0	31 44	Goffin96
Apr 29	216*	Kleopatra	137	0.08	722	M	0.215	301.8		55591159	A	6 46.8	0.81N	J	13 52.6	-12 29	Goffin89
Apr 29	216*	Kleopatra	137	0.08	722	M	0.215	301.8		55590096	B	6 50.4	2.38N	J	13 52.6	-12 29	Goffin89
Apr 29	13	Egeria	215	0.19	1027	G	0.246	260.1		L2 2109		12 11.8	0.29S	H	13 25.2	0-53	Goffin96
Apr 29	270	Anahita	52	0.05	113	S	0.262	295.2		CR0 7661		15 2.7	1.07S	T	13 36.6	-13 2	Goffin90
Apr 29	139*	Juewa	164	0.13	620	CP	0.159	144.4	99111	M 127386		22 23.7	2.72N	M	10 25.3	11 10	Goffin93
Apr 30	746	Marlu	75	0.05	203	P	0.280	95.1		M 3 586		19 19.4	0.20N	M	20 46.1	-39 5	MPC18085
May 2	67	Asia	60	0.05	121	S	0.381	67.0		M 722049		8 14.8	0.16N	M	20 36.3	-11 24	Goffin95
May 2	185*	Eunike	165	0.10	805	C	0.161	321.6	122258	M 163791	A	9 8.3	3.51N	T	17 18.2	9 31	MPC24549
May 2	259*	Aletheia	185	0.14	915	CP	0.197	274.9		M 198552		9 8.6	2.57S	M	15 24.0	-7 27	MPC16996
May 4	282	Clorinde	40	0.04	81	BFU:	0.245	290.0		M 198636		6 23.4	1.45S	M	15 28.2	-3 30	Goffin95
May 5	301	Bavaria	55	0.03	134		0.224	74.9		M 237954		22 10.8	0.91S	M	20 48.9	-14 30	Goffin94
May 5	2	Pallas	533	0.24	5305	B	0.147	19.4		16162301		0 -5.8	3.09N	J	19 57.2	16 35	Goffin92
May 6	804*	Hispania	161	0.12	760	PC	0.221	277.9		M 745862		11 36.8	0.47S	M	14 21.9	-35 11	Goffin92
May 8	8	Flora	141	0.09	455	S	0.455	72.7		CR1 5757		6 53.8	0.72N	T	22 45.0	-10 6	MPC24084
May 10	173	Ino	159	0.07	750	C	0.299	90.1		L4 2753		16 7.1	0.30N	H	7 49.1	17 49	Goffin96
May 10	627	Charis	59	0.04	169	XB:	0.210	286.0		M 198513		16 38.0	1.47S	M	15 22.0	-8 14	Goffin90
May 10	759	Vinifera	52	0.04	127		0.194	310.2		M 290475		19 46.7	0.53N	M	12 41.9	-37 12	MPC16006

Table 1 (concluded).

1997 Date	Universal Time h	m m	PLANET Name	m v	d,AU	STAR SAO No	m v	Sp	R.A. (1950) h	m	Dec. °	'	Occultation dm	dur s	df	P	Possible Path Lo1 °	La1 °	LoM °	LaM °	LoE °	LaE °	El Sun °	MOON El °	%Snl	up °
May 12	4	14-21	Rosa	14.5	2.328	184086	9.3	K2	16	1.7	-21	13	5.2	7	23	38	-2	40	-44	38	-87	53	168	121	33+	w 87W
May 12	16	60-73	Gudrun	13.8	2.501		9.7		16	26.8	-43	25	4.2	9	24	30	-165	-32	106	-65	14	-30	151	113	37+	w 84E
May 13	0	27-30	Xanthe	14.8	3.129	80767	8.6	F0	9	17.1	27	23	6.2	4	19	57	-50	56	-28	38	-6	22	82	30	40+	w 19W
May 13	2	5-57	Picka	14.8	2.380		9.6	K0	19	14.0	-18	20	5.2	13	78	68	-81	-71	2	-17	-17	57	124	153	41+	w 45W
May 13	18	18-32	Deborah	15.1	2.278		9.6	F8	10	44.3	0	6	5.5	9	45	56	13	27	49	29	89	30	110	25	47+	w 77E
May 13	21	8- 9	Messalina	15.6	4.218	79394	7.7	A2	7	24.2	27	24	7.9	4	14	53	-21	39	-5	29	12	17	56	37	48+	all
May 14	1	20-36	Regina	14.9	1.976		10.7		15	55.9	-45	44	4.2	4	25	60	51	7	-8	-15	-68	15	152	96	50+	w 23W
May 14	20	1- 8	Euphrosyne	11.9	2.557	182599	7.8	K1	14	27.0	-25	19	4.1	15	19	15	(s.C.I.S.,cen.Eur.)?2"s						165	70	56+	w 60E
May 15	16	26-31	Ella	13.6	1.554	184304	9.8	F5	16	15.3	-23	10	3.9	4	23	52	159	50	134	47	107	55	168	86	64+	w128E
May 15	21	15	MARS	-0.1	0.915		10.2	F0	11	18.0	6	4		1209	34	0	e.Argentina, Uruguay						114	10	65+	all
May 17*	9	55-57	Europa	12.5	3.564		11.5		23	20.5	-7	15	1.4	10	14	19	-113	-32	-88	-32	-62	-29	68	169	77+	none
May 18	20	29-29	Leto	11.9	2.791	128901	8.7	G0	0	39.0	-1	34	3.3	3	8	32	107	21	115	21	124	23	49	175	86+	none
May 21	7	50-61	Scylla	16.7	2.561		9.6		17	30.8	-32	37	7.1	3	23	76	-22	-41	-104	-69	152	-45	154	48	96+	w 40W
May 22*	3	24-35	Eleonora	10.6	1.899		9.8	A2	16	56.3	4	18	1.2	14	24	17	10	35	-43	43	-105	47	151	18	97+	all
May 22	6	59-71	Corduba	13.9	2.230		13.2		15	42.3	-4	39	1.2	8	21	29	-33	9	-92	20	-159	42	164	6	97+	all
May 24	2	42-43	Ino	13.7	3.353		10.5	A	8	3.9	17	49	3.3	5	11	31	-109	24	-95	20	-78	14	57	139	93-	e107W
May 25	5	37-69	Penelope	12.0	1.554		9.9		18	15.2	-14	31	2.3	12	43	32	-1	-8	-66	-2	-132	17	149	16	86-	all
May 25	23	1-29	Brucia	13.7	1.673	188476	9.0	M0	19	39.9	-20	19	4.8	5	36	66	59	51	53	-21	-66	-73	131	21	81-	e 29W
May 27*	2	47-51	Panopaea	12.5	1.938		9.3	K0	23	0.8	-20	4	3.2	6	13	22	-30	-35	8	-43	56	-42	87	42	70-	all
May 27	14	52-89	Mocia	14.4	2.490		9.6		12	19.6	-23	57	4.8	26	88	39	165	-20	118	-1	110	45	126	126	65-	e111E
May 28*	18	20-50	Campania	14.0	2.314	138533	6.3	G8	11	58.5	-1	29	7.7	19	61	36	-17	-39	39	-32	94	-26	113	151	54-	e 73E
May 28*	20	37-38	Vibilia	12.5	2.439	109442	9.7	F8	0	43.5	0	15	2.9	4	8	24	102	-50	123	-47	146	-42	57	39	53-	all
May 29*	9	30-39	Eunomia	9.5	1.931		9.4		17	58.9	-32	33	0.8	25	26	10	-78	33	-114	26	-151	42	156	73	47-	e141W
May 31	5	21-26	Aglaja	13.5	2.833		12.0		11	6.5	5	33	1.8	12	30	30	-126	45	-107	32	-84	23	96	162	29-	none
May 31	10	60-76	Eunomia	9.5	1.917		11.7		17	57.1	-32	30	0.1	24	24	10	-73	-35	-159	-44	129	-13	158	97	27-	e136W

Table 2 (Concluded).

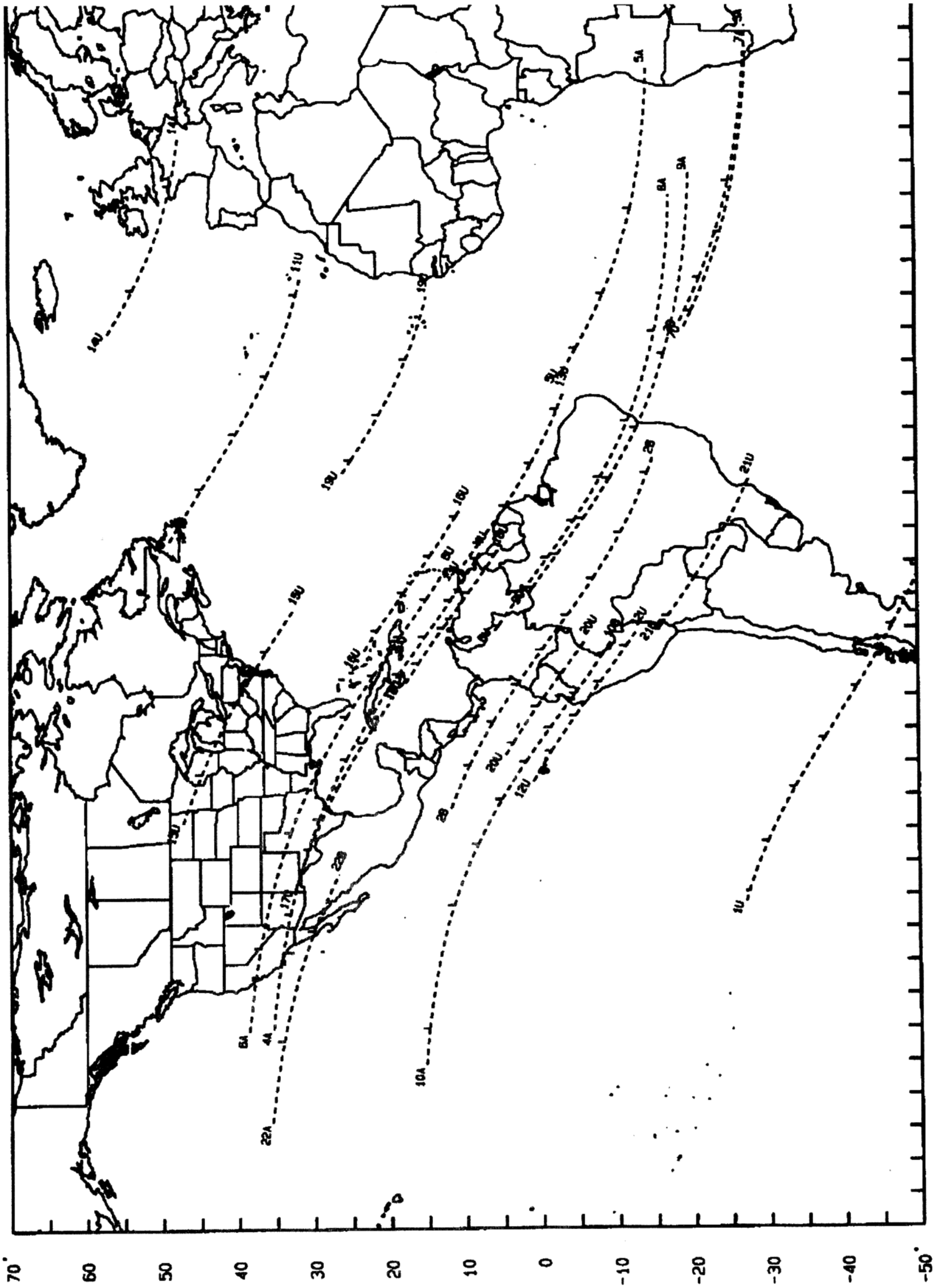
1997 Date	MINOR PLANET No.	Name	km-Diam.	-//	RSOI km	Type	Motion o/day	P.A. °	STAR SAO No	DM/ID No	D	Min. Geocentric U.T. h	m	Sep. "	S	Apparent R.A. h	m	Dec. °	'	Ephem. Source
May 12	223	Rosa	90	0.05	366	X	0.189	278.6		M 265076		4	17.1	3.27N	M	16	4.5	-21	21	MPC16554
May 12	328	Gudrun	120	0.07	579	S	0.174	259.8		M 761967		17	5.7	1.24S	M	16	30.2	-43	31	MPC18084
May 13	411	Xanthe	79	0.03	285		0.194	113.2		M 99496		0	26.0	1.91N	L	9	19.9	27	11	Goffin96
May 13	803	Picka	51	0.03	144		0.054	0.7		M 720340		2	31.0	1.08W	M	19	16.7	-18	15	MPC16394
May 13	541	Deborah	59	0.04	163		0.097	86.9		M 178288		18	18.5	1.78N	M	10	46.7	0	-9	MPC16209
May 13	545	Messalina	115	0.04	596	CD	0.234	106.8	79394	M 97520	K	21	6.1	1.11N	M	7	27.1	27	18	Goffin92
May 14	285	Regina	48	0.03	124		0.182	276.7		M 761598		1	28.2	2.28N	M	15	59.2	-45	52	MPC19473
May 14	31*	Euphrosyne	248	0.13	1783	C	0.216	270.2	182599	M 263026		20	4.0	5.07N	M	14	29.7	-25	32	MPC24219
May 15	435	Ella	43	0.04	93	DCX	0.225	276.4		M 265380		16	28.6	5.37N	M	16	18.2	-23	17	MPC25034
May 15	4	MARS	6782	10.22			0.203	123.2		M 157758		21	15.3	11.70S	M	11	20.4	5	48	DE200
May 17	52*	Europa	278	0.11	1981	CF	0.250	73.2		CR1 7496		9	59.0	0.62S	T	23	22.9	-7	0	Goffin94
May 18	68	Leto	127	0.06	417	S	0.471	66.4	128901	M 174773		20	30.7	2.20N	L		41.4	-1	19	MPC24548
May 21	155	Scylla	49	0.03	155	XFC	0.181	256.6		M 748855		7	54.6	1.98S	M	17	33.9	-32	39	Goffin92
May 22	354*	Eleonora	162	0.12	751	S	0.201	278.0		M 163336		3	28.6	2.87N	M	16	58.6	4	14	Goffin92
May 22	365	Corduba	110	0.07	478	X	0.211	289.6		CR1 1310		7	5.7	1.96N	T	15	44.8	-4	48	Goffin94
May 24	173	Ino	159	0.07	756	C	0.320	93.5		L1 4254		2	39.7	0.69N	H	8	6.6	17	41	Goffin96
May 25	201	Penelope	70	0.06	187	M	0.123	282.0		M 719071		5	51.2	0.98N	M	18	17.9	-14	29	Goffin95
May 25	323	Brucia	37	0.03	71	S	0.142	184.5		M 270175		23	14.4	0.82W	M	19	42.7	-20	12	Goffin96
May 27	70*	Panopaea	127	0.09	394	C	0.372	79.1		M 241119		2	51.2	1.72S	M	23	3.3	-19	48	MPC20607
May 27	733	Mocia	92	0.05	363	CF	0.047	338.5		M 260235		15	10.5	2.69N	M	12	22.1	-24	13	MPC16392
May 28	377*	Campania	94	0.06	337	PD	0.070	82.5	138533	M 178659		18	31.7	2.10S	L	12	0.9	-1	45	Goffin96
May 28	144*	Vibilia	146	0.08	470	C	0.514	68.6		M 143863		20	39.5	1.81S	M		45.9	0	30	Goffin92
May 29	15*	Eunomia	272	0.19	1668	S	0.184	276.6		73950724		9	34.0	3.93N	J	18	2.1	-32	33	MPC24219
May 31	47	Aglaja	137	0.07	643	C	0.130	119.7		CR0 7993		5	20.4	2.39N	T	11	9.0	5	17	Goffin95
May 31	15	Eunomia	272	0.20	1666	S	0.193	277.3		73950022		11	7.5	1.12S	J	18	0.2	-32	30	MPC24219

Table 3. Stars with Significant Angular Diameters

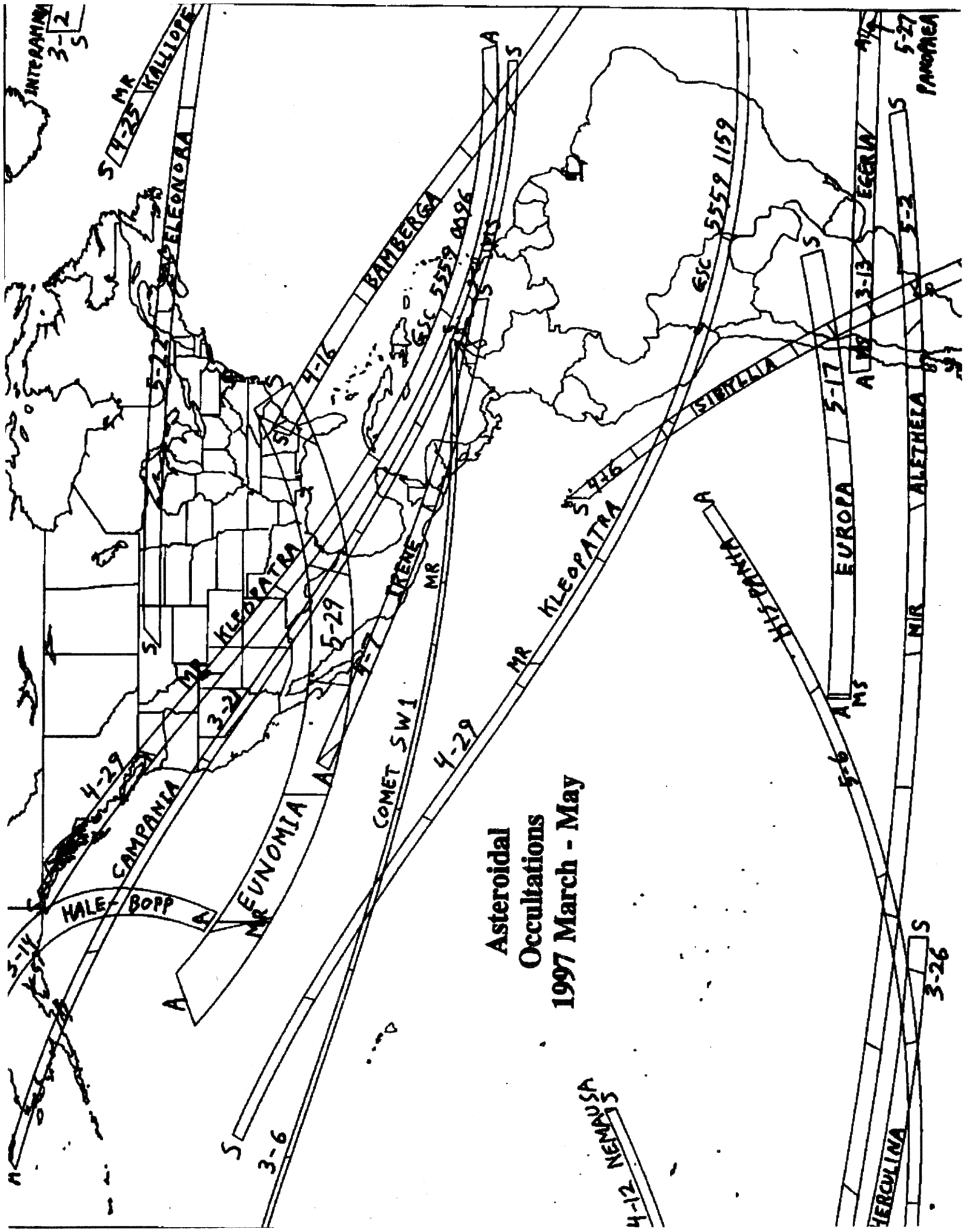
1997 Date	PLANET No.	PLANET Name	STAR SAO/DM/ID	Vmag	B-V	STELLAR DIAMETER m//	m	time	df
Mar 1	34	Circe	L5 1134	11.49	1.91	0.38	961	26	2.6
Mar 6	64	Angelina	M 156746	8.90	0.50	0.12	120	13	0.5
Mar 12	219	Thusnelda	095016	9.40	0.50	0.09	155	11	0.5
Mar 12	772	Tanete	039911	9.60	0.50	0.09	184	12	0.5
Mar 14	10	Hygiea	092654	8.53	0.17	0.08	247	6	0.6
Mar 17	2196	Ellicott	116073	9.05	0.35	0.09	166	33	0.5
Apr 7	282	Clorinde	140751	6.24	1.17	1.24	1464	211	5.8
Apr 8	6	Hebe	14330560	11.11	1.00	0.10	144	17	0.5
Apr 8	541	Deborah	137784	8.41	0.59	0.17	242	31	0.9
Apr 14	159	Aemilia	079563	9.40	0.50	0.09	178	10	0.6
Apr 16	324	Bamberga	079765	8.80	0.50	0.12	247	15	0.8
Apr 25	22	Kalliope	058797	8.89	0.21	0.07	165	5	0.5
Apr 29	13	Egeria	L2 2109	11.29	0.40	0.03	38	3	0.2
Apr 29	139	Juewa	099111	7.70	0.50	0.21	251	31	1.0
May 2	185	Eunike	122258	8.09	0.31	0.12	196	19	0.7
May 10	173	Ino	L4 2753	10.00	0.99	0.16	373	13	1.1
May 13	411	Xanthe	080767	8.62	0.28	0.09	211	12	0.6
May 13	541	Deborah	M 178288	9.60	0.50	0.09	142	21	0.5
May 13	545	Messalina	079394	7.70	0.50	0.21	629	21	1.6
May 28	377	Campania	138533	6.31	1.21	1.29	2159	442	7.2

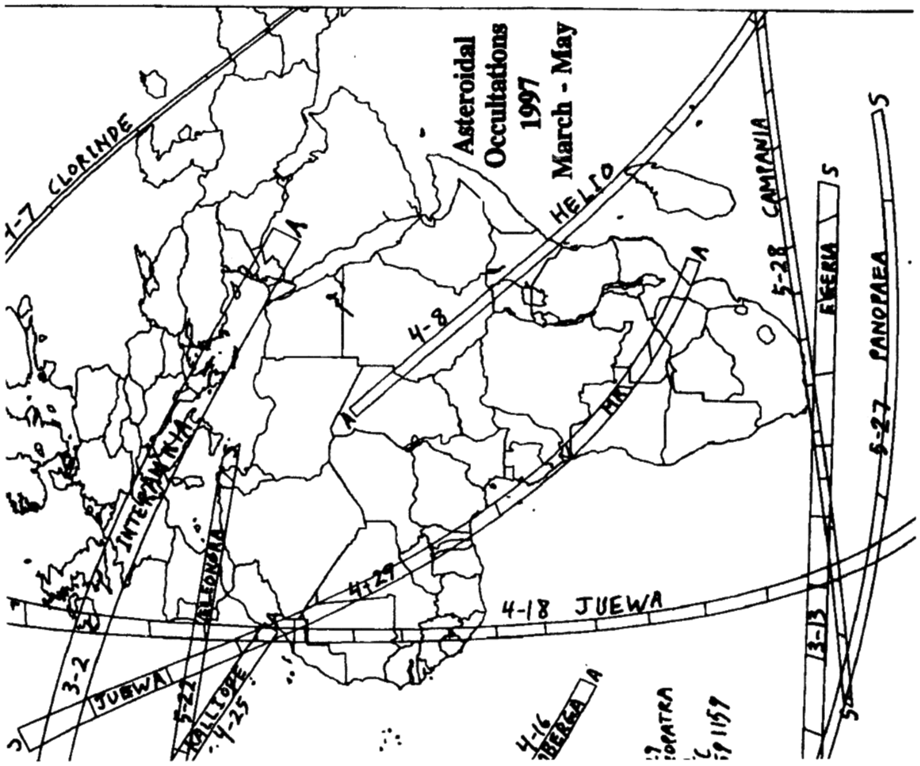
Table 4. Some Priority Events

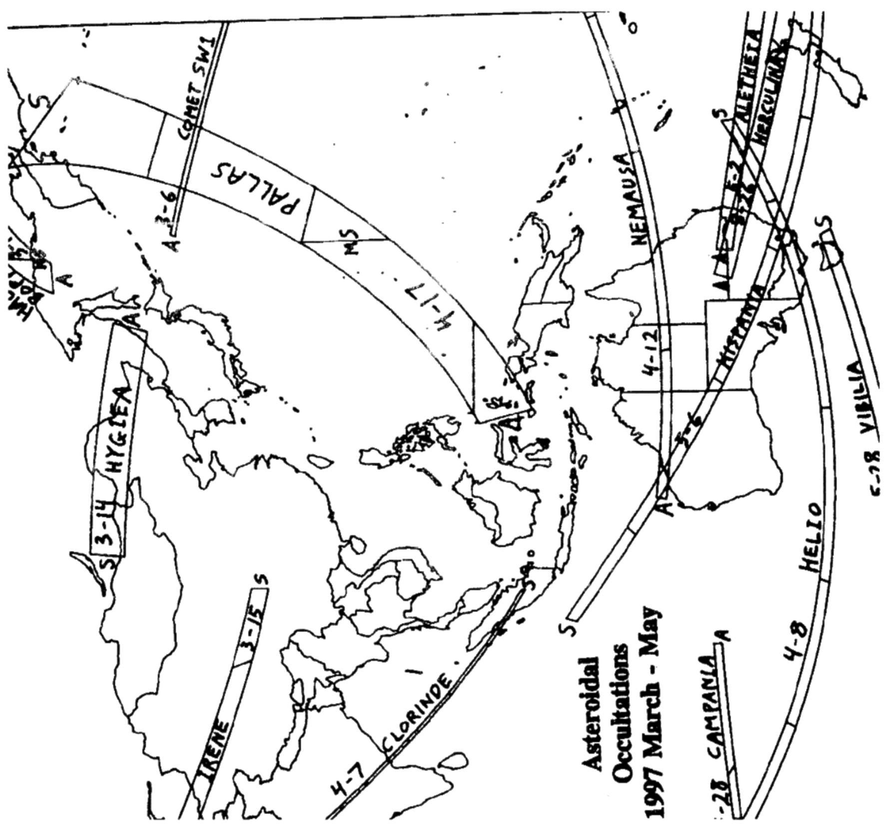
1997 Date	Occulting Object	North Amer.	EAON	IOTA/ES
Mar. 2	Interamnia		x	
Mar. 6	Comet SW-1	x		
Mar. 14	Hale-Bopp	x		
Mar. 21	Campania	x		
Mar. 23	Tjilaki		x	x
Apr. 4	Elisabetha		x	x
Apr. 7	Clorinde		x	x
Apr. 9	Nike		x	
Apr. 14	Aemilia		x	
Apr. 16	Bamberga	x		
Apr. 18	Juewa		x	x
Apr. 22	Turandot		x	x
Apr. 25	Kalliope		x	
Apr. 29	Juewa		x	x
May 2	Eunike	x		
May 5	Eichsfeldia			x
May 12	Rosa		x	x
May 13	Xanthe		x	
May 13	Picka		x	x
May 13	Messalina		x	x
May 14	Hohensteina		x	
May 22	Eleonora	x	x	x



70°
60
50
40
30
20
10
0
-10
-20
-30
-40
-50°
14U
11U
19U
5A
9A
8A
2B
21U
20U
12U
1U
10A
22A
6A
4A


Asteroidal
Occultations
1997 March - May
INTERAMNIA
KALLIOPE
ELEONORA
BAMBERGA
ESC 5559 0696
ESC 5559 1159
EGERIA
PANOPAEA
SIBYLLA
KLEOPATRA
IRENE
COMET SW1
EUNOMIA
CAMPANIA
HALE-BOPP
EUROPA
ALETHEIA
HISPANIA
HERCULINA
NEMAUSA


Asteroidal Occultations 1997 March - May
4-7 CLORINDE
4-8 HELIO
5-28 CAMPANIA
EGERIA
5-27 PANOPAEA
4-18 JUEWA
3-2 JUEWA
INTERAMNIA
4-29
3-13


Asteroidal Occultations 1997 March - May
COMET SW1
3-6
PALLAS
4-17
3-14 HYGIEA
3-15 IRENE
4-7 CLORINDE
NEMAUSA
4-12
HISPANIA
ALETHEIA
HERCULINA
VIBILIA
HELIO
4-8
CAMPANIA

the same, I would be interested in investigating the cause.

CCD astrometry to update asteroidal occultation predictions was described on pages 157 and 158 of *ON* vol. 6, no. 7. Astrometric updates have been distributed widely by e-mail, and have also been posted on this Web site. An article on the need to use GSC version 1.2 data for this work is in this issue.

Regional charts showing the paths of the asterisked asteroidal occultations for March, April, and May are given here. Tables and maps for events later in 1997 will be given in the next issue.

Notes about Individual Events (March - May):

March 6, Comet SW-1: This is the giant periodic comet Schwaschmann-Wachmann 1 that is in a nearly circular orbit just beyond Jupiter's orbit.

March 14, Hygeia: The star is number 271 in Robertson's Zodiacal Catalog (Z.C.) and is also a wide visual double, STF 173. The 10.2-mag. secondary star is 22".8 away in position angle (P.A.) 204°; it will not be occulted by Hygeia as seen from anywhere on the Earth.

March 26: The star is Z.C. 2812. Herculina may have a large (about 45 km) satellite based on a secondary occultation timed at two sites during the 1978 June occultation by the asteroid.

April 7, Clorinde: The star is HR 5866 in the Bright Star Catalog.

April 29, Kleopatra: The two stars are both mag. 11.7, are separated by only 2".4 in R.A. and have virtually the same declination. I would normally dismiss this as a GSC duplicate, the same star measured from separate plates, but the two stars have the same GSC plate number (that is, they were measured from the same plate). The pair is not listed in the Washington Double Star catalog. It would be useful if someone could look at the star(s) in Virgo and tell us if there is only one star there, or a close pair. We can put the result on IOTA's asteroidal occultation Web site.

May 2, Eunike: The star is BD +9° 3361 and has the double star designation STT 326. The 12.4-mag. secondary is 17".4 in P.A. 222° and will not be occulted.

May 13, Messalina: The star may be a close double, according to a total lunar occultation observed by W.O. in South Africa on 1932 April 13.

May 14, Euphrosyne: Edwin Goffin's prediction used data from the Guide Star Catalog, which gives the mag. as 6.6. But the star is in the PPM and has significant motion in declination. The path computed with the more accurate PPM data misses the Earth's surface so it is unlikely that an occultation will be seen. The star is also ADS 9280, with the 10.3-mag. secondary 12".8 away in P.A. 58°; it will not be occulted.

May 15, Mars: The event will probably not be observable, with the faint star overwhelmed by Mars, which will be about 10,000 times brighter.

May 28, Campania: The star is ZC 1735 = HR 4591 in the Bright Star Catalog. ι

PHEMU97: The Campaign of Observation of Mutual Occultations and Eclipses of the Galilean Satellites of Jupiter in 1997*

Jean-Eudes ARLOT
Bureau des longitudes
and
Richard P. Wilds
Heartland Astronomical Research Team

Introduction:

Occultations have been observed around the world for thousands of years with great interest, because the information obtained from these events can be derived , at times, only by such observations. The occultation of stars by asteroids have been an area of scientific interest. The observations allow us to obtain information on the size of the asteroids, on the nearby material that may be around them, such as satellites, and on their positions if the occulted star belongs to an astrometric catalogue. In fact, occultations may also occur between objects of the solar system and their observations provide valuable information. As far back as 1889, E.E. Barnard used an eclipse of Iapetus (one of Saturn's moons) by the rings of Saturn to discover that the Crape Ring of Saturn was transparent. Also, the reader should remember that occultation observers were the first to discover the rings of Neptune long before the Voyager spacecraft got to that planet. Everyone knows about the eclipses of the Galilean satellites by the shadow of Jupiter. The eclipses of the Galilean satellites were extensively observed at the beginning of the 20th century in order to provide observed astrometric positions of the satellites. Unfortunately, the atmosphere of Jupiter refracts the light rays, disturbing the observations and decreasing their astrometric accuracy.

However, another type of event, the mutual eclipses and occultations of Jupiter's moons, may occur between the satellites themselves because of the configuration of their orbits. Every six years, the Earth and the Sun will go through the common orbital plane of the satellites and during a one year period events will occur. These events are very easy to observe because the satellites are bright (around magnitude 5) and because the light flux drop during an event is sufficient for easy observations. Moreover, these events are usually only a few minutes long and that limits the amount of data to be recorded. It is not too long and it is not too short.

The observations of such events started only twenty years ago for two reasons: first, fast photoelectric photometers became available and second, the prediction of such events became easier, thanks to computers.

The mutual events:

As mentioned before, the eclipses by Jupiter are biased by the atmosphere of Jupiter but the mutual events are not, because the satellites have no atmosphere. So, the accuracy of the light curves obtained is better and the astrometric accuracy of the mutual events is better than those of any other kind of event. Also, the accuracy of the observations should be increased with the use of sophisticated models of the events.

Before explaining what will be deduced from these observations, let's describe these events which imply objects with apparent disks of one second of arc which do not look like stars.

The occultation of a satellite by another will imply the decrease of the light flux received from the satellites. The shape of the light curve will depend on the relative positions of the satellites, on the phase angle and on the nature of the surface of the occulted satellite. The analysis of the light curve will permit us to determine the relative positions of the two satellites and to get information about the surface of the occulted satellite.

During an eclipse, a satellite will go through the shadow cone (umbra or penumbra) of another satellite leading to a decrease of the light flux. Such events may be partial, annular or total such as with occultations. Note that the light flux must be measured in reference to the Universal Time to a precision of one or two tenths of a second of time. This is absolutely necessary in order to link all the observations together.

As shown by the examples of observations in Figure 1, the light curves are made of points which must sample the event sufficiently. More than one point per second is necessary except for the long events (one hour long) where one point every one or two seconds is sufficient.

On the figures, several types of light curves are shown. The points correspond to the observation and the curves to the model of the event. The first event is a very faint one with a small magnitude drop of about five hundredths of a magnitude. The noise of the light curve depends on the sky and also on the integrating time of the receptor. Some light curves are not symmetrical and this is also an important piece of information concerning the surfaces of the satellites.

Let us now come back to the satellites themselves. The Pioneer, Voyager and Galileo space probes provided us pictures of the surface of the satellites which show the diversity of the ground: volcanoes on Io, ice and dust on the other satellites. This explains that the shape of the light curves may vary from one event to another.

The scientific value of the observations of the mutual events:

The first goal is to determine the relative positions of the satellites at the time of an event with a high accuracy which may reach ten kilometers by observing mutual events, when direct astrometric observations reach only an accuracy of three hundred kilometers. Second, we wish to improve our knowledge of the surface of the satellites thanks to the analysis of the shape of the light curves. These two goals are interdependent: we need to know the surfaces of the satellites to get more accurate positions, and we need relative positions to analyze the light curves and deduce surface parameters.

The highly accurate astrometric data is necessary to improve our knowledge of the dynamics of the motion of the Galilean satellites and to understand the evolution of the Jovian system which looks like a small solar system. We suspect an acceleration in the motion of the satellite Io, but we need to measure it. Only very accurate astrometric observations may help us in that purpose. When analyzing the light curve in order to determine the relative positions of the satellites, we introduce parameters describing the surfaces. These parameters, determined in several wavelengths, provide information on the surfaces of the satellites; not only on the large features as seen by the space probes, but also on the granularity of the dust at the surface of the satellites. This is all due to the analysis of the reflection of the light. We would like to give the example of Io: the space probes have shown that the volcanoes are bright at 3.8 microns. In 1991 we observed an occultation of Io at this wavelength and the light curve permitted the measure of the flux and the position of the volcanoes Loki and Pele. This shows the value of the occultation method which may also be applied to the four satellites in other spectral bands. The observer should keep in mind the makeup of each satellite: J1 (Io) - Sulfur Compounds, J2 (Europe) - Ice, J3 (Ganymede) - Ice and Carbonous material, J4 (Callisto) - Ice and Carbonous material. Io is not the only satellite on which interesting spectral information may be obtained. Ganymede, in particular, has a number of bright spots, but each of the satellites needs additional exploration by occultation observers. The general spectral readings, however, would be in regions farther to the red than the 3.8 microns used on Io's volcanoes.

The observations:

Let us now come to the making of the observations. First, it is important to understand that a small telescope with a twenty centimeters aperture is sufficient thanks to the brightness of the satellites as shown by the light curves obtained by amateur astronomers in 1985 and 1991. However, if a narrow filter is used, then a larger telescope will be necessary. This is because we need more than one point per second of time for the light curve. But, if the seeing is very good with a high signal to noise ratio, then a smaller telescope may be used.

Concerning the receptor, the choice will be made in order to get enough points for the light curve. More than one point per second of time is necessary. Photometers were commonly used, but fast CCD's and video cameras may be used associated with a long focus telescope in order to have a narrow field and to separate the satellites. IOTA members have had much success in video recording short-lived, but active, events with the time, in UTC, recorded with the event on the tape. The time can either be recorded on screen at the time of the recording of the event, or a video time insertion device can be

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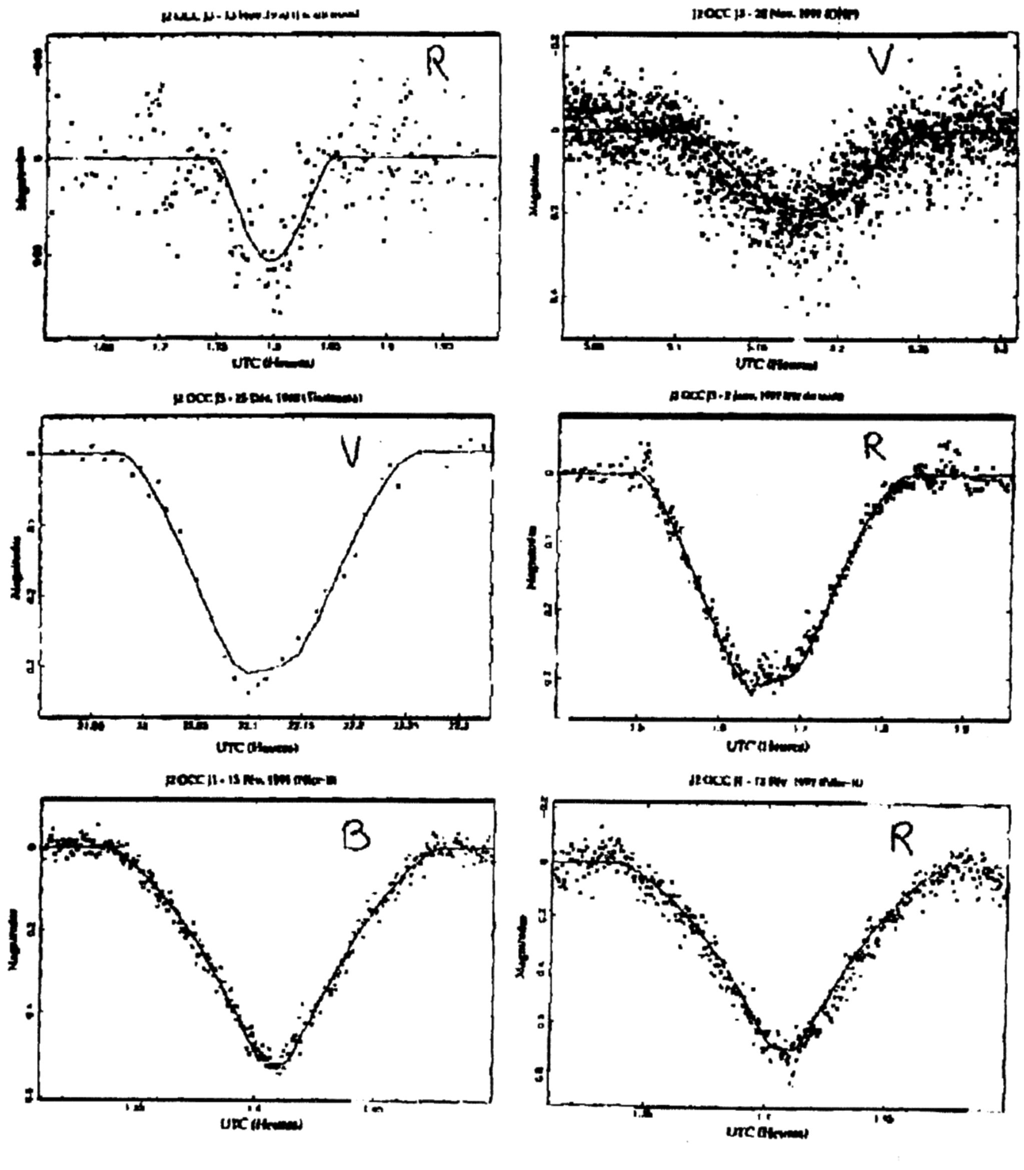
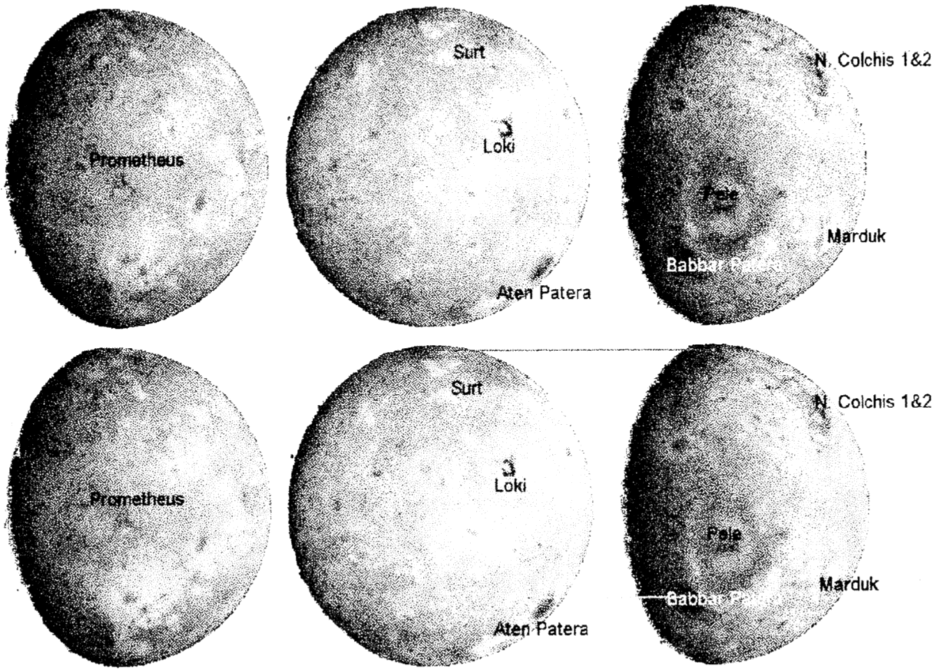
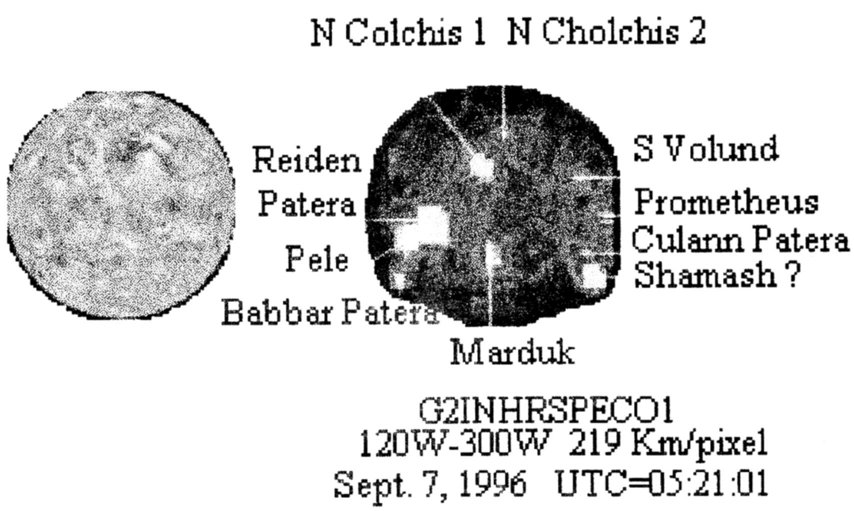
PHENOMENES MUTUELS DE 1991

PHEMU91 Campaign

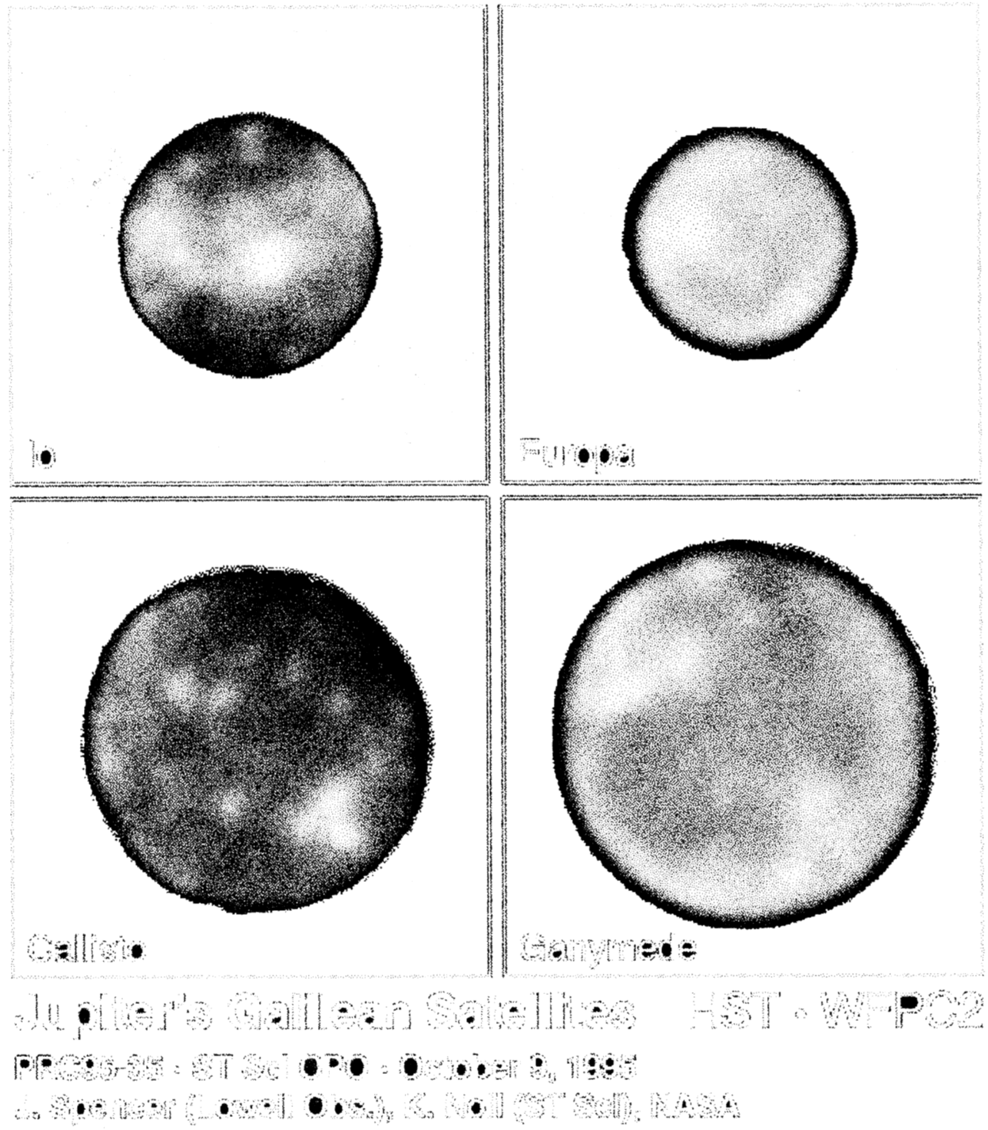




(full color image available at http://www.jpl.nasa.gov/galileo/ganymede/092496.html)
The Jet Propulsion Laboratory, Pasadena, CA manages the mission for NASA's Office of Space Science, Washington, DC. Labels provided by Heartland Astronomical Research Team. This color image, without labels, can be seen in the March 1997 Sky & Telescope, *page 35.*



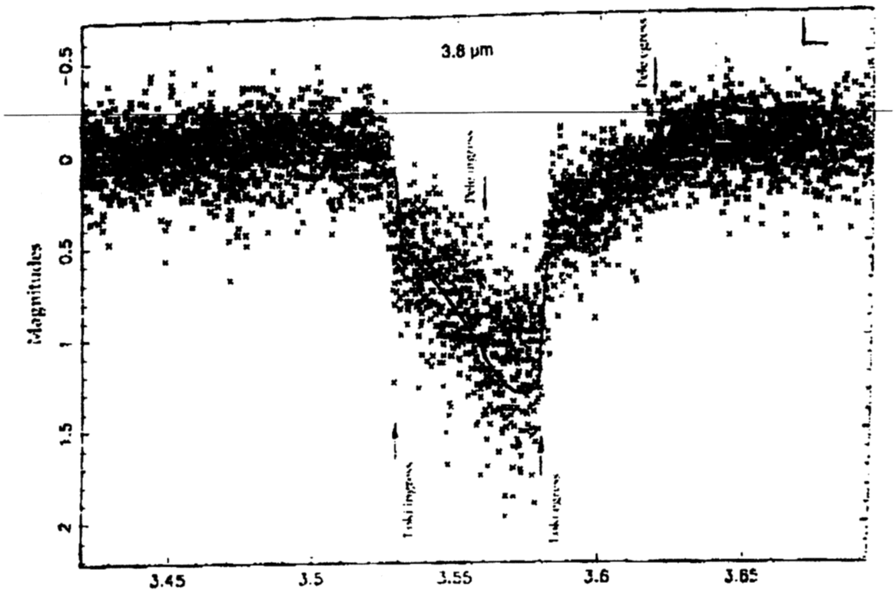
(full color image available at http://www.jpl.nasa.gov/galileo/ganymede/121796.html)
The Jet Propulsion Laboratory, Pasadena, CA manages the mission for NASA's Office of Space Science, Washington, DC.

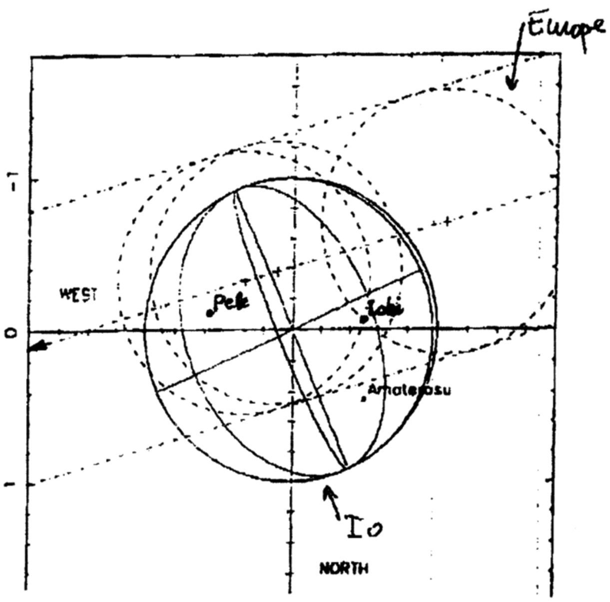


(full color image available at http://oposite.stsci.edu/pubinfo/gif/GalSat.gif)
This image was created with support to Space Telescope Science Institute, operated by the Association of Universities for Research in Astronomy, Inc., from NASA contract NAS5-26555 and is reproduced with permission from AURA/STScI. The color images can also be seen in the March 1997 Sky & Telescope *pages 28-35.*

OCCULTATION DE IO PAR EUROPE

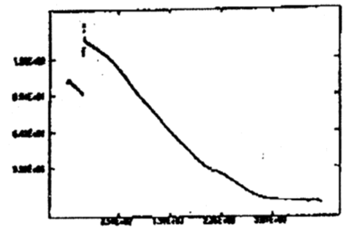
20 Février 1991 (ESO) - 3.8 µm



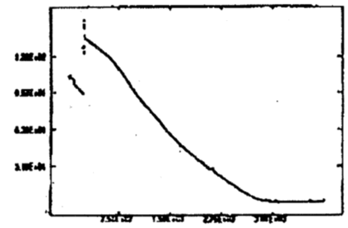


Provided by the Bureau des longitudes
Compare the locations of the volcanoes on this diagram to the labeled NASA image of Io shown earlier.

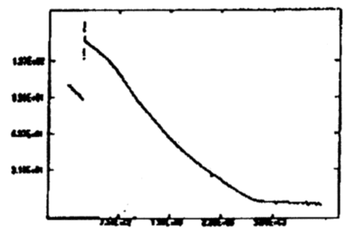
Two Dimentional Observation of a Mutual Eclipse
Meudon Observatory I-Band
J1 Eclipses J2 on April 22, 1991



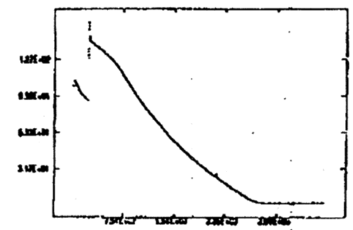
Raw signal of J2
(eclipsed satellite)



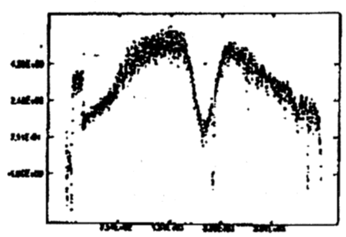
Sky background of J2



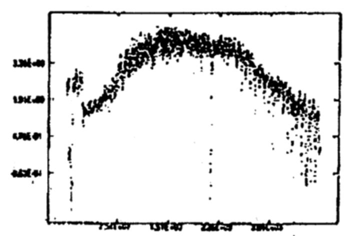
Raw signal of J1
(reference object)



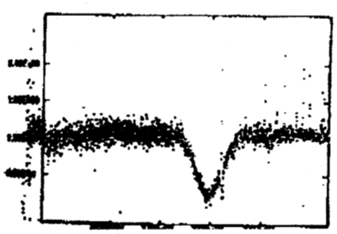
Sky background of J1



Light flux of J2 (eclipsed satellite)
without the sky background



Light flux of J1 (reference object)
without the sky background



(Provided by the Bureau des longitudes)

used as long as the UTC signal is clearly recorded on the audio section of the tape. In any event, however, the time must be on the tape to 0.1 seconds accuracy before it is sent to the Bureau des longitudes. *Note that some light curves may be recorded* even during twilight. If the event is long, we need to record the sky background several times during the event. In the case of a light curve made with increasing absorption, a reference object should be recorded. But it may appear that the absorption comes from small clouds. The use of two dimensional receptors, such as CCDs or video cameras, may allow the observation of events in very poor conditions. If the sky background, the reference object and the occulted satellite are observed simultaneously, then the figures show that observations may be made during poor conditions. This is shown by an observation made near Paris during twilight through clouds and one also through clouds at Observatoire de Haute-Provence. The minimum is well determined after treatment and reduction.

Some errors are to be avoided, and we have to be aware of some important points to be sure to obtain usable observations:

- identify with certainty the satellites to be observed by using software downloaded from the ftp site below or by using other software, such as Guide v5.0. A sample of an early event is shown on the next page (Jupiter has four satellites that look very similar through a telescope)
- prepare the observation and start observing in advance in order to avoid surprises
- make calibrations before the observation of the event since it may rain after the event
- try to observe even in difficult conditions (small clouds, twilight, . . .)
- take into account the proper motion of the satellites mainly during a long event and the possibility of Jupiter coming into the field
- be sure of the time scale which must be related to the UTC at less than one tenth of a second of time.

The PHEMU97 campaign:

The 1997 events occur when the Jovian declination of the Earth and the Sun are small from April to November. Fortunately, the opposition between Jupiter and the Sun will allow us to observe the maximum number of events.

We need a network of observers for two reasons:

- first, an event occurs only one time, and several observers should try to observe in order to get at least one light curve: clouds may arrive and everything can happen to prevent the observation. The majority of observations in 1991 made by members of HART were the only observations made of the events being observed. This was the case experienced many times by other observing teams throughout the world
- second, a selected event is observable only from a selected area on Earth, so that the network must be worldwide. During the previous campaigns, observations were made worldwide, but not enough since we were not able to observe all events. In 1985, we observed one third of the events. In 1991, we observed half of them. So, we encourage observers to join us for *this campaign of observations in order to observe almost all the* events.

*This article was first presented by Dr. J.E. Arlot of the Bureau des longitudes at ESOP XV Conference, Berlin August 1996.

Data are available on the ftp server of Bureau des longitudes, and information is available at the following addresses:
ftp.bdl.fr/pub/ephem/satel/phemu97/
http://www.bdl.fr
arlot@bdl.fr

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77, avenue Denfert-Rochereau
F-75014 Paris, FRANCE

A workshop will be organized in Catania, Italy on March 4-6, 1997 in order to prepare the campaign and to see how to improve the techniques of observation.

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Bibliography:

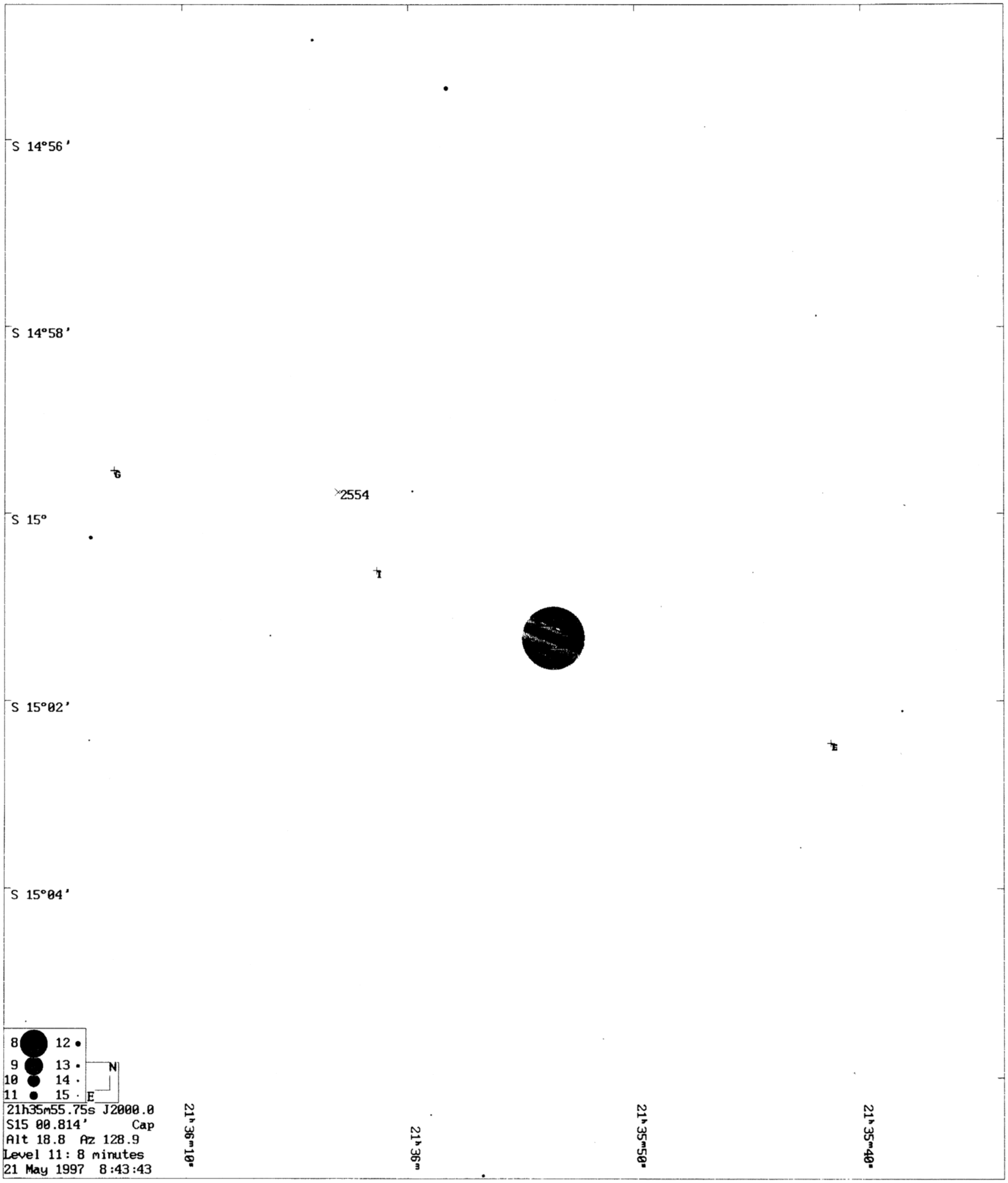
Arlot, J.E., (1996). "Predictions of the Mutual Events of the Galilean Satellites of Jupiter occurring in 1997." Astronomy and Astrophysics, Vol. 314, Page 312.

Arlot, J.E., Descamps, P., Thuillot, W., (1996). "Occultations of Io in 1997-1998: Predictions for the Observations of Hot Spots." (Icarus, 1996) In Press.

Campbell, Tom, (1992) "Video Tips and VCR Q & A." Occultation Newsletter, September, Vol. V, #8, Page 214. Also see November, 1993, Vol. VI, #1, Page 14.

McManus, Craig Alan, (1994) "The H.A.R.T. Mobile Observatory." Occultation Newsletter, June, Vol. VI, #2, Page 44.

(This is a printout from Guide v5.0 by Project Pluto.)
The printout shows the Jovian moon Callisto being occulted by the Jovian moon Ganymede on 21 May 1997. The field is made more interesting by the passage of the Asteroid 2554 named after Lowell Observatory astronomer Brian Skiff.



Occultations during the Deep Partial Lunar Eclipse of 1997 March 24

Eberhard Riedel and David W. Dunham

On Sunday night-Monday morning, March 23-24, the Moon will dive deeply into the Earth's shadow, as shown on pages 82 and 83 of the March issue of *Sky & Telescope*, as well as in many other publications. But none of these mention occultations during this eclipse, and that is almost alright this time, since the Moon is passing over a sparse part of western Virgo. Only a few relatively faint stars will be covered, and their occultations will be difficult to observe due to glare from the part of the Moon that will remain outside the umbra. The brightest stars occulted are 7.6-mag. SAO 138613 (visible from Namibia, Angola, and part of the Atlantic Ocean) and Z.C. 1760 (visible from Mexico, Central America, and northwestern South America). The "best" occultations (we use that in a relative sense since none of them will be real easy to observe) will be southern-limit grazes that will be deepest in the Earth's shadow. All such grazes from the XZ94E catalog are shown on the map that is keyed to the table below. SAO 138613 may be a close double, with component magnitudes 8.2 and 8.5 separated by about $0''.2$, according to observations of a graze observed at Indian Town, FL, by Harold Povenmire on 1968 Nov. 16th and reported in *ON* vol. 6, no. 5, p. 45. Similarly, SAO 18114 may be a close double with approximately equal 10th-mag. components, based on a "gradual" disappearance reported by R. Innes in South Africa on 1922 July 28th. Z.C. 1760 is a wide visual double with a 10.8-mag. companion 36″ away in P.A. 56°. Two grazes of 9th-mag. stars (SAO 138663 and 138662) will produce observable grazes in the southwestern U.S.A., near San Francisco, Las Vegas, Albuquerque, south of Dallas, and near Lafayette, LA; and over Los Angeles and near Phoenix, Tucson, El Paso, and San Antonio, respectively. The graze of 10.7-mag. X34857 north of Minneapolis, and near Milwaukee, Toledo, and Fredericksburg, VA, will be quite difficult due to the faintness of the star. Of course, a polar diameter measurement will not be possible since northern-limit grazes can't be observed. Predictions of a few occultations (of SAO stars only, computed with OCCULT version 2.0) for selected cities around the world appear on Byron Soulsby's Web page (see p. 339), and he will generate local predictions upon request by e-mail. If time permits, Dunham will try to produce a view of the field for this eclipse showing tracks of the Moon's center for different major cities, and maybe some tables of the better occultations, for including on the sky.net home page, but this effort will have low priority.

Southern Limits, March Eclipse Occultations

NO.	USNO	SAOPPM D	MAG	%SNL	W.U.T.	LONG	LAT
1	X 18196	138658	8.5	100E	3 23.7	111	-27
2	X 18191	138654	8.0	100E	3 24.5	97	12
3	X 18112	138613X	7.6	64E	3 26.3	24	-19
4	X 18202	138662	8.9	61E	3 29.4	130	35
5	ZC 1750	138618	8.9	62E	3 29.6	31	-3
6	X 18203	138663	9.0	56E	3 33.7	130	39
7	X 18114	138615K	9.0	64E	3 35.0	24	-19
8	X 18170	138646	9.1	62E	3 37.0	70	6
9	X 18161	138642	9.0	62E	3 37.3	64	1
10	ZC 1760	138670C	7.6	50E	3 37.7	135	15
11	X 18162	P178713	9.8	69E	4 2.7	56	49
12	X 18204	P178727	9.8	69E	4 5.5	93	1
13	X 18167	P178714	9.8	63E	4 7.8	60	10
14	X 18149	P178709	10.0	71E	4 8.7	25	57
15	X 34857	P705699	10.7	39E	4 9.9	99	47
16	X 18179	P178719	9.9	67E	4 10.3	73	23
17	X 34877	P705700	10.7	38E	4 10.3	109	32
18	X 18185	P178720	9.9	67E	4 10.4	78	18
19	X 34818	P705698	10.6	65E	4 13.7	46	26
20	X 18201	P178724D	10.0	69E	4 14.2	89	4
21	X 18178	P178718	10.0	64E	4 15.4	69	-16
22	X 18239	P178737	10.0	8E	4 33.2	144	36

The 1996 IOTA Annual Meeting

Rocky Harper

The annual meeting of IOTA was held December 7, 1996 in the new Lunar and Planetary Institute in Houston, Texas. The meeting was held in the Hess room, which provides a wonderful interface to the surrounding woods. Throughout the day we were frequently visited by several deer as they came and peered through the windows. Members present were President David Dunham, Wayne Warren from Maryland, and Paul Maley, Wayne Hutchinson, Richard Nugent, Lynn Palmer, and Rocky Harper from the Houston area. Also attending were a few members from the JSCAS (Johnson Space Center Astronomical Society). The occultation of a 9.6 GSC star by 22 Kalliope was to take place around 9:30 p.m. that evening locally and a possible expedition was planned.

The business meeting was called to order by President David Dunham at 9:16 a.m. Central Standard Time. He presented a financial report from the Treasurers. At present IOTA is in good shape but the IOTA Observer's Manual hasn't been printed or mailed yet. There are 225 members and 55 others that only subscribe to the Occultation Newsletter. There was a discussion on how we could reduce cost. One way would be to e-mail the Newsletter to people who could receive it or put it on a Web page. It was pointed out that there is some difficulty in resolving and printing finder charts in this manner. Wayne Warren, who co-authored the manual with the Dunhams, would like to know whether we want it in Microsoft Word or maybe in a PDF (Portable Document Format). To view or print a PDF document requires Adobe Acrobat Reader which can be downloaded free. The two current Web sites were discussed. David Dunham spoke of the desire to have several regional web sites linked to one domain. This central domain would be linked to many others like Lowell Observatory, weather sites, satellite photos and other web pages useful to observers.

David Dunham began a discussion concerning future meetings. Since IOTA is incorporated in Texas the business meetings must be held here [This isn't true, as Richard Nugent found out after the meeting; see IOTA News]. It was suggested that the next annual meeting be held in Dallas. This would be easier for many other members outside Texas. The Astronomical League is holding its 50th

Anniversary Convention at Copper Mountain Ski Resort in Colorado on July 1-6, 1997. They are interested in IOTA having a meeting during this time. The location is 9000' and will be held around new moon. Another possible meeting could be held in conjunction with the July 29, 1997 spectacular graze of Aldebaran somewhere in the western U.S. Paul Maley also suggested that IOTA/US join with IOTA/ES for their meeting in September in Cambridge [but now elsewhere in the U.K., according to the latest information from IOTA/ES; this is very unlikely for the IOTA/US meeting] or have a joint meeting in northern Turkey around the August 11, 1999 total solar eclipse. Last but not least, a meeting might be held in the northeast U.S. in conjunction with the near full moon graze of Saturn on November 11, 1997 [this is no longer being considered]. A motion was made and excepted to adjourn the business meeting at 10:21 a.m.

Wayne Warren started the technical meeting off by discussing the changes that are about to occur concerning star catalogues. He first described the Hipparcos space astrometry mission and its impact on IOTA. The accuracy of star positions, distances, and proper motions have taken an extraordinary leap forward with the data returned by Hipparcos. The final Hipparcos Catalogue will contain 118,000 stars with 1 milliarcsec level astrometry and the final Tycho Catalogue will have more than one million stars with 20-30 milliarcsec astrometry and two-color photometry. The two catalogues will be available in June or July. There is another space-based astrometry mission in the planning. The European Space Agency is planning on launching something called GAIA (Global Astrometric Interferometer for Astrophysics). At the earliest the launch will take place in 2009. GAIA, in its present form, is estimated to lead to positions, annual proper motions, and parallaxes of some 50 million objects, complete to about V=15 mag, with an accuracy of better than 10 micro arcsec, along with multi-color multi-epoch photometry of each object. Many millions of fainter objects, as faint as 20 mag, would also be measurable with somewhat lower accuracy. David Dunham said a new comprehensive star catalog for IOTA use were planned with the Hipparcos and Tycho catalogues. The implications are enormous. All of the observed asteroid occultations (over 100 now) could be re-reduced giving better positions. Future occultations of asteroids would not need last minute astrometry; instead, the orbit could be updated accurately enough weeks or even months in advance. Expeditions could be organized much earlier. And as Wayne Warren pointed out, with ongoing improvements in the lunar profile combined with the new star catalogues, graze shifts will be practically eliminated. Wayne also told everyone about the new USNO program to measure star positions and motions using the photographic plates obtained at the Palomar Observatory in the 1950's and the 1990's. This will provide a catalog of over 500 millions stars with very accurate positions and motions, referred to the positions of the distant quasars. A very large and very precise plate measuring machine has been constructed for that purpose in Flagstaff, Arizona.

David Dunham continued the discussion of the advances of technology as it pertains to IOTA. Radar astronomy will soon have a more powerful tool to observe asteroids when the new Gregorian Upgrade at the Arecibo Observatory in Puerto Rico is completed next year. The Planetary Radar transmitter is being upgraded to one million watts of transmitted power. Currently, Arecibo can barely skim the main belt's inner edge, but the upgraded telescope will have access to asteroids throughout the belt. The resolution is good enough to detect a steel golf ball on the moon. This telescope should clear up the Herculina satellite controversy (see *ON* vol. 6, no. 15, p. 151).

DGPS: Next, Paul Maley described DGPS measurements taken during the JSCAS/ IOTA expedition to Venezuela in September. He along with members Lynn Palmer, Richard Nugent and Becky Schultz of the JSCAS were attempting to improve the polar diameter of the moon by observing the graze of Z.C. 35 during a total lunar eclipse. Paul explained his "Base site - rover" system with two GPS receivers generously loaned by Trimble Navigation. One problem that was pointed out is obtaining accurate coordinates when returning to sites after observations. If too much time has passed, the area reference points may change considerably. In this case, the observer should take several photographs of the site and general surrounding before leaving to adequately record the position. It was also mentioned that to create a one meter base site in remote areas like the Amazon an observer would need two GPS receivers and a Personal Computer. One GPS receiver would record signals until it filled its memory with data. Then it would have to download its contents to a P.C. To avoid a break in receiving, the second GPS receiver would be used while the first was downloading. This overlapping procedure would have to continue for 29 hours. Next, Wayne Warren speculated on the possible future use of the GLONASS satellite system of Russia. The results from that system are more accurate since it is not purposely degraded by Selective Availability (S/A), but current GLONASS receivers are much more expensive than GPS receivers. By the time suitable inexpensive GLONASS receivers are available, the GPS S/A might be turned off, since there is a federal guideline to do that within a couple of years.

Lunar Grazes: David Dunham discussed Dietmar Büttner and Reinhold Büchner's project to derive lunar profiles from occultation observers. He also talked about using past observations of grazes as an aid to future ones involving the same star. He described this process as used in the spectacular grazing occultation of δ^1 Tauri, video recorded by Tom Campbell in Florida. Tom changed his location based on David's calculation using Mitsuru Sôma's reduction profile of a graze of the same star that was observed in Europe months earlier. The change was a good one as it produced 14 events. The April 21, 1996 δ^1 Tauri graze was also observed by a six station expedition led by Harold Povenmire. The same technique was used for the 6 Leonis graze that was observed on April 26, 1996 in Texas and Oregon. Wayne Hutchinson, graze coordinator for the South West U.S., questioned how regional computors would know when a star had been previously grazed. A plan is to be put into effect, whereby Richard Wilds and David Dunham will coordinate the effort. Communication via e-mail should help in this matter. But as Wayne Warren remarked again, this becomes a moot point when the Hipparcos and Tycho star catalogs come into play. The series of occultations of Aldebaran continue with the last one occurring on February 14, 2000.

Asteroidal Occultations: David next reviewed recent asteroidal occultations. An excellent observation of (93) Minerva occulting an 8.8 magnitude star was video recorded by two Japanese observers on November 25, 1996. They also obtained photoelectric data on this event. Two weeks earlier, Richard Miles, of Cheshire, England, observed the occultation of an 11th magnitude GSC star by (892) Seeligeria. Richard now holds the distinction of being the first person to see an asteroidal occultation that occurred in the UK. The Japanese also had success earlier in the year when they observed an occultation of SAO 79988 by (14) Irene on January 24, 1996. A few days later, on January 29, French and Belgium observers witnessed an occultation of a star by (893) Leopoldina. The final observation discussed was the (27) Euterpe event of October 9, 1993. Nine stations in Arizona, New Mexico, and Texas got very good results. The success proved how valuable electronic mail is when new astrometry changes the shadow path.

At 12:30 p.m David made a quick call to IOTA central where his wife Joan was receiving updated astrometry for the asteroidal occultation by (22) Kalliope. After getting the information we all headed over to a local cafeteria to have lunch. After eating, David began crunching the numbers on his laptop computer while the rest of us carried on an informal discussion. In a few minutes David announced that the path had shifted far to the north several hundred miles. We then headed back to the LPI for the afternoon session of the meeting. Before starting David made several calls to alert observers in the new path.

At 2:15 p.m. the discussion centered on the September 27, 1996 total lunar eclipse and the graze of ZC 35. Paul Maley showed a video of his expedition to Venezuela. Unfortunately clouds moved in before totality and the graze was missed; however they did see the last part of the eclipse. David mentioned that Richard Wilds and Craig McManus obtained good video of the ZC 35 northern-limit graze in Iowa. Before moving on to the 1997 events, David described 3 upcoming 1996 asteroidal occultations: The first was the occultation of Pi Arietis by (975) Perseverantia and later two events by (704) Interamnia. Next year looks good for U.S. observers. On June 10th (170) Maria will occult a 6.2 mag. star, September 16th (906) Repsolda occults a 5.6 mag. star and the best one of the year occurs December 4th when (105) Artemis occults a 6.0 mag. star. There will be a 7.8 magnitude drop on the Repsolda event. Nine grazes of Aldebaran will occur in 1997 with several being visible to the naked eye. Saturn will be occulted by the moon five times next year. Also Jupiter and Venus will occult stars in 1997. On November 13, 1997 Jupiter will cover a 6.1-magnitude star. Also, the mutual phenomena of Jupiter's Galilean satellites begin in 1997.

Solar Eclipses: Paul Maley showed a video of his trip to the islands of Aruba and Curacao where he and Lynn Palmer scouted out observing sites for the February 26, 1998 total solar eclipse. He also talked about his upcoming adventurous trip to Mongolia for the March 9, 1997 total solar eclipse. The February 16, 1999 annular solar eclipse in Australia and the August 11, 1999 total solar eclipse in Europe were also discussed. The techniques for observing Baily's beads were compared. There was a suggestion to have two observers at one site with one video taping and the other visually timing the event. Also should a person use high or low resolution? Finally, different filters and camcorders were mentioned. It was noted by David Dunham that there are still a lot of data that needs to be reduced from past observations. The hope was that sometime in the future a proposal could be submitted to get funding to help in this matter.

The rest of the afternoon was spent watching graze videos. First was the outstanding video of the spectacular graze of delta Tauri by Tom Campbell. We also saw another nice graze of Spica taken on November 29, 1994 in Japan. At 5:00 p.m. we were required to leave the LPI. It was good to see everyone again. The weather was perfect in Houston so the plan was to observe the (22) Kalliope appulse later that night. [Observations were made at sites many kilometers north and south of Houston, but no occultation occurred, as expected from the updated astrometry. Dunham knows of no observations that were made of that occultation]. ι

IOTA Annual Financial Report

Craig A. and Terri A. McManus

Cash Flow Report
12/01/95 Through 11/30/96

Category/Description	Amount
Income	
Full Memberships	6,110.00
Gifts from Members	230.00
Interest on Checking	106.93
ON Subscription Only	1,225.00
Occult Program	12.00
ON Back Issues	62.50
Sale of IOTA Items	5.00
TOTAL Income	7,751.43
Expenses	
Ast. & Graze Supplements	765.14
Credit Card Costs	143.36
Email	206.20
Mailing Costs All	2,154.18
Misc Printing	139.45
Newsletter Only	1,565.00
Office Expenses	147.26
other expenses	30.00
TOTAL Expenses	5,150.59
NET Income	2,600.84

An Evans Graze Event at Manzanita Observatory 1990 August

Richard P. Wilds
Terri A. McManus

Occultation observations in Kansas were very successful in 1990. We observed 19 grazes, possibly discovered three new double stars, observed total occultations to 13th magnitude, and were able to time grazes as faint as 9.4 magnitude. Our most interesting event, however, was not in Kansas but was the trip that three Kansas astronomers took to Manzanita Observatory of the Tierra Astronomical Institute in southern California, USA.

The story of this trip began several years ago. I (Richard) had been giving a large number of talks on astronomy - to local clubs, to the Astronomical League, and to my local church. I received a call from an astronomy group in southern California to talk to them about "Dark Nebulae." In February of 1988 I gave my presentation. Of course, I could not avoid talking about grazes. I was invited to come back to give a presentation on grazes. I asked Don Stotz, from Dallas, if he would join me. The two of us flew to California in August 1988. We gave our talk on grazing occultations including the research and discoveries IOTA had to its credit. Our contact, Norman Butler, also shared with us that their group was building a 48" telescope. He asked me if I wanted to use it. I thought a long time, nearly a tenth of a second, and said, "YES!!"

I worked up a ten day observing schedule for August 1989 which was when the observatory was to be finished. There were delays. We had to wait. I rebuilt our program for August 1990, but this meant that Don Stotz could not make the trip. I asked fellow Kansas observers Gary Hug, an instrument specialist, and Charles Baker, a computer specialist, if they would fly to California for ten days in August. They agreed.

The 1990 program had three objectives:

1. Image NGC 6822 and locate more dark nebulae than the 11 already known
2. Conduct an occultation run down to 15th magnitude similar to those done at McDonald Observatory by Dr. David S. Evans (not the same Evans as the prediction programs)
3. Survey faint reflection nebulae and dark nebulae to review the evidence of light variations over time

NGC 6822 would be imaged by a Lynx computer controlled CCD in both red and blue light. The blue light would then be subtracted from the red light by a program written by Charles Baker. The remaining image would be the areas of dark nebulae.

The occultation run would use a specialized, low light CCD camera of 0.5 lux on the 48" telescope. Additionally, I discovered a 9th magnitude grazing occultation of SAO 078009 that would be occurring right over the Observatory. We would try for that at the same time.

The survey of faint reflection nebulae would be done with the same Lynx computer controlled CCD in both red and blue. The results could then be compared to earlier views of the nebulae on the Palomar Observatory Sky Survey. There have been a number of variable reflection nebulae found to date, with the most famous being Hubble's Variable Nebula.

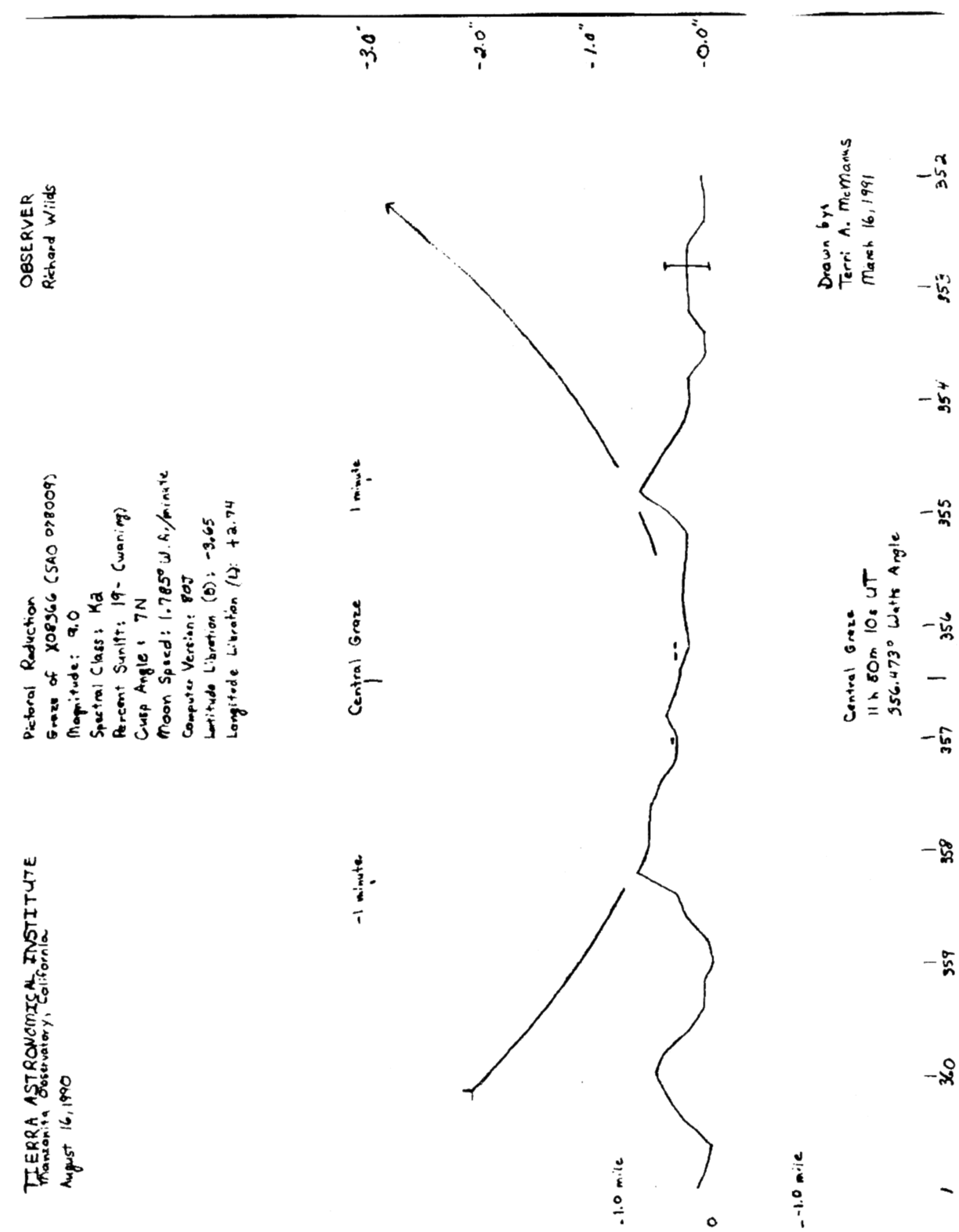
Upon arriving, we found the 48" was down and could not be repaired in time for our use. Unbeknown to us, Murphy had invited himself along for the fun! This left the 9th magnitude graze as the one project we might still accomplish. I found this graze on our USNO Evans Total Occultation Predictions. Using the Graze Nearby (Straight Line) formulae in the predictions, I found that the limit line ran about a half mile north of the Observatory. Where were the moon's limb features in relation to the limit line? I called Walter Morgan, the computor for the California region, and asked for graze predictions for the star and for a lunar profile. The star was too faint for the graze program. Murphy!! I searched the other predictions for grazes that night and found one for the same time at the same Watts angle but for a different star a hundred miles away. I asked Walter Morgan to send that one. It was a perfect match to the predicted profile I had already drawn by hand from the old Watts Charts (1). (Today one can predict such faint grazes by using OCCULT by David Herald. This can be extended to even fainter magnitudes during a lunar eclipse if the computor uses the original Hubble Guide Star Catalog Version 1.1 from NASA.) The profile showed that the lunar limb shifted about a half mile south, right on us. This was good because the profile also showed that the graze area was just one thin plateau. At this time though, graze leaders were to factor in an additional south shift giving us a miss at the Observatory. Our Kansas graze team had just finished a graze in Hubbell, Nebraska and found that there were not any south shifts at that time. We decided to stay at the Observatory and observe the graze from there.

The night of August 16, 1990 was beautifully clear. I had borrowed an 8" Celestron and had the star, SAO 078009, crossing the terminator. I called out ten events! I am sure I had actually seen 14 events, but six events were only partial views of the star, so faint that I did not call four of them until it was too late to get good timings. I had seen the 9th magnitude star have four clean disappearances and four clean reappearances with one 10th magnitude flash. There were two more flashes of 11th magnitude to 12th magnitude, but the 8" could just barely pull such faint flashes into view. These faint flashes were apparently caused by the lunar limb allowing only part of the star's image into my field of view. Oh! If I could only have had the 48" to have videotaped this graze.

Once the tape was reduced and grazing elements were compiled, I passed the information to Terri McManus who used the data to draw the pictorial reduction. I (Terri) used the Watts Charts (1) to draw the expected profile, then used the Graze Elements Table from the USNO (2) to plot the disappearances and reappearances. The exciting time along the plateau can be seen on the Pictorial Reduction between Watts Angles 357 - 355. The unreported faint flashes came around Watts Angle 355.8.

Perhaps the future is now open to us to use our modern technologies and our large telescopes to observe fainter grazes more often. These events happen all the time. We wonder how many are simply being missed through lack of knowledge or willingness to take a risk on an "impossible" graze.

1. Watts, C. B., The Marginal Zone of the Moon, Nautical Almanac Office, US Naval Observatory, Washington, D.C., 1963.
2. Graze Elements, Version -80J-, Nautical Almanac Office, US Naval Observatory, Washington, D. C.. (These are now obtained from Dr. Soma in Japan.) ι



Be Aggressive with E-mail and the Web

David W. Dunham

Most of you are all too aware of important asteroidal and grazing occultations in your area being poorly observed relative to the available astronomical resources. On Sunday morning, January 19th, an Aldebaran graze path crossed Boston, Massachusetts, a metropolitan area with at least 400 professional and amateur astronomers, yet as far as I know, only one of them tried to observe the graze. The one attempt was in response to an e-mail message that I distributed to a few observers there a couple of days before the event. He observed ten events from his home in suburban Bedford, but made no timings when his tape recorder stopped in the cold (maybe he should have consulted our cold weather tips on IOTA's sky.net Web page). In another example on January 31st, a good graze of a 6th-mag. star by the last-quarter Moon passed over New Orleans, Louisiana, but I think that nobody there was even aware of it.

As the maps on pages 293 and 294 of the last *ON* show, opportunities to observe grazes of Aldebaran are not that frequent within 100 miles of a given location; to have one pass over a major metropolitan area when the sky is clear is certainly a rare treat. But now with so many observers online, it should be possible to reach more of them in a timely fashion to obtain more observations. If you have e-mail, please collect and add to your address directory the e-mail addresses of as many potential observers as you can in your metropolitan area, and in other cities in your region. Many astronomy clubs now have home pages on the Web where they list member e-mail addresses, and these are also given more now in club newsletters and rosters. The membership directory of the American Astronomical Society is a rich source of e-mail addresses of members (a geographical index is most helpful), and of institutions in North America and around the world (there are members in over 50 countries). Pay attention in particular to observers in outlying areas that could significantly broaden the coverage for asteroidal occultations. When you talk to observers by telephone or at meetings, ask them for their e-mail address, or that of a friend, if they don't already have one. Prime them for potential asteroidal occultations and good grazes in the area one or two weeks in advance, and perhaps provide a summary list for at least a couple of months in advance. Point out to them that they are not getting the full value of their telescope if they do not make room in their busy schedule for interesting occultations, and they can plan to get caught up on other less time-critical work if the weather cancels the event, which will often be the case in most areas. Then, if the chances for clear sky are good, distribute more detailed information one or two days in advance. Also, you can put graze maps and finder charts for asteroidal events on either a local or on IOTA's Web page. I have used IOTA's Web page, located in Kansas, to help considerably with local grazes here in Maryland. You can make arrangements with Rob Robinson (robinson@sky.net, phone +1-913-422-1280) to fax a map showing a graze path and meeting place directly to his PC for placing on IOTA's Web page. Maps suitable for faxing can be made by Xeroxing, for example, a 1:250,000-scale or 1:100,000-scale topographic map of the area with the path plotted; useful maps can also be produced (in the USA) with software MapExpert or Street Atlas USA, or possibly at the map Web site (see below). When you distribute an expedition announcement by e-mail, please copy to Robinson so he can place it on the Web; we have way too few announcements about planned expeditions there.

My own e-mail address directory has a few hundred addresses, arranged geographically, but the explosion in e-mail access makes it impossible for me to reach all potential observers. I have a collection of 1:250,000-scale maps covering most of the USA and part of Canada, so I can plot the paths of some grazes on them and have put a few on the Web, such as for the Aldebaran graze near Seattle, Washington, last October. But I can do this for only a few of the very best events. I need help from local and regional IOTA coordinators to collect e-mail addresses for as many potential observers as possible, so they can pass on the asteroidal occultation update notices that I distribute. Also, I recommend buying 1:250,000-scale maps covering your whole State or region, perhaps for a distance of 300 km, so you can identify good graze possibilities in your and neighboring regions, and distribute appropriate information about them. Go out and pester as many observers as possible in your region; maybe more of them will start getting more value out of their telescope. ι

Web Sites for IOTA

David W. Dunham

Everyone seems to have their list of favorite Web sites. Below I list several that I think will be of interest to **ON** readers. If you know of other good sites that might be of interest to other readers, please let me know about them.

Occultation sites:

IOTA Lunar Occultations and Eclipses
http://www.sky.net/~robinson/iotandx.htm

IOTA Asteroidal and Planetary Occultations
http://www.anomalies.com/iota/splash.htm

IOTA/ES asteroidal occultations and other news
http://www.uni-siegen.de/~uastro/#iota

European Asteroidal Occultation Network
http://www.xcom.it/cana/EAON

Occultations by Solar System Objects (mainly occultations of stars by major planets and satellites, linked from IOTA's asteroidal site:
http://tdc-www.harvard.edu:80/occultations/

Lowell Obs. planetary/asteroidal occultation site, linked from IOTA's asteroidal site:
http://www.lowell.edu/users/buie/occ/predict.html

Lunar Occultations at AAO - Stresses Aldebaran, and infrared and

photoelectric recording, and includes total occultation maps and prediction service:
http://www.arcetri.astro.it/~richichi/occult.html

BAA (Asteroidal) Occultation Predictions for U.K. and surrounding areas:
http://www.ast.cam.ac.uk/~baa/occ.html

Spanish language occultation site
http://www.iac.es/AA/AAM/ocul.html

General lunar eclipse site, but look at the bottom of the information on upcoming eclipses, where Byron Soulsby lists occultation predictions for many cities, and offers predictions computed with Occult version 2.0 (he should go across town and get an upgrade from David Herald!) to anyone who e-mails their coordinates to him. Occult 2.0 uses the old XZ without all the new PPM stars that especially increases the number of events in the southern sky; also, with a more recent version, he could include predictions of dozens of faint GSC stars. Nevertheless, this site has much unique information.
http://www.spirit.com.au/~minnah/LEO.html

Astronomical Society Directories: Use the sites below to obtain e-mail addresses for contacting other astronomy clubs in your region. Be aggressive in notifying potential observers in your area about grazing and asteroidal occultations that they might (should) observe. Many societies now have their own Web pages that give e-mail addresses for many of their members; that is useful for reaching additional observers in outlying areas to increase coverage of important events.

S&T's Directory of Astronomy Clubs, Planetariums, Observatories
http://www.skypub.com/astrodir/astrodir.html

Member Societies of the Astronomical League
http://www.mcs.net/~bstevens/al/society.html

AstroNet - Clubs-Etc.
http://www.rahul.net/resource/regular/clubs-etc/clubsetc.html

Map Site:

TMS Direct Map Request Instructions - get detailed maps of the USA
http://tiger.census.gov/instruct.html

New Star Catalogs useful for Occultations:

The Zodiacal Catalog (Z.C.) downloadable 403K file
http://spitfile.ausys.se/psr/zc/zc.zip

The Double Star Library (speckle & occultation doubles, and more)
http://www.chara.gsu.edu/DoubleStars/intro.html

Washington Double Star Catalog (visual double star data and orbits)
http://aries.usno.navy.mil/ad_home/wds/wds.html

USNO Twin Astrographic Catalog data, with 3 times the density of the PPM and with more accurate positions and proper motions in the northern sky:
http://aries.usno.navy.mil/ad/tac.html

Guide Star Catalog (GSC) version 1.2, positions much better (to about 0.3") than the widely used GSC 1.1. GSC 1.2 is a MUST for obtaining accurate enough data for updating asteroidal occultation predictions by reducing CCD astrometric observations:
http://www-gsss.stsci.edu/casbhome.html for information and
http://www-gsss.stsci.edu/gsc/gsc12/gsc12_form.html for requests.

Brand new catalog USNO-SA1.0 of 54,787,624 sources (mainly stars) between mags. 16 and 19, expected accuracy about 0.25", to provide a much denser network for narrow-field CCD observers:
http://www.usno.navy.mil/pmm

Other Astronomical Services:

Asteroid orbital elements and observability, as well as software for accessing the USNO-SA1.0 catalog (see above):
http://asteroid.lowell.edu

IAU: Minor Planet Center
http://cfa-www.harvard.edu/cfa/ps/mpc.html

Comet Ephemerides
http://encke.jpl.nasa.gov/eph.html

Artificial Satellite Pass Prediction Service
http://www.chara.gsu.edu/sat.html

Space Calendar (JPL; includes asteroidal occultations with links to IOTA's asteroidal site)
http://newproducts.jpl.nasa.gov/calendar

STANO COMPONENTS less expensive image intensifiers
http://www.stano.night-vision.com/

Weather sites: I have had lots of advice about these for North America, but would also be interested in learning of sites giving weather information for Europe, Australia, the Far East, and other areas of the world.

USA, s. Canada, & n. Mexico weather image, composite of satellite infrared and radar (precipitation) GIF image 640x350 pixels
http://rs560.cl.msu.edu/weather/uscmp.gif

N. America visual satellite GIF image 1024x900 pixels http://wxweb.msu.edu/weather/g8vis.gif

Interactive Weather Browser
http://wxweb.msu.edu/weather/interactive.html

Current Weather and Forecasts
http://taiga.geog.niu.edu/chaser/satwx.html

Real-Time Weather Data: Satellite Page
http://www.rap.ucar.edu/weather/satellite.html

Some other services:

USPS ZIP Code Lookup and Address Information
http://www.usps.gov/ncsc/

A few IOTA members have portable equipment for travelling by air to solar eclipse and updated asteroidal occultation paths. Especially for the latter, up-to-date information on airfares and discounts is important, and some airline companies have comprehensive Web sites that give this information, as well as some special short-term discounts available nowhere else. Electronic tickets can even be purchased over the Web. The yellow pages, advertisements, or airline reservation personnel can provide Web sites for airlines of interest; one is given below (for one of the generally less expensive airlines) ONLY as an example, not as a specific IOTA endorsement:

Southwest Airlines Home Gate
http://www.iflyswa.com/ ι

Upcoming Giant Star Catalogues and Sky Atlases

Brian Skiff
(bas@lowell.edu)

This article came from the Newsgroup: sci.astro.amateur on 23 Jan 1997 00:12:43-0800.

It's occurred to me recently that most sci.aastro.amateur. readers are completely unaware that several major changes are coming along soon in the field of comprehensive star catalogues and star atlases. By about this time next year, whatever you're using now (in both print and machine-readable form) will be obsolete. Here's a summary of what's happening along with some Web links for further information, or in case you want to get a head start.

Star catalogues that are already obsolete (AGK3, SAO)

Under this heading are the two venerable B1950.0 catalogues: the AGK3 and the SAO. The AGK3 has about 200,000 stars north of -2 Dec, containing positions, proper motions, and photo-blue magnitudes complete to about blue magnitude 8.5, but with many stars down to mag. 12 or so. This used to be the catalogue of choice for the northern hemisphere. At present, the positions in the AGK3 are good to about 0".75.

The SAO catalogue was compiled in the 1960's from a large number of sources, reduced as well as possible (at that time) to a common system. The catalogue contains about 260,000 stars for the whole sky (less dense than the AGK3 in the north). It was intended for satellite tracking (from the ground) and also for attitude-control on orbiting spacecraft. Despite having these origins as an engineering tool, the compilers tried to make it useful for astronomy as well. At present the positions in the SAO have rather large errors, typically around 1".2 in the north, and progressively worse south of about -20 Dec, with many cases of errors up to 10" in the far-southern sky. The reason for this is the sheer age of the positions that went into the catalogue, which have a mean ending epoch around 1940. As a result, when the proper-motions derived from the older data is extrapolated to the present, substantial errors creep in, even if the original positions are good. You should no longer be using either of these catalogues.

Star catalogues that are about to be superseded (PPM, ACRS, GSC v1.1)

For most purposes there are again two "catalogues of precision" in use for doing astrometry, making charts, etc. One is the ACRS ("Astrographic Catalog Reference Stars"), which was produced about 1990 by the U. S. Naval Observatory. It is an all-sky catalogue of about 380,000 stars, compiled as was the SAO from a large number of older sources. In this case, the analysis of the input data was much better than before, and more stars could be included as well from modern observations. The current accuracy of the positions is about 0".3, a factor of four better than the SAO; the motions are factors of six to ten more accurate.

The other catalogue is the PPM ("Positions and Proper Motions"), which was compiled in 1990 by the Astronomisches Rechen-Institut in Heidelberg. This catalogue contains altogether about 470,000 stars with mean errors similar to the ACRS. Since many people get confused: in the northern sky, the PPM lists the photo-blue magnitudes directly from the AGK3. These magnitudes will be about 0.5 to 1.0 (typically) fainter than visual magnitudes. In the south, the magnitudes are a mix of photo-visual and photo-blue magnitudes, and even some real visual estimates surviving from hundred-year-old catalogues such as the Cordoba Durchmusterung. There is a code in the PPM-South that tells the source of the magnitude for each star. In all cases, the magnitudes scatter from "truth" by around ± 0.3-0.5 mag. For most of the naked-eye stars, however, no matter where in the sky they are, accurate photoelectric V magnitudes are given (to 0.1 mag. precision).

Far more comprehensive, but of lower accuracy, is the Space Telescope Guide Star Catalogue (GSC). The GSC, version 1.1, now appears in many software packages intended for the amateur market, including those produced by contributors to this newsgroup. It contains about 16,000,000 'things' from digitally-scanned Schmidt plates. Most of these are stars and galaxies, but also emulsion flaws, asteroids, parts of galaxies, pieces of diffraction spikes emanating from bright stars, etc.; there are also bits of dust, dandruff flakes, hairs, and whatnot included in the GSC. It is also an engineering product, not a true astronomical catalogue, no matter that both professionals and amateurs are using as if it were the latter. For the star positions, the GSC v1.1 used as the reference net the AGK3 in the north, and the SAO in the south, there being no other reference catalogues available when the plates were scanned. On top of this problem, the equations used to convert the x,y pixel coordinates of the scans into RA and Dec did not adequately model the distortions of the Schmidt plates. As a result, in the corners of the plates, the star positions are frequently off by 2"-3", plus having the general errors caused by the old star catalogue reference nets.

This is a good place to mention the magnitudes in the GSC: they [are not good]! In the north (specifically north of about +3 Dec), the GSC derives from short-exposure yellow-light plates taken in a special survey at Palomar. South of +3 Dec, the deep blue-light survey plates from the UK Schmidt in Australia were used. Along the southern Milky Way, in order to avoid severe crowding problems, a series of V-band plates was taken. Special plates were taken for such areas as the Magellanic Clouds, M31, etc. The magnitudes were calibrated with sequences of about six stars near the centers of each field. In the immediate region of the those sequences, say within a circle 1 degree across, the GSC magnitudes are often pretty good. Outside that area, all bets are off, and the GSC magnitudes scatter over a range of two to three whole magnitudes. Sometimes they're okay, but usually they're off by half a magnitude or more. In the north, of course, the magnitudes are in the yellow, but in the south they're blue-light magnitudes (i.e. fainter than visual for most stars). Except for the near-Milky Way regions, none of the magnitudes are "visual". In the north, they're redward of visual, so red stars come out too bright; in the south, they're blue, so red stars come out too faint. The bottom line is not to use the GSC magnitudes for anything. No, not anything.

Star catalogues right now (until circa June 1997; TAC, GSC v1.2, UA1.0)

The ACRS mentioned above was compiled mainly to re-reduce measurements from the "Astrographic Catalogue" (AC). The AC and accompanying "Carte du Ciel" (Sky Atlas) was a mammoth project from the turn of the Century to compile a catalogue of stars down to about mag. 11.5, and a photographic star atlas down to about 14th magnitude. About 20 different observatories participated in the project, each assigned a narrow strip of Declination to cover. The project was simply too unwieldy, and was completed only in a few of the zones. However, nearly all the observatories got as far as publishing raw x,y measurements of stars from the photographic plates taken for the atlas, totaling some four or five million stars. These printed volumes take up about 20 feet of shelf space. It turns out the accuracy of these x,y measurements is quite good enough to be still useful a century later. What they provide is a very early starting epoch from which to determine the proper-motions for stars. The USNO-Washington folks have done this work, and the results are now becoming available. These old observations aren't really of that much use without some new positions to go along with them, however.

What the Naval Observatory has done is to prepare a new star catalogue combining the old AC x,y positions (reduced to RA/Dec) and new positions measured on plates taken with the Twin Astrograph in Washington DC. This catalogue obviously doesn't cover the whole sky (yet), but reaches to -18 Dec. In this area are some 750,000 stars, nominally complete to photo-blue mag. 10.5, with a lot of stars included that are up to one magnitude fainter. This is triple the areal density of the ACRS or the PPM, and further, the accuracy of the positions is three times better, approaching 0".1! This is limited now mainly by the fundamental reference frame of positions on the sky. You can download the "Twin Astrograph Catalogue" (TAC) in one-degree strips directly from the USNO at: **http://aries.usno.navy.mil/ad/tac.html.**

It's three times larger than the PPM, so have plenty of disc space ready! Be sure to read the introductory text at the Web site, since there are some caveats on the quality of the data for certain zones. This Web page also has a link to the original AC re-reductions, too. There's some interesting historical reading provided about the origins of the AC.

The other up-to-the-minute catalogue is the GSC, version 1.2. This is a re-reduction of the GSC using this time the denser PPM star catalogue as the reference net, and also taking into account very carefully the distortions of the Schmidt plates. The GSC v1.2 is not available yet "in toto", but can be explored on a star-by-star basis at the Web site for the "Catalogues and Surveys Branch" (CASB) at Space Telescope: **http://www-gsss.stsci.edu/gsc/gsc12/gsc12_form.html**.

The claim is that the GSC v1.2 is reliable at the 0".3 level, and this appears to be the case for several examples tested by asteroid occultation predictions. Thus the data are ten times better than v1.1! The main CASB Web area homepage is at: **http://haven.stsci.edu/** which contains other interesting stuff.

Even the GSC is small change nowadays, thanks to complete deep scans of the original sky survey plates in both hemispheres in two colors. How deep? Magnitude 20. How big? How does 500,000,000 stars sound?! That's something like 2 percent of all the stars in the Milky Way galaxy! Compared to the GSC, this is like a hippopotamus squatting on a pocket Bible. The sky survey that's readily available now has been produced by the U. S. Naval Observatory in Flagstaff. The products from the "Proper Motion Machine" (PMM, not PPM!) are described at another USNO Web site: **http://www.usno.navy.mil/pmm**.

There are two main catalogues. "SA1.0" is a selected list of a mere 54 million stars between mag. 16 and 19 uniformly distributed around the sky. It is intended to be used as an astrometric reference net for large telescopes and narrow-field instruments, such as for amateurs doing asteroid and comet astrometry with commercial CCDs. Often there are only a few GSC stars in a field, not really enough to get a good asteroid position. This catalogue will allow even small chips to get enough reference stars to do such measurements. Obviously, this is not a catalogue to use to make star charts, since the stars are chosen by their distribution, not to make maps. If you do astrometry, head to the Web page above to read about getting a copy of the CD this catalogue is on.

The catalogue everyone should be excited about is "UA1.0". This is [a] real inventory of the Schmidt sky survey plates, done from the original plates (not copies), and reaching even fainter than you can see on the POSS prints, comprising 488,000,000 'detections', with some star/nonstar discrimination. Using the preliminary "A0.9" catalogue we have on-line at Lowell, I have extracted positions for mag. 19 variable stars in the thickest parts of the Aquila and Cygnus Milky Way. This comes on 10 CDS (6 gigabytes), and will not be generally available (at least for now) except to professionals, mainly because USNO-Flagstaff is not in the business of spending their time cutting CD-ROMs to sell.

Because a lot of people have their fingers in the pie, it is not clear how these can be used in commercial products. Besides the Navy, there's also the National Geographic (who's paid for both surveys in the north), the European Southern Observatory and the Anglo-Australian Observatory (for the south), Cal Tech, and Space Telescope Science Institute, all of whom have various claims and copyrights on the source material. As the project maestro Dave Monet has said, "don't make me wake up the lawyers". However, you guys that make sky-chart software ought to write Dave (**dgm@nofs.navy.mil**) to see what the prospects are downstream.

Catalogues of the near future (Hipparcos/Tycho, Millennium Star Atlas)

If you talk to anybody making star catalogues now, they'll all tell you that everything is going to be swept aside by Hipparcos. The Hipparcos spacecraft operated in the early 1990's to obtain parallaxes, positions, plus B and V magnitudes for stars. The results have been under tight wraps, but will be released in a few months. The parallax part of the mission (Hipparcos) produced parallaxes good to about 1 milliarcsecond (one thousandth of an arcsecond) and high-precision proper-motions for about 100,000 stars. Another instrument on the same spacecraft, called Tycho, has produced positions plus B and V magnitudes for one million stars---complete to mag. 10.5, and lots of stars to 11.5 (not quite as complete as the TAC).

Much more interesting for amateur observers is that a new large-scale star atlas, the "Millennium Star Atlas", is being produced from the Tycho data by Roger Sinnott and colleagues at Sky Publishing. When it comes out later this year, it will blow the Uranometria and Herald-Bobroff atlases out of the water. (Is it going to be perfect? No.) This is not just a rumor---they're taking orders! You can find out about the Hipparcos/Tycho mission and its products at the ESA Web site: **http://astro.estec.esa.nl/SA-general/Projects/Hipparcos/hipparcos.html**.

The ESA folks are taking orders for the complete set of books and CD-ROMs or for various major parts (including the atlas) until the end of January. The Sky Pub atlas of course will be more generally available. Again, software guys should find out about it now. See the Web page for sample catalogue pages, charts, and a price list (the prices are very reasonable: US$400 for the complete package of sixteen bound volumes plus six CD-ROMs and software).

The high-precision positions from Hipparcos/Tycho will mean that all previous ground-based reference frames will become obsolete. Once the data become available to mere mortals this summer, everyone will re-reduce their position catalogues using the Hipparcos stars as the reference frame. The GSC will be redone again, A1.0 will become A2.0 (or something), the Twin Astrograph Catalogue will get re-reduced; new star catalogues will be started to extend the high-precision to fainter limits. Already the USNO-Washington has proposed a digital sky survey to 15th magnitude that will have the same accuracy as Hipparcos.

You read/hear about a lot of amazing stuff coming out of astronomy, but it's mostly about specific objects, or an obscure new discovery. Here are some things that will really change the way we do even amateur astronomy. Watch this space! [the newsgroup sci.astro.amateur] ι

GSC Version 1.2 is Needed for CCD Asteroidal Occultation Astrometry

David W. Dunham

The occultation of 10th-magnitude BD +33° 633 by (704) Interamnia on 1996 December 17th was timed from at least 12 stations in the southwestern U.S.A. Some preliminary reductions of the observations are given on IOTA's asteroidal occultation Web site and will be published here later after some refinements in some of the data are obtained. But an important result from the occultation was the realization of a better way for the reduction of CCD observations, or "last-second astrometry", for these events.

The occultation path had been updated days in advance using meridian circle observations of the star and Interamnia obtained with the U. S. Naval Observatory (USNO) transit circle at Flagstaff, AZ and with the Carlsberg Automated Meridian Circle (CAMC) in the Canary Islands. Shortly before the occultation, those two results differed by 3/4th of a path width, so I hoped that CCD observations made several hours before the event might help decide which path might be the better one. Jan Manek obtained such observations with the 65 cm telescope at Ondrejov Observatory, Czech Republic, but my analysis of his observations, reduced the usual way with Guide Star Catalog (GSC) Version 1.1 data, but this gave a result over 0.3", or more than a path width, north of the other predictions. Other CCD observations by Gordon Garradd in Australia and Fiona Vincent in Scotland were similarly inconclusive. This was disappointing, because CCD observations to update asteroidal occultation paths are made more frequently than the meridian circle observations. For this occultation, the prediction by Martin Federspiel using the CAMC observations predicted the path almost exactly, to within 0.01". We hope that this is not just "beginner's luck" and eagerly await CAMC updates for more asteroidal occultations (one was made for the February 10th occultation by 451 Patientia, but that event was clouded out along the whole updated path from Georgia to Saskatoon).

When Jan Manek learned of his error after the occultation, he was angry, knowing that the internal accuracies of the CCD observations were much better. So he re-reduced his observations using the new GSC Version 1.2 positions (their accuracy is about 0.3", compared with GSC 1.1's accuracy of about 1.0") for his reference stars which he obtained from the World Wide Web (see p. 339) and sent me the new positions for the star and Interamnia that resulted from this. It made a BIG difference! A version of my astrometry table from the message that I sent out less than 2 hours before the occultation is copied below, with the occultation itself, and then the new reductions (Manek 1.2), added. As you can see, with GSC 1.2, the prediction is only 0.03" different in the path from what happened, as compared with 0.4" with GSC 1.1.

From the results before the event, I was beginning to doubt the value of any "last-second" CCD astrometry for asteroidal occultation predictions, with the 3 pre-occultation CCD results all disagreeing with what happened by sizeable amounts. Vincent's result with DSS was better than GSC 1.1 results, but GSC 1.2 was significantly better than DSS. I believe my fears about "last-second" astrometry being almost useless are true with GSC 1.1 - the positions are just too poor for this work. I strongly recommend that those attempting CCD astrometry for occultations upgrade to GSC 1.2 as soon as they can (currently, GSC 1.2 is available only via the World Wide Web for small fields whose center the user specifies). A new catalog with about 400 million stars was recently produced at Flagstaff, and it should be better than GSC 1.2, both in terms of positional accuracy and density of stars. It should help even more when it becomes widely available to those using CCD's for astrometry.

Astrometry for the 1996 Dec. 17th Interamnia Event

Source	Track	Time Corr. m	Path widths from Occ'n	MIN. U. T. h m	GEOCENTRIC SEP. "
USNO-Dec.15	80S	0.0	0.74S	9 13.4	2.40S
Goffin	80N	+2.7	0.09S	9 16.1	2.24S**
CAMC	98N	+0.3	0.02S	9 13.7	2.22S
USNO-Dec.2	0	0.0	0.41S	9 13.4	2.32S
Garradd	380N	+1.2	1.12N	9 14.6	1.94S
Vincent	110S	+1.1	0.86S	9 14.5	2.43S
Manek 1.1	390N	+1.1	1.17N	9 14.5	1.84S
Occult'n	101N	+0.1	0.00	9 13.5	2.22S
Manek 1.2	130N	+0.7	0.11N	9 14.1	2.19S

** Normal prediction

The parallel "Tracks" given in the table are in units of 0.001" in a system that was widely distributed to observers before the occultation. "Goffin" is the nominal prediction computed by Edwin Goffin before the occultation and published in my article on 1996 planetary/asteroidal occultations in the 1996 February issue of *Sky & Telescope*. The table shows that, although CAMC had the best prediction of the path for the occultation (and that's most important), USNO had the best prediction for the time of the event.

The technique was vindicated again for an occultation by 363 Padua on January 6th. Jim Roe obtained CCD images the night before the occultation at Oaxaca, Mexico, and reduced them with GSC 1.2. I distributed by e-mail a prediction based on those observations. Jose Gomez Castano observed a short occultation at the expected time near Madrid, while Jose Ripero, about 20 km farther north relative to the path, had no occultation. This showed that the northern limit passed between their sites, and that the prediction based on Roe's data was only 0.07" in error, quite good for CCD observations with an 8-inch telescope. So now we look forward to more GSC 1.2 "last-second" CCD astrometry for updating asteroidal occultation paths. ι

Stations for the 1993 Oct. 9th occultation of SAO 128735 by (27) Euterpe

David W. Dunham

The outline of (27) Euterpe that I derived from the 1993 occultation was published on p. 301 of the last issue without an explanation. That is only a preliminary figure that may be modified slightly when some of the timings might be determined more accurately. The stations are arranged as they are on the asteroid from north to south, and are identified below; the heights above sea level in the last column are in meters.

Code specifies the form of the lat. and long. (negative w. of Greenwich):

O means that the form is +/-DDMMSS.S, or +/-DD deg. MM' SS".S

H = O but with the long. in the form +/-HHMMSS.SS or +/-HH h MM m SS.SS s. ι

Location	Code	Latitude	Longitude	Observer	#	Height
Coolidge, AZ	O	325730.	-1113915.	Allen Morton, C14 video	6	450
Florence, AZ - LW	H	325135.9	-72455.19	Wasserman&Thompson C14pe	9	693
Belen, NM - Alb.	O	343120.2	-1065041.7	Gen.NathanTwiningObs.41cmV	8	1558
Socorro, NM	O	340414.	-1065454.	Etscorn Obs.C14,NMIT	1	1424
Dumas, TX - PM&RN	O	355115.6	-1015801.2	PaulMaley&RichNugent,Md10	7	1116
Tucson, AZ - JS	O	322513.4	-1105752.2	Jim Stamm	5	842
Tucson, AZ - LW	O	321948.	-1105437.	Larry Wilson	3	878
Tucson, AZ - JB	O	321610.3	-1105713.5	Joe Bergeron	4	719
Tucson, AZ - AV	O	321735.3	-1104738.5	Albert Vreeland	2	805

Heartland Astronomical Research Team Image Intensified Video System

Craig A. McManus

The Heartland Astronomical Research Team (HART) is based in Topeka, Kansas. We are a group of amateur astronomers that banded together in order to support each other and combine resources to buy equipment. I wrote earlier (*ON* vol. 6, no. 2, "The H.A.R.T. Mobile Observatory") about the video system that we had put together for grazes and total occultations. This system has worked very well since that time. We have recorded Bailey's beads at a solar eclipse, grazes (regular and during total lunar eclipses), and attempted asteroidal occultations. We have also used the system for our teaching star parties for schools and social groups. It is amazing how much easier it is to talk about the moon and planets when everyone can see what you are talking about on a video monitor!

However, like most active amateur astronomers, we wanted to be able to do more with the system. (MORE POWER!!) We were not sure what to do. We could buy an intensified camera, but that would cost big bucks. Then Tom Campbell told us about an intensified system that he had built. We were very interested in what he had to say. He graciously allowed us to borrow the system from him for a couple of months. After even just one use we were convinced that we wanted to build something similar. With Tom's system and a 10" f/10 LX200 we were able to image (in real time) stars down to the 13th magnitude in the middle of the city of Topeka (Area Population 160,000)! The incredible things that we were able to do with Tom's system sent us on our way.

The biggest problem was where to find an image intensifier that was both high quality and relatively inexpensive. Tom had purchased his intensifier from STANO. At the regular price he was able to get a sensitive image intensifier but with two burned out areas. We did not want any spots so we bought a similar image intensifier but with no flaws. Of course it was much more expensive but we felt the extra expense necessary because of the image quality. We used the same basic design that Tom had used on his system. PVC pipe was routed out to the diameter of the image intensifier. The intensifier is held in place by screws. The power supply and variable sensitivity controls were run from the image intensifier to a phone jack. This allows us to use regular phone wire to control the image intensifier from a distance. A box was constructed to control the image intensifier. It holds the power supply (two D-cell alkaline batteries) and the rheostat for sensitivity. Both of these go to another phone jack. A switch to turn it off and on is a separate control. When the image intensifier is connected to the power supply but not turned on, a red LED blinks to remind us the wire is attached. When the image intensifier is powered on, the LED does not blink.

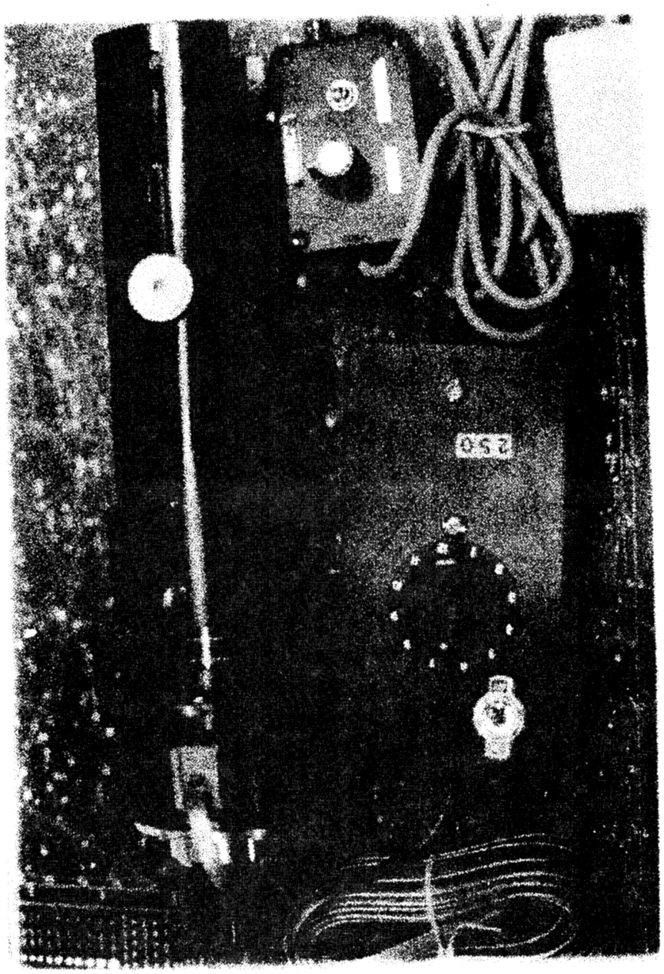
Behind the image intensifier is the camera. We use a 0.01 lux camera with 600 lines of resolution by CCTV Corp. (280 Huyler Street, South Hackensack, New Jersey 07606 USA Phone 1-800-221-2240, Fax 1-201-489-0111. CCTV Corp. offers a discount to all IOTA members who supply proof of membership.) Two grooves were routed out of the sides of the PVC pipe to act as channels for the camera and as sites for the threaded bolts that act as the attachment points for the camera to the PVC pipe. The good quality lens that we ordered with the camera could not focus close enough to the view plate of the image intensifier to utilize full or even near full field of view with the camera. We tried a 5 mm spacer but this was too big. The problem was solved by going to a hardware store and buying rubber o-rings about 1 mm thick of the appropriate diameter to go around the screw mount on the lens. One of these turned out to be the perfect spacing for the lens. We can focus close enough to zoom in on a smaller object, but we can also have a full field of view when we need it. We have not noticed any degradation of the view even with the lens extremely close to the view plate of the intensifier.

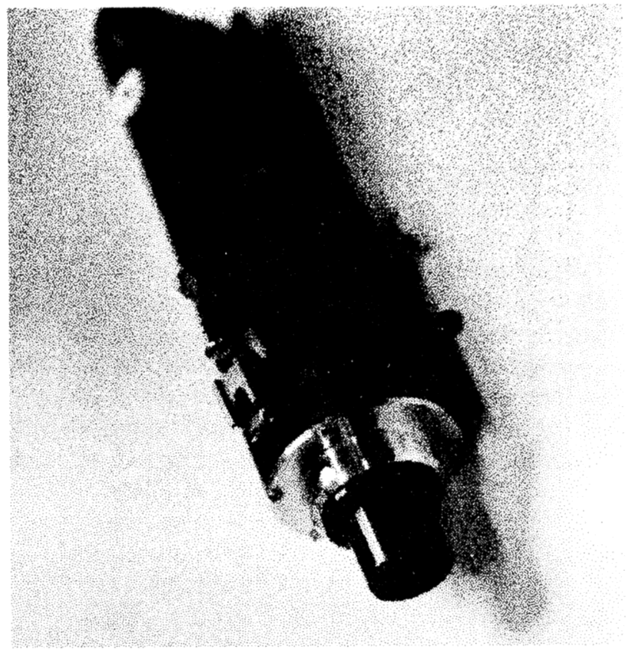
The total field of view in the 10" f/10, at prime focus, is larger than the moon! It works tremendously well on open clusters, globular clusters, and even on faint extended objects. We can directly image galaxies such as M31, M32, and M110. Comet Hyakutake showed up extremely well. We can image stars down to 13th magnitude with clear resolution on our videotape. The ability to use the video system to show people globular clusters, the Ring Nebula, open clusters, and the planets really makes star parties fun. We can stand at the monitor and explain to people what they are seeing and point out interesting and significant features. Of course, we also have plenty of scopes set up so people can see these objects with their own eyes, but many people appreciate the fact that they can see these things without standing in line. Older people and those with glasses are often able to see these things for the first time. We never have to refocus for each person. With a computer guided system on two of our telescopes we can take people on a tour of the sky quickly with no wasted time looking for objects of interest.

Of course not all of this occurred with out problems. We worked as a team to get it done and the system continues to be refined. We had been plagued by a mysterious light leak that we could not eliminate unless we draped the entire assembly with an EPED: Extraneous Photon Eliminating Device (a dark cloth). This worked well but was not a permanent solution. The problem turned out to be light leaking through the PVC pipe itself! We then painted the exterior of the PVC with two layers of black paint and that solved the problem.

Our next project is fitting the image intensifier with an occulting bar so we can use it on the moon for both grazes and total occultations. Even the fully eclipsed moon was too bright for the system! We hope the occulting bar will allow us to use the system for the cluster passages that will be occurring starting next year and to record the faint grazes (fainter than the 9th magnitude we can record without the image intensifier now) that we attempt visually. We are very excited about the arrival of our next piece of equipment. Hopefully, we will be using the system with a 20" f/5 Obsession telescope by the time you read this. It will have the same field of view as the 10" f/10 but with four times the light gathering capacity! We cannot wait to see what our limiting magnitude will be with this system! Galaxies should be plentiful and clusters should be unbelievable! We will be using the image intensifier system for the mutual events of the Jovian moons this year with the occulting bar if we can get it to work well. But we may find that the Galilean moons are just too bright for the system. We may need to do them with *just* the 20" and the camera! That will be a tough choice, but somebody has to make it!

HART is always looking for astronomical research projects that our system can help with. If you have any projects that we can do, please contact us at HART, PO Box 3938, Topeka, KS 66604-6938, USA. You can e-mail us at any of the following addresses: Richard Wilds at **DarkMatter-at-HART@worldnet.att.net**, Rex Easton at **SkyGazer@inlandnet.net**, or Terri & Craig McManus at **IOTA@inlandnet.net**. An introduction to our group can be found at **http://www.sky.net/~robinson/hart.htm**. ι





So What Did I Learn?

Robert H. Stewart

On the evening of January 20, 1997 I attempted a grazing occultation of SAO 95456 down in North Carolina, USA. I did not get any useful data (I lost the star in the lunar glare), but in retrospect, I learned a great deal that evening, so I thought I might write a short article that might help other neophytes such as myself.

There are two things I really like about astronomy. One is going on the hunt. Trying to find that faint fuzzy or dim star requires a planned attack: learn the constellations, study the star charts, and learn to star hop (no computer pointing gizmos on my scope). The second is observing lunar occultations. This is about as real as it gets. I call it "Prime time, Live time" astronomy. You get to watch all the forces of the cosmos at work, and it didn't happen 40 million years ago.

So there I sat, 1 km south of Hertford, NC, having attempted a grazing occultation of SAO 95456, and had not gotten any useful data. So what did I learn? A great deal, actually. This was the first graze I was able to do that I had planned from OCCULT (ver. 3.11). Also, the first I had used a 30' x 60' map to plot the track and plan my location. The mere fact that I actually saw the star with the moon approaching at the place I had plotted made me feel good. From the prediction I knew that the moon was 94%+ sunlit, and my first disappearance would be at a sunlit feature on the lunar limb. SAO 95456 is a 6.8 mag. double star, and I thought I would be able to get the graze with this bright of a star. I lost it in the lunar glare just before first contact. But if I hadn't gone south I wouldn't know what I learned about planning and plotting graze paths. And I wouldn't know to pay more attention to the %sunlit information. Besides, the sky in North Carolina is awesome this time of year. ι

IOTA's Mission

The International Occultation Timing Association, Inc. 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.

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IOTA Online--Timely Updates

The Occultation Information Line at 301-474-4945 is maintained by David and Joan Dunham. Messages may also be left at that number. When updates become available for asteroidal occultations in the central USA, the information can also be obtained from either 708-259-2376 (Chicago, IL) or 713-480-9878 (Houston, TX). The IOTA WWW Home Pages are at **http://www.sky.net/~robinson/iotandx.htm** for Lunar Occultations and Eclipses--maintained by Walter L. "Rob" Robinson--and **http://www.anomalies.com/iota/splash.htm** for Asteroidal Occultations--maintained by Jim Hart.

IOTA European Service (IOTA/ES)

Observers from Europe and the British Isles should join IOTA/ES, sending a Eurocheck for DM 40,00 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" to their bank account. Please contact the secretary for a blank form. 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:

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