Occultation Newsletter

Volume IV, Number 2 December, 1986 ISSN 0737-6766

Occultation Newsletter is published by the International Occultation Timing Association. Editor and compositor: H. F. DaBoll; 6N106 White Oak Lane; St. Charles, IL 60174; U.S.A. Please send editorial matters, new and renewal memberships and subscriptions, back issue requests, address changes, graze prediction requests, reimbursement requests, special requests, and other IOTA business, but not observation reports, to the above.

FROM THE PUBLISHER

This is the fourth issue of 1986. Please note the membership and subscription price rate changes.

When renewing, please give your name and address exactly as they appear on your mailing label, so that we can locate your file; if the label should be revised, tell us how it should be changed.

If you wish, you may use your VISA or MasterCard for payments to IOTA; include the account number, the expiration date, and your signature. Card users must pay the full prices. If paying by cash, check, or money order, please pay only the discount prices.

	Full price	Discount price
IOTA membership dues (incl. *O.N.* and any supplements)		
for U.S.A., Canada, and Mexico	$12.50	$12.00
for all others (to cover higher postage costs)	17.71	17.00
Occultation Newsletter subscription[1] (1 year = 4 issues)		
by surface mail		
for U.S.A., Canada, and Mexico[2]	8.33	8.00
for all others	8.17	7.84
by air (AO) mail[3]		
for area "A"[4]	9.96	9.56
for area "B"[5]	11.38	10.92
for all other countries	12.79	12.28
Back issues of *O.N.* by surface mail		
O.N. *1* (1) thru *O.N.* *2* (13), each	1.04	1.00
O.N. *2* (14) thru *O.N.* *3* (13), each	1.46	1.40
O.N. *3* (14) and later issues, each	1.82	1.75
Back issues of *O.N.* by air (AO) mail[3]		
O.N. *1* (1) thru *O.N.* *2* (13), each	1.51	1.45
O.N. *2* (14) thru *O.N.* *3* (13), each	1.93	1.85
O.N. *3* (14) and later issues, each	2.29	2.20
(There are 16 issues per volume, all still available)		

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

Local circumstance (asteroidal appulse) predictions (entire current list for your area)	1.04	1.00
Graze limit and profile prediction (each graze)	1.56	1.50
Papers explaining the use of the predictions	2.60	2.50

Supplements for South America will be available at extra cost through Ignacio Ferrin (Apartado 700; Merida 5101-A; Venezuela), for Europe through Roland Boninsegna (Rue de Mariembourg, 33; B-6381 DOURBES; Belgium), for southern Africa, through M. D. Overbeek (Box 212; Edenvale 1610; Republic of South Africa), for Australia and New Zealand, through Graham Blow (P.O. Box 2241; Wellington; New Zealand), for Japan, through Toshio Hirose (1-13 Shimomaruko 1-chome; Ota-ku, Tokyo 146, Japan). Supplements for all other areas will be available from Jim Stamm (Route 13, Box 109; London, KY 40741; U.S.A.) by surface mail at the low price of 1.23 1.18 or by air (AO) mail at 2.04 1.96

Observers from Europe and the British Isles should join IOTA/ES, sending DM 50.-- to Hans-J. Bode, Bartold-Knaust Str. 8, 3000 Hannover 91, German Federal Republic. Full membership in IOTA/ES includes the supplement for European observers.

[1] Single issue available at ¼ of price shown.
[2] Price includes any supplements for North American observers.
[3] Not available for U.S.A., Canada, or Mexico.
[4] Area "A" includes Central America, St. Pierre and Miquelon, Caribbean islands, Bahamas, Bermuda, Colombia, and Venezuela. If desired, area "A" observers may order the supplement for North American observers by surface mail @ 1.23 1.18 or by air (AO) mail @ 1.56 1.50
[5] Area "B" includes the rest of South America, Mediterranean Africa, and Europe (except Estonia, Latvia, Lithuania, and U.S.S.R.).

IOTA NEWS

David W. Dunham

This issue is a few weeks later than I intended. The production of the enclosed grazing occultation supplement, and distribution of data for 1987 grazes to the computors, took longer than I expected. The latter was partly caused by the software problems at the U. S. Naval Observatory (USNO), described in *O.N.* *3* (16), 343, which have been fixed (see p. 23), and partly to the bringing on line of three new graze computors (thanks in large part to Donald Oliver's efforts; see p. 25). Although Stamm's and Stockbauer's articles on observations are now over a month out-of-date, they will soon have another chance to bring things up-to-date. Sometime in December, two or three weeks after this issue, we plan to distribute the next issue (number 3), that will include my article on asteroidal and planetary occultations for 1987, and Goffin's asteroidal occultation supplement for North American subscribers. We received Goffin's material in October, and David Werner has added constellation boundaries, Greek letters, and Flamsteed numbers to the 15° charts so that they will not need to be published separately, as was the case for 1986. For preliminary planning purposes, in January, some of the better events include ones on the 4th [14^h U.T., 11.5-mag. LS 2488 and (159) Aemilia, nominal path in Alaska and western Canada]; the 11th [13^h, 7.6-mag. SAO 109035 and Mars, India and China]; 13th [2^h, 6.3-mag. SAO 183058 and (54) Alexandra, S. Africa]; 25th [0^h, 8.0-mag. SAO 58556A and (471) Papagena, Canary Is. and n.e. U.S.A.; and 10^h, 9.1-mag. SAO 98160 and (30) Urania, U.S.A. FL to CA and east Siberia]; and 27th [21^h, 10.9-mag. A.C. star and (704) Interamnia, U.S.S.R. and northern Europe].

Price increases. It is again necessary to raise membership and subscription prices, effective with publication of this issue; see "From the Publisher," on this page.

Aurora event, Nov. 4. Unfortunately, I will not have time to write an article on astrometric updates for asteroidal occultations for this issue, but hope to include it next time. In spite of quite a bit of activity, only one event this year has been found to be favorable for much of the U.S.A. This was the occultation of SAO 79994 by (94) Aurora on November 4. According to a Lowell Observatory plate, the path shift was 0".39 north, crossing the continent from Baja California to Labrador. I got the result of the Oct. 28th plate on the 29th, and spent all that night and much of the next day preparing, duplicating, and distributing 200 notices of the event to *O.N.* subscribers, Astronomical League club correspondents (Alcors), academic astronomy departments, and others in and near the path. Incredibly, it was cloudy over virtually the entire path, from the Tucson, AZ, area to Labrador. It was clear in Baja California, and it also cleared up across most of Wisconsin, where observers as far south as Milwaukee (near the updated southern limit) saw no occultation. Unfortunately, it was still overcast just a little farther south, where the actual path probably was located.

IOTA enclosures. With this issue, IOTA members are also being sent a roster of members and direct *O.N.* subscribers prepared by DaBoll, and an IOTA sticker (4-inch or 10.16-cm diameter) whose production was arranged by Joan Dunham. Non-members can obtain these from DaBoll – rosters: in North America 75¢, elsewhere $1.30 by A.O. mail – stickers: in North America 50¢, or 25¢ and a SASE (up to 8 @ 25¢ each will go in a sub. 20 $4^1/_8 \times 9\frac{1}{2}$ envelope without extra postage), elsewhere 75¢ each by air mail.

ASTROCON 86. An IOTA session was held in Baltimore, MD, on August 8th, during the Astronomical League's 40th annual convention: see *Sky and Telescope 72* (5), 520. No business was conducted, but five scientific papers were given: "Eclipse Solar Diameter Measurements" by Joan Dunham, Paul Maley, and me; "Asteroidal and Cometary Occultations" by Peter Anderson and me; "The 1983 Pallas Occultation: The Best Yet" by Joan Dunham, Paul Maley, Harold Povenmire, and me; "A Graze of the Close Binary Sigma Sco in Baja" by Joan Dunham, Jared Zitwer, and me; and "Video Grazing Occultations" by me. About forty attended the session, better than the session at the Texas Star Party in May, but still a little disappointing due to the low attendance at the convention apparently caused by most A.L. members using up vacation time and travel expenses for Halley's Comet four months before. The IOTA papers, that contain mostly material that has appeared in *O.N.*, have been published in the proceedings of the convention.

Comet Wilson appulse. On October 22nd, I computed an ephemeris for Comet Wilson using improved orbital elements that had just been published in the *Minor Planet Circulars*, and compared it with a new combined star catalog (which I will describe in the next issue) and discovered that an occultation of 9.0-mag. SAO 125375 by the nucleus would occur shortly after 4^h U.T. of October 28, along a path across the eastern Pacific Ocean and Central America. Since the prediction could be in error by enough to shift the path into Mexico or the western U.S.A., I prepared a notice about the event and sent it to coordinators in those areas. I also telephoned Brian Marsden, who put a note about it on an I.A.U. card sent out on the 23rd. Several observers monitored the star and all reported no dimmings.

IOTA records. Derald Nye's taking over the job of maintaining IOTA's computerized records was noted on p. 2 of the last issue. In late October, he produced address labels and station data for graze predictions for the first half of 1987, and distributed the data to the graze computors. I distributed USNO graze data at about the same time. Nye has written a program that computes the distance of each station from the super standard station center (see the graze supplement). This distance should be 500 miles minus the observer's travel radius to ensure complete coverage. Nye can now check this, and add the station to an adjacent region, if needed, for complete coverage.

Pluto. According to an article in the *Washington Post* on November 10th, Manfred Pakull and Klaus Reinsch recorded an eclipse of Charon by Pluto at the European Southern Observatory. Analysis of their data shows that Pluto's diameter is only 2212 km, so that the planet's density is greater, more like the rocky terrestrial planets than like ice.

Galilean mutual events. A comprehensive set of observations of mutual occultations and eclipses of the Galilean Satellites during 1985 and 1986, recorded photoelectrically at Sutherland, has been published by Iain M. Coulson in *Mon. Not. Astron. Soc. Southern Africa 45* (7 & 8), 77. In September, 1985, I videorecorded an eclipse of Europa by Io. The observations will be useful to improve the orbits to support the Galileo mission. Brian Loader, 14 Heathglen Avenue, Christchurch 9, New Zealand, also collects timings of eclipses by Jupiter; he can provide report forms. On p. 73 of the same issue of *M.N.A.S.S.A.*, T. P. Cooper summarizes the evidence for binary asteroids from light curves (some of these have been rejected by others on dynamical grounds) and occultations, and encourages observations of close asteroidal appulses.

Asteroid results at D.P.S. meeting. The 18th annual meeting of the American Astronomical Society's Division for Planetary Sciences was held in early November in Paris, France. Abstracts of the papers have been published in *Bull. Amer. Astron. Soc. 18* (3). In the asteroids session #21, S. Ostro, D. Campbell, and I. Shapiro reported the radar detection of twelve asteroids from Arecibo since October, 1985, including asteroids numbered 18, 21, 33, 84, 192, 216, 230, 393, 1036, 1866, and 3103, and also 1986 DA. They found dimensions of 120 and 270 km for (216) Kleopatra. Their plot of the return when the long axis is broadside shows a clear dip in the middle, leading the authors to remark: "The wider spectrum's bifurcation is unique among mainbelt asteroid (radar) spectra and supports the conjecture (Weidenschilling, 1980, *Icarus 44*, 807, etc.) that Kleopatra is a 'dumbbell-shaped' asteroid." Or a contact binary? Too bad (624) Hektor is too far away for radar work. L. Wasserman, R. Millis, and O. Franz reported that from the 1985 April 11 occultation of B.D. +20° 2390 = AG +20° 1138, they determined the diameter of (129) Antigone to be 113 ±4 km. They note that this is in exact agreement with the TRIAD diameter determined from infrared radiometry, but the abstract did not mention that the observations were all west of the center of the asteroid; see *O.N. 3* (12), 252. The two visual observations of the event could not be used since these timings were several seconds late compared with the photoelectric recordings. P. Maley confirmed that there could have been a substantial decision time to recognize the relatively small magnitude change when the faint star disappeared and reappeared. R. Taylor, T. Gehrels, and J. Drummond, all from the University of Arizona, gave two papers on (532) Herculina, stating that 1984 lightcurve data show two maxima and two minima which can only be explained by a spherical model with two dark (13% of the average brightness) spots separated by about 160° great-circle distance. This is quite different from Drummond's hypothesis from speckle data noted in *O.N. 3*, (12), 340. They conjecture that the dark spots are maria that resulted from an impact great enough to cause a break in the side opposite impact by forward shock. Could the impact knock off a 45-km satellite?

Sigma Scorpii. David Evans *et al*. have a lengthy discussion of Sigma Scorpii in *Astron. J. 92* (5), 1210. They photoelectrically recorded the March 30th reappearance at McDonald Observatory, obtaining a Δm of 2.2, the same as obtained at Sutherland Observatory in 1972 and included in IOTA's double star files. They discuss the speckle observations, including previously unpublished measurements by McAlister in 1983 and 1984 that I did not have for my discussion in *O.N. 3* (16), 349. The formulae for the sep. and p.a. given on that page can be improved using the new data. Differencing McAlister's 1984 and 1977 observations gives the slightly revised formulae:

$$\text{sep.} = 0''.392 + 0''.0045(\text{year} - 1986.24)$$

$$\text{p.a.} = 263^\circ.9 - 2^\circ.45(\text{year} - 1986.24).$$

These values are close to those deduced by Evans *et al*. and agree well with their observed occultation projected separation. This would give a 0''.19 vertical profile separation, or 380 m on the ground, for our graze in Baja, which is also consistent with our observations. As noted in the *O.N.* article, more information about the profile is needed to get a good observed value for the vertical profile separation.

Lunar occultations of asteroids. Nat White, Lowell Observatory, Flagstaff, AZ, tells me that he photoelectrically recorded a lunar occultation of (9) Metis on 1985 Sept. 22. Metis was 11th magnitude and the Moon 58% sunlit. The photoelectric record was good enough to confirm the predicted duration, and hence the predicted diameter (as given in TRIAD) of Metis. There was no evidence of a step event, casting further doubt on the existence of a large satellite. As far as I know, this is the first photoelectric record of a lunar occultation that is good enough for even a crude asteroidal diameter determination. For future such events, it would be preferable to record the occultations at two telescopes separated by 100 m or more, so that the local lunar slope could be measured. The resulting adjusted motion could be used to get a rather accurate diameter. Nat also recorded a lunar occultation of another asteroid about two months later, but the photoelectric trace was too noisy for even a crude diameter estimate.

USNO NEWS

David W. Dunham

Grazing Occultation Predictions. In August, I created a new version of the XZ catalog that removed Perth 70 data north of +5° declination and replaced positional data for the Pleiades stars with more accurate data from the P catalog. Changes were also made to the XZ data and to the CMS version of the OCC program so that original positional source information is again available in the data produced by OCC for computing graze predictions.

The libration problem has also been fixed. First, David Herald's independent calculation showed that the MVT version results were correct, and the CMS wrong. Mitsuru Sôma also found this to be the case. Wanting to fix the CMS version of OCC, I sent a listing of the LIBRA Fortran subroutine to Sôma, along with a printout of all calculations performed in the subroutine. He quickly found the error. The rate of lunar longitude was compiled with less precision in the CMS version, resulting in the longitude libration error. When I changed this, and related, quantities specifically to double precision, the CMS version computed the correct values, in agreement with the MVT version. This change, the one above, and the new XZ catalog constitute a new CMS version of OCC, called 80H, that was used to generate the basic data for all 1987 grazes. You should ignore spurious 8's and 9's that now appear at the end of the names of a few Z.C. stars.

At about the same time (late August), Alan Fiala found out that the MVT load modules might be moved to CMS, delinked, and relinked. He successfully did this with both the 78A and 80F versions of OCC. I helped him set up the datasets for the relinked OCC, mostly all the same as those used for the CMS 80G version, and successfully reproduced most of the 78A and 80F test cases on CMS. There were some minor differences that were due to updates that had been made to the geodetic datum file. Since these were improvements, the CMS versions of the MVT programs are better than the original MVT versions. We called the CMS relinked versions of 78A and 80F OCC 78B and 81A, respectively. So there was no problem when the MVT system and associated disk drives were removed in late September. Marie Lukac and I were thankful that Fiala's solution allowed us to continue our work. For the rest of 1986, graze profile updates have been processed with the 78B version of OCC.

In the future, we would like to use only the 80H version of the program, the only one where we can change the program (Fortran source code). I have run several cases, for which we have 78A results, with all three CMS versions, 80H, 78B, and 81A. If there are not any big discrepancies, we will use 80H and archive the other two versions. Before processing the data needed by the computors to produce the profiles, in early December, I plan to merge improved star positions from the Lick Observatory Voyager catalogs into the XZ. This should give more accurate predictions, but will delay the distribution of early 1987 profiles. But the computors can compute and distribute the limit predictions now.

Old photoelectric occultation data. During the late 1950s and early 1960s, the Army Map Service (AMS; now the Defense Mapping Agency) purchased several portable 12-inch telescopes, and photoelectrically recorded hundreds of occultations from numerous islands in the Pacific, from Hawaii to Japan to the Philippines. This was done for geodetic purposes, which can now be accomplished much better by artificial satellites. Seventeen boxes containing the original AMS photoelectric traces and records are now taking up space in Marie Lukac's office. This is a potential treasure trove of information about close double stars. Also, much of the AMS data have apparently been added to the computer file of occultation timings, but probably not all of it, perhaps not a majority. Volunteers are sought who could safely store this information, and would be willing to check it against a listing of our current computerized occultation timing file so that the missing events could be entered on ILOC's forms. Our double star files might also be updated with these observations. Anyone interested should contact me at P.O. Box 7488; Silver Spring, MD 20907; phone 301,585-0989.

GRAZING OCCULTATIONS

Don Stockbauer

Date	V p	Star #	Mag	% Snl	CA	Location	# Sta	# Tm	S S	Ap Cm	Organizer	C	St	WA	b
1985															
0212		2241	5.0	47-	14S	Auckland, N. Z	5	35		8	Gordon Herdman				
0409		2443	5.8	77-	14S	Whangaparoa, N. Z.	1	4		20	Gordon Herdman				
0427		1213	7.0	41+	13N	Childers,Australia	2	4		20	Dennis Lowe		2N		
0526		1424	6.8	37+	13N	Ruawai, N. Z.	1	2		15	G. Hudson				
0811		0740	6.3	28--	16S	Barcelona, Spain	2	13	2	16	Carles Schnabel			164	-34
0907		0611	7.0	58-	18N	Kawakawa, N. Z.	2	14		15	G. Hudson				
1221		109892	8.6	70+	7S	Sealy, TX	2	1	1	20	Donald L. Oliver	>	1N	171	18
1986															
0204		185102	8.3	23-	15S	Waihopai, Vly,N.Z.	1	4		20	Brian Loader		0		
0512		0840	6.5	8+	15N	Tynan, TX	1	6	1	20	Don Stockbauer		1S	8	-54
0614		099234	8.9	36+	11N	Goodrich, TX	2	7	1	32	Don Stockbauer		5N	11	-45
0628		3535	5.2	56-	9N	Live Oak Spr., CA	1	1	1	20	David Paul Werner		10N	350	39
0712		118709	8.6	22+	14N	Borden, TX	4	8	1	20	Don Stockbauer		2N	13	-36
0718		2366	1.2	85+-	19S	Carmel Highland,CA	3	14	1	8	James H. Van Nuland		0	194	54
0730		0487	5.2	36-	16N	Arabell, Spain	3	35	1	11	Carles, Schnabel			343	
0829		0885	5.6	31-	15N	Reidsville, NC	8	75	1	10	Mark Lang				
0829		0885	5.6	31-		Narragansett, RI	4	66	1	10	Philip Dombrowski		0		-57
0913		2788	6.2	71+	9S	Lewisville, TX	4	34	2	13	Don Stockbauer		0	169	73
0923		0556	5.5	75-	17N	Katy, TX	4	22	1	15	Don Stockbauer		0	340	-41

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

Please check that all reports of grazes sent to me appear in the graze table either in the next issue after mailing or the one after that. If one doesn't appear, please send another copy and a note explaining the matter. The mail system is not infallible; I feel that the redundancy provided by sending copies to both ILOC and IOTA is well worth the extra postage.

I appreciate the graze summaries being sent by various groups who normally report only to ILOC. Copies of the actual reports would also be appreciated, since ILOC does not send copies to IOTA. In these summaries, please try to include all items given in the *o.n.* graze table, especially the shift value. These items were explained in full in *o.n.* *3* (13), 273; they are also explained (as is the entire report form) in the paper "Use of Form for Recording Occultation Observations," available from me upon request.

General trends of graze shifts as determined from actual observations must not be taken as certain to occur. As an example, northern-limit grazes of northern-declination stars have been shifting 0".3 to the north of the 78A predictions on the average. This is an empirical correction to the lunar ephemeris; the other factor which can shift the shadow is error in the star's position. An example of this is the graze of Z.C. 556 observed on 1986 Sept. 23 near Katy, TX; a 0".3 star-position error offset the ephemeris correction, causing a net shift of zero. Expedition leaders must always allow for such errors in their predictions; we are much better off today than we once were, but the problem has not been totally eliminated.

All tables of grazing occultation expedition summaries back to *o.n.* *1* (1) (1974 July) have been put into machine-readable format. This large task was done almost entirely by Don Oliver, who provided the software, hardware, and virtually all of the labor; I helped key in some of the records. The next step will be to put Van Flandern's file of observations made prior to ca. 1976 in the same format, thus completing the project for pre-*o.n.* events. This will involve mainly programming rather than data entry, and Don Oliver will begin it after he catches his breath. We will not publish any statistics concerning individual expedition leaders until the second half of the project is complete; those mainly active prior to *o.n.*'s inception would be shortchanged. However, some general figures are quite interesting:

1. 1,516 grazes were listed in *o.n.* from 1974 July to 1986 June.
2. 154 grazes per year were listed from 1974 to 1980 on the average; for 1981 to 1985 the yearly average was 82. I hope it will decline no farther; it has levelled off at the figure of 82.
3. 26% of the 1,516 reports had a shift reported!

I believe that the low percentage of shifts reported is due to its not always having been emphasized as an important quantity to calculate and report. At one time, it was thought that it would be calculated by machine during a general analysis of all graze observations, but this work was never funded. Also, some observers are unaware of what a shift is, or how to compute it. I will supply an explanation and worked example of the process to anyone on request.

The direction of the 0".5 shift observed by Dennis Lowe during the graze of SAO 128607 on 1985 Dec. 19, at Welcome Creek, Australia, is south, according to the 1986 June Circular of the Royal Astronomical Society of New Zealand. This is a correction to the graze table in *o.n.* *3* (16), 342 (1986 June).

The northern-limit grazing occultation of Z.C. 885 on August 29 was observed from several stations in Maryland and Massachusetts. The observations showed no shift; the event will be included in the next list.

Several graze reports from Harold Povenmire will be included in the next listing.

Thanks for the reports received. Let's all strive to return to the level of the mid-1970s.

IOTA GRAZE PREDICTIONS AND PROJECTS USING PERSONAL COMPUTERS

Donald L. Oliver and David W. Dunham

The first success in running the IOTA grazing occultation limit prediction and profile programs by one of us (Oliver) on a PC was mentioned in *o.N. 3* (16), 340. Since then, three other IOTA members, Steven Hutcheon, Guillermo (and his daughter, Gabriella) Mallén, and Wai-Chun Yue, have successfully run copies of Oliver's versions of the programs on their IBM XT PCs or PC clones. This proliferation of IOTA's computing base is a welcome development that promises to solve most of our previous problems with graze predictions. The work is spread to more people, making the job less burdensome for each. The graze software and data system is not perfect, and another byproduct is that more people are now thinking about the problems encountered and coming up with new solutions and improved software. The predictions for regions with numerous observers will continue to be computed mainly on large mainframe computers, since the large amounts of intermediate data generated and the printing of large volumes of predictions and profiles becomes prohibitive with PCs. However, this could change in two or three years as disk memory is expanded and as laser printers become more affordable. For the time being, PCs are most practical for the regions with few observers, outside of the U.S.A. and Europe. This proliferation means more local control, and lower costs since more predictions can now be sent with local mail rather than overseas air mail. For this reason, we especially encourage overseas owners of PCs to write to either of us (addresses in the graze supplement) for copies of the programs on diskette. After you have successfully reproduced some sample output, we can send documentation describing the procedures for setting up input for, processing, and distributing the predictions, and the basic USNO graze input data for your region for 1987. Unfortunately, the documentation for the program has accumulated over the years, and is rather fragmented and not well organized; it was written mostly before Dunham achieved a word-processing capability in 1982. Typing the parts of the documentation that are not out-of-date, and organizing it better, with a PC word processor to create a version on floppy disk, would be an extremely valuable project; any volunteers would be most welcome and should contact Dunham.

Oliver completed the conversion of the graze lists published in *o.N.* into machine-readable form. This project has been mentioned by Don Stockbauer in his graze articles in previous issues, such as *o.N. 3* (16), 343, and on p. 24 of this issue, and Stockbauer gave valuable advice and guidance. He also checked the list to spot obvious errors, which have been corrected. But a volunteer is needed for a thorough proofreading; he will be provided by IOTA with any missing issue of *o.N.* Dunham sent Oliver a tape with all graze timings used for analyses, and also a file to convert Z numbers into Z.C. or SAO numbers. Oliver used the latter to convert the Z numbers given in the earlier *o.N.* summaries. He also processed the data to provide a list in star number order, and to give such things as averaged shift values and a list of the number of grazes listed for each expedition leader, sorted on that number. IOTA plans to distribute these data to all members, after the larger job of processing the USNO data to provide summary-list-style data is completed. By merging the two datasets, we should have a comprehensive set of graze observations. Before this can be done, Dunham needs to process the USNO data to add quantities such as the percent of the Moon sunlit and the cusp angle of each event. In the meantime, those planning large expeditions can contact us to find out the previous history of the star, at least as published in all issues of *o.N.* This could be useful for estimating a correction to (shift from) the nominal prediction.

Oliver, assisted by Stockbauer, has also started to look into the possibilities of organizing IOTA's double star data so that they can be automatically merged into the graze data. Dunham has provided a copy of his various double star files, and advice, for this project. In a related project, Walter Nissen (Takoma Park, MD) has obtained updated elements of double stars whose orbits have been determined, and an updated version of MacAlister's machine-readable catalog of speckle interferometric double star observations, with the aim of updating IOTA's double star files with the best possible information, especially for close stars. Wayne Warren (College Park, MD) and Charles Worley (USNO) provided the data.

Dunham's downloading of a subset of Watts' lunar limb correction data to floppy disk was described in *o.N. 3* (16), 344. The data were received by David Herald, who transferred the data from IBM PCs at his office to his Commodore 64 computer at home. He wrote some programs to process the data to check for transmission errors, and discovered some errors in the original database at USNO. The biggest problem that he found was that all of the data for Watts angle 36°0 are wrong! Fortunately, grazes can never happen that far from the lunar north pole. But the problem should be fixed for prediction and analysis of total occultations. Producing a set of correct data from the chart for 36°0 published by Watts would be another useful project for someone with a PC.

REPORTS OF ASTEROIDAL APPULSES AND OCCULTATIONS

Jim Stamm

Unless otherwise noted, the following have all sent in negative reports of 1985 events. Unless the observer's location was different, it was not listed after the first reference.

(97) Klotho and SAO 130148, Jan 10, 1985: (*o.N. 3* (13), 279). South Africans Joe Churms (Cape Town), D. Blane (Henley on Klip), and Danie Overbeek (East Rand).

(747) Winchester and DM +10°1040, Jan 22: (*o.N. 3* (13), 279). Tim Cooper (Sasolburg, South Africa).

(7) Iris and SAO 94467, Feb 16: (*o.N. 3* (13), 279). A. Morrisby (Bulawayo, South Africa) and D. Blane.

(74) Galatea and DM +01°2551, Feb 22: A. Morrisby and J. Churms.

(29) Amphitrite and SAO 183620, Mar 4: J. Bennett (Pretoria, South Africa).

(375) Ursula and SAO 157187, Mar 5: J. Churms and

J. de Klerk (Potchefstroom, South Africa).

(Text continues in next column.)

Table 1. Asteroidal appulses and occultations observed from January through June 1986.

Asteroid	Star	Date	Observers	Notes
(197) Arete	AGK3 +26 0654	Jan 01	Jn	1
(419) Aurelia	AGK3 +19 0533	Jan 08	JhKm	
(1456) Saldanha	AGK3 +06 1234	Jan 12	DnMkFbTh	
(2127) Tanya	SAO 94991	Jan 12	Ly	
(510) Mabella	SAO 115666	Jan 15	16 observers	2
(104) Klymene	SAO 146524	Jan 15	SmCjCpCmMbDkSp	3
(735) Marghanna	AGK3 +32 1033	Jan 16	St	
(48) Doris	LJ 4839	Jan 16	HtSc	
(54) Alexandra	AGK3 +08 1358	Jan 16	MrQd	
(511) Davida	SAO 77911	Jan 17	LyGnSh	
(729) Watsonia	AGK3 +01 1680	Jan 18	Ld	
(521) Brixia	SAO 80380	Jan 19	Ht	
(786) Bredichina	AGK3 +20 0446	Jan 19	PmTr	
(407) Arachne	LJ 3455	Jan 20	Ht	
(369) Aeria	AGK3 +25 0563	Jan 23	MbLkCm	4
(727) Nipponia	SAO 97286	Jan 25	Fr	
(326) Tamara	AGK3 +33 0262	Jan 25	An	
(318) Magdalena	AGK3 +07 1362	Jan 30	LdHtSc	
(2) Pallas	SAO 170643	Feb 01	Dn	
(87) Sylvia	SAO 110095	Feb 06	StFr	
(444) Gyptis	SAO 137517	Feb 08	IrGnDsJrGtNlMa	
(596) Schella	SAO 61871	Feb 09	LtHtScAn	
(535) Montaque	AGK3 +05 1776	Feb 10	BsCpDkSp	
(77) Frigga	AGK3 +18 0965	Feb 12	Sc	
(804) Hispania	SAO 60650	Feb 15	Ht	
(90) Antiope	AGK3 +22 0988	Feb 18	LhZmMeSmCp	
(494) Virtus	SAO 76104	Feb 24	Ty	
(174) Phaedra	AGK3 +31 0671	Mar 01	An	
(354) Eleonora	AGK3 +04 0399	Mar 02	BtBd	
(162) Laurentia	SAO 119391	Mar 03	SdMdBt	
(1148) Rarahu	SAO 140829	Mar 04	Ly	
(751) Faina	SAO 100323	Mar 05	ScHtAn	
(705) Erminia	AGK3 +31 0190	Mar 06	Bn	
(306) Unitas	SAO 160950	Mar 10	St	
(448) Natalie	AGK3 +05 1776	Mar 10	St	
(354) Eleonora	AGK3 +05 0433	Mar 12	CrJlMsMhMt	
(66) Maja	SAO 139305	Mar 21	HsCp	
(1021) Flammario	AGK3 +13 1334	Mar 22	St	
(284) Amalia	AGK3 +09 1022	Mar 26	BrMgWk	
(1013) Tombecka	AGK3 +04 1630	Mar 28	AnHtSc	
(162) Laurentia	AGK3 +05 1687	Mar 29	St	
(140) Siwa	SAO 159625	Mar 25	Ln	
(211) Isolda	AGK3 +21 0389	Apr 05	Wk	
(195) Eurykleia	AGK3 +13 1042	Apr 10	HsCpBl	
(643) Scheherezade	SAO 145581	Apr 21	AnDhSc	
(31) Euphrosyne	SAO 206608	Apr 26	Sc	
(96) Aegle	SAO 205232	Apr 29	Sc	
(126) Velleda	SAO 164996	Apr 30	Ov	
(259) Aletheia	SAO 160139	May 10	Mn	
(393) Lampetia	SAO 143749	May 12	FrLnGr	
(336) Lacadiera	SAO 185428	May 12	PrBb	7
(1867) Diephobus	SAO 209844	May 16	OvElFsHmCp SmGyLvKtCj	8
(96) Aegle	SAO 204909	May 19	OvSmLvKt	
(212) Medea	SAO 185485	Jun 01	St	
(778) Theo	AGK3 +12 0087	Jun 06	Md	
(165) Loreley	SAO 207376	Jun 08	Ln	
(633) Zelima	SAO 142361	Jun 11	KtSmOvElLvHsDkSp	
(306) Unitas	SAO 162213	Jun 13	St	
(305) Gordonia	SAO 145713	Jun 21	KtKgOvFsMlSm DkSpCpTkLvSz	
(362) Havnia	SAO 109835	Jun 22	KtKgCmTkElCpSmDkSp	
(1023 Thomana	SAO 143526	Jun 28	AzSy	

(85) Io and SAO 158545, Apr 2: D. Overbeek, P. van Blommestein (Cape Town), A. Morrisby, D. Blane, J. de Klerk, J. Spoelstra (Potchefstroom), and Tim Cooper.

(1624) Rabe and SAO 139575, Apr. 10: A. Morrisby, D. Overbeek, Jan Hers (Sedgefield, South Africa), and T. Cooper.

(51) Nemausa and anonymous star, Apr 16: (*O.N. 3* (12), 252). Steve Hutcheon (Sheldon, Queensland, Australia); Glenn Evans (Oxford, New Zealand).

(57) Mnemosyne and SAO 137722, Apr 19: (*O.N. 3* (12), 253). Steve Hutcheon; Charlie Smith (Woodridge, Queensland, Australia).

(12) Victoria and SAO 183095, Apr 21: (*O.N. 3* (13), 280). David Dunham contacted some South African observers by telephone, and indicated that the occultation could occur two minutes earlier than predicted. Misses were reported by J. de Klerk, J. Spoelstra, D. Overbeek, B. Fraser (Johannesburg), A. Morrisby, V. Hirsch (Port Elizabeth), J. Hers, and R. Field and 3 anonymous observers (Durban), but J. van Ellinckhuyzen (Bloemfontein, South Africa) reported a definite disappearance at 21:11:2.12, and an uncertain reappearance at 21:12:14.8. The duration was longer than predicted, but van Ellinckhuyzen's time was about two minutes early. He was not informed of Dunham's update.

(372) Palma and BD +02°2250, Apr 25: (*O.N. 3* (12), 253). Louis Gonzalez and Mike Mooney (Miami, FL).

(731) Sorga and SAO 183605, May 25: Scott Ireland and Mike Mooney (Miami, FL).

(165) Loreley and SAO 137693, May 31: Chris Frick (Como, Western Australia).

(471) Papagena and SAO 189954, Jun 6: Steve Hutcheon; Peter Anderson (The Gap, Queensland, Australia); Glenn Evans; Sean Ryan (Christchurch, N. Z.).

(46) Hestia and SAO 159657, Jun 21: Steve Hutcheon; Peter Anderson.

(128) Nemesis and SAO 188456, Jul 6: Brian Loader (Blenheim, New Zealand); B. Fraser; R. Wallace (Johannesburg, South Africa); T. Cooper.

(212) Medea and SAO 157588, Jul 17: Peter Anderson.

(29) Amphitrite and unknown star, Jul 26: B. Fraser, J. Hers.

(21) Lutetia and SAO 93083, Aug 9: (*O.N. 3* (14), 298). Mike Mooney and Dave Finley (Miami, FL).

(28) Bellona and SAO 162924, Aug 17: (*O.N. 3* (14), 297). T. Cooper.

(230) Athamantis and SAO 108412, Aug 25: (*O.N. 3* (13), 280). Peter Anderson.

(137) Meliboea and SAO 142583, Sep 9: Steve Hutcheon; Charlie Smith; Peter Anderson; Brian Loader; Steve Hayward (Madang, Papua New Guinea).

(105) Artemis and SAO 109095, Sep 28: Glenn Evans.

(159) Aemilia and SAO 96895, Oct 31: (*O.N.* 3 (14), 298). Scott Ireland, Mike Mooney, and Skip Jarrett (Miami, FL).

(508) Princetonia and AGK3 +34 0833, Nov 16: Peter Anderson.

(651) Antikleia and SAO 190559, Nov 27: Mike Mooney and Scott Ireland.

(115) Thyra and SAO 127949, Dec 6: (*O.N.* 3 (15), 326). Mike Mooney and Scott Ireland.

(89) Julia and SAO 40825, Dec 20: (*O.N.* 3 (14), 298). Charlie Smith; Steve Hutcheon.

(18) Melpomene and SAO 114658, Dec 30: (*O.N.* 3 (16), 343). J. Smit (Pretoria, South Africa) and T. Cooper.

The remainder of this report includes observations for the first half of 1986, and is made up of two tables and a section of notes.

Table 1 lists all observed events that were reported to me as of 1986 Oct. 29. The columns represent the asteroid's number, name, the star that was appulsed or occulted, the date of the event, the list of observers (a two-letter ID that is paired with the observer's name and location of observation in Table 2), and a number that refers to my notes.

Table 2 lists the observers who have monitored events, their IDs (which are used in Table 1), the location of the observation, the total number of observations made in the period, and possibly one or two numbers referring to the notes section.

The notes section is used to include any other pertinent data that could not be included in the tables. Usually, reports other than negative will be included here, and many of them will have been published prior to this report.

Table 2. Observers and locations of events recorded from January through June 1986.

Observer	ID	Location	No.	Notes
Bob Ariail	Ar	Columbia, SC	1	
Bill Allen	Al	Blenheim, New Zealand	1	
Peter Anderson	An	The Gap, Qnslnd, Australia	6	
John Asztalos	Az	Milwaukee, WI	1	
Gsd Babu	Bb	Leh, India	1	7
C. Baetens	Bt	Boechout, Belgium	2	
P. Barufetti	Br	Massa, Italy	1	
Perry Black	Bk	Lawton, OK	1	2
D. Blane	Bl	Henley on Klip, R.S.A.	1	
J. Bodenstein	Bs	East Rand, R.S.A.	1	
Roland Boninsegna	Bn	Dourbes, Belgium	1	
H. Bulder	Bd	Zoetermeer, Netherlands	1	
Joe Churms	Cm	Cape Town, R.S.A.	3	3,4
J. Cooper	Cj	Sasolburg, R.S.A.	2	3,8
Tim Cooper	Cp	Sasolburg, R.S.A.	8	3,8
F. Courbin	Cr	Vernon, France	1	
J. de Klerk	Dk	Potchefstroom, R.S.A.	5	3
Ray Desmarais	Ds	Everglades Nat. Pk., FL	1	
Richard Dietz	Dt	Greeley, CO	1	2
David Dunham	Dn	Silver Spring, MD	3	2
David Dunham	Dh	The Gap, Qnslnd, Australia	1	
G. Earle	El	East Rand, R.S.A.	3	8
Glen Erickson	Er	Davis, CA	1	2
J. Fabregat	Fb	Valencia, Spain	1	
B. Fraser	Fs	Johannesburg, R.S.A.	1	8
Tony Freeman	Fr	Berkeley, CA	3	
M. Geyser	Gy	Pretoria, R.S.A.	1	8
Guillermo Gonzalez	Gn	Tucson, AZ	2	
Francis Graham	Gr	East Pittsburgh, PA	1	
Bob Grant	Gt	Homestead, FL	1	
Rocky Harper	Hr	La Porte, TX	1	2
Roger Harvey	Hv	Concord, NC	1	2
Jan Hers	Hs	Sedgefield, R.S.A.	3	
H. Homer	Hm	Johannesburg, R.S.A.	1	8
Steve Hutcheon	Ht	Sheldon, Qnslnd, Australia	8	
Scott Ireland	Ir	Everglades Nat. Pk., FL	1	
Jost Jahn	Jh	Hamburg, G.F.R.	1	
Jost Jahn	Jn	Molln, G.F.R.	1	1
Skip Jarrett	Jr	Everglades Nat. Pk., FL	1	
N. Jonlet	Jl	Glons, Belgium	1	
Christian Kampf	Km	Hamburg, G.F.R.	1	
J. Knight	Kt	Witbank, R.S.A.	5	8
S. Knight	Kg	Witbank, R.S.A.	2	
C. Lake	Lk	Pietermaritzburg, R.S.A.	1	4
Mark Lang	Lg	Cary, NC	1	2
Thomas Langhans	Ln	San Bruno, CA	3	
N. Laverack	Lv	Durban, R.S.A.	4	8
A. Lheureux	Lh	Brussels, Belgium	1	
Brian Loader	Ld	Blenheim, New Zealand	3	
Greg Lyzenga	Ly	La Verne, CA	3	
Craig MacDougal	Md	Tampa, FL	2	
S. Maksymowicz	Ms	Mezieres/Seine, France	1	
Paul Maley	Ma	Harlingen, TX	1	
A. Manganaro	Mg	Massa, Italy	1	
M. March	Mh	Mataro, Spain	1	
W. Marinello	Mr	Bassano Bres., Italy	1	
G. Marshall	Ml	Johannesburg, R.S.A.	1	
J. Marti	Mt	Mataro, Spain	1	
R. H. McNaught	Mn	Siding Spring, Australia	1	6
A. McRae	Mc	Johannesburg, R.S.A.	1	
Jeff Medkeff	Mk	Hartville, OH	1	
A. Morrisby	Mb	Bulawayo, R.S.A.	2	3,4
Richard Nolthenius	Nl	Tucson, AZ	1	
Bob Oldham	Od	Burnsville, NC	1	2
Don Oliver	Ol	Houston, TX	1	2
Danie Overbeek	Ov	East Rand, R.S.A.	5	8
Arvind Paranjpye	Pr	Leh, India	1	7
Pic du Midi Obs.	Pm	Pic du Midi, France	1	
U. Quadri	Qd	Bassano Bres., Italy	1	
Walter Russell	Rs	Boone, CO	1	2
John Safko	Sf	Columbia, SC	1	2
Gerard Samolyk	Sy	Milwaukee, WI	1	
D. Scholz	Sz	Vanderbijlpark, R.S.A.	1	
Joe Senne	Sn	Rolla, MO	1	2
Glenn Shaw	Sh	Fairbanks, AK	1	
Scott Shaw	Sw	Athens, GA	1	2
J. Smit	Sm	Pretoria, R.S.A.	7	3,8
Charlie Smith	Sc	Woodridge, Qnslnd, Austrl.	9	
Doug Smith	Sd	Murfreesboro, TN	1	
J. Spoelstra	Sp	Potchefstroom, R.S.A.	5	3
Jim Stamm	St	London, KY	9	2
Don Stockbauer	Sk	Webster, TX	1	2
Y. Thirionet	Th	Brussels, Belgium	1	
B. Thooris	Tr	Wervik, Belgium	1	
C. Turk	Tk	Cape Town, R.S.A.	2	
John Tyrrel	Ty	Knoxville, TN	1	5
N. P. Wieth-Knudsen	Wk	Tisvildeleje, Denmark	2	
L. Zimmermann	Zm	Brussels, Belgium	1	

Notes to asteroidal appulse and occultation observations made from January through June 1986. All times are UT.

(1) Several blinks were reported by Jost Jahn as having a 50% chance of realness. The longest one occurred from 18:33:59.2 to 18:33:59.6.
(2) See *O.N. 3* (15), 326. Observers participating in this event were ArBkDtDnErHrHvLgOdOlRsSfSnSw, StSk. Russell also reported that two dimmings occurred before the occultation — one about 1 min. 45 sec. before the occultation, and the other about 9 before. "The star dimmed swiftly but not instantly, and returned in the same fashion for both events." The drop in magnitude was less than that of the occultation.
(3) J. Smit reported a definite disappearance for approximately one second. The star was then visible for one second, and then "winked out momentarily." Although some haze was present, the sharpness of the events, and the fact that some fainter field stars remained visible led Dr. Smit to believe that the event was real. He is an experienced occultation observer. His tape recorder failed, but the time of the events was between 19:21 and 19:22.
(4) Joe Churms, another very experienced observer, reported a wink 40 seconds after the predicted time, but feels that it probably was due to seeing.
(5) John Tyrrel observed ¼-sec. flickerings at 00:05:28.5 and 00:08:41.
(6) See *O.N. 3* (16), 343.
(7) See *O.N. 3* (16), 343.
(8) J. Knight reported a 4.9-second disappearance at about the predicted time, but Danie Overbeek feels that the 'event' probably was due to seeing, because of the misses reported along the Pretoria-East Rand-Johannesburg-Sasolburg fence.

ON THE PRECISION OF THE MINNAERT METHOD

N. Wieth-Knudsen

This article is an abbreviation of a contribution presented at the ESOP IV.

The investigation presented here was prompted by two papers by William J. Westbrooke, in *O.N. 1* (6), 53 (Oct. '75) and *O.N. 2* (5), 50 (Nov. '79), on the Minnaert method of timing the exterior contacts of a solar eclipse, depending on the fact that the squares of the chords between the cusps of the notch by the Moon in the solar disk are a linear function of the time during about the first ten minutes after first contact, as well as during the last ten minutes before fourth contact — whence the contact times can be determined as the intersection points of the line representing the graph of that function, with the time axis.

In the second paper, — dealing, too, with considering the function mentioned, during the entire eclipse, as then represented by a polynomial of the fourth degree, Westbrooke himself is dissatisfied with the results of an experiment of that kind, as showing discrepancies against the instants predicted, of about ¼ minute to nearly one minute, — while he reports the result by the "linear procedure" dealt with in the first paper, as satisfactory. However, even there no indication of the precision obtainable is given, in the sense of a standard error of the result; — but a glance at his graph there shows the maximum residual in time of a single plot as about $0^h\!.03 = 108^s$; of course that of the intersection point must be much smaller. Westbrooke mentions as desirable the determination of the linear function by an electronic computer, but regrets such ones to be not commonly available; this was written in 1975!!!

Since almost about then no computer is needed, as now any pocket calculator a little advanced, — or a more advanced one, such as the TI59, — is preprogrammed for linear regression; — with a printer it will fully serve for our purpose, as a mini-computer, — as once claimed by its manufacturer. Certainly, for utilizing the fact that such preprogramming allows the calculation, by a single operation, the ordinate (with the notations of the user's manual for the TI59 (in the following a little adapted)), b, of the line's intersection with the y-axis, you will have to consider the inverse function of that plotted upon Westbrooke's graph, as well as upon mine in the following, — taking as the independent variable, x, the chords squared, and as the dependent one, y, the moments of measurement.

As not foreseen by that preprogramming, the use of integer weights, p_i, to be applied to each equation of condition, — as indicated upon the graphs following, — can be performed by entering p_i times the couple (x_i, y_i). Without mentally counting, this can be done by a key-called program for first printing the triple (p_i, x_i, y_i) for a check, and when found satisfactory, sequentially storing the triples in memory registers, and after that performing by the Dsz instruction the p_i entries, using as a subroutine the statistical entry procedure of the calculator.

With or without weights, the calculator's pre-program cannot be used by itself for a direct calculation of the standard deviation of the quantity b, but by a (second) key-called program, and from the recalled couples (x_i, y_i), the residuals of the y_is against the adjusted values of y, as represented by the points of the fitted straight line, can be calculated, stored in memory registers, and printed, utilizing as a subroutine the operation of the calculator for getting the adjusted values, y. Then a (third) key-called program will give the standard deviation of unit weight:

$$\sigma = \sqrt{\frac{\Sigma p_i (y_i - y)^2}{N-2}}$$

, where N is the number of equations of condition (couples(x_i, y_i)).

For deriving the standard deviation of b, we then need the "weight coefficient":

$$B_{11}^{-1} = \frac{\Sigma p_i x_i^2}{\Sigma p_i \cdot \Sigma p_i x_i^2 - (\Sigma p_i x_i)^2}$$

, of which the quantities required for computing can be found in the registers R_{01} to R_{06}, the contents of which, after having entered the couples (x_i, y_i) as weighted, must be:

R_{01}	R_{02}	R_{03}	R_{04}	R_{05}	R_{06}
$\Sigma p_i y_i$	$\Sigma p_i y_i$	Σp_i	$\Sigma p_i x_i$	$\Sigma p_i x_i$	$\Sigma p_i x_i y_i$,

respectively — as to be learned from the information user's manual on the content of those registers by an ordinary entry without weights — further, for calculating σ by the formula given, when using weights we must enter N separately in some register chosen for that, as then in R_{03} N is replaced by Σp_i.

Then we shall have: $\sigma(b) = \sqrt{B_{11}^{-1}}\cdot\sigma$.

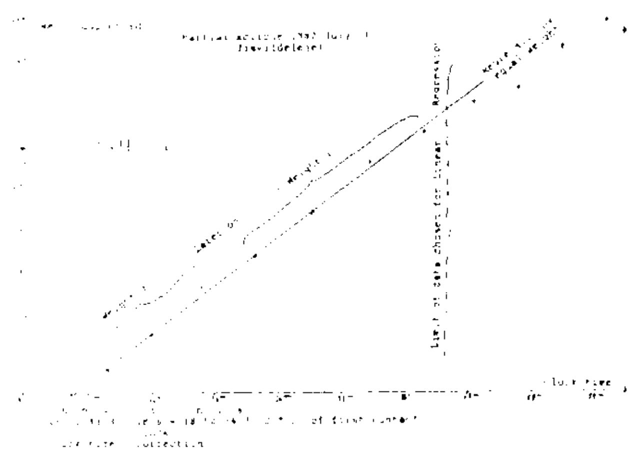
We shall use, too, the slope, m, – even calculable by a preprogrammed operation; – hence the entire program was completed by making calculable, too, the quantity:

$$B_{22}^{-1} = \frac{\Sigma p_i}{\Sigma p_i\cdot\Sigma p_i x_i^2 - (\Sigma p_i x_i)^2}$$; then we shall have:

$\sigma(m) = \sqrt{B_{22}^{-1}}\cdot\sigma$, – with which the entire procedure is rendered applicable to any linear problem.

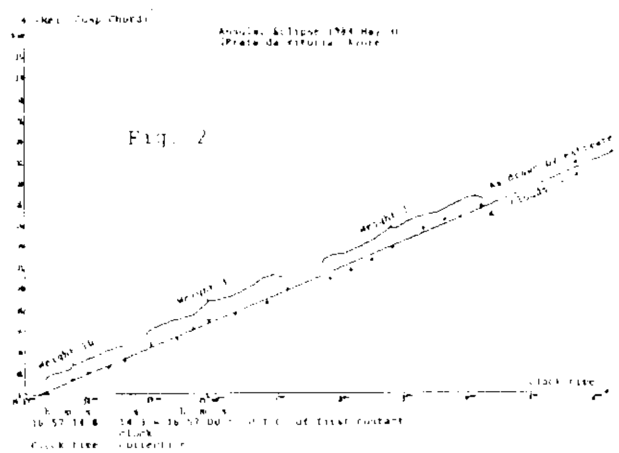
Since publication of the first paper by Westbrooke, I have sought any possible opportunity to test the method as confined to the linear interval, out of regard to the method of calculating just described. However, due to weather conditions, only two eclipses allowed performance of the test, with three exterior contacts in all.

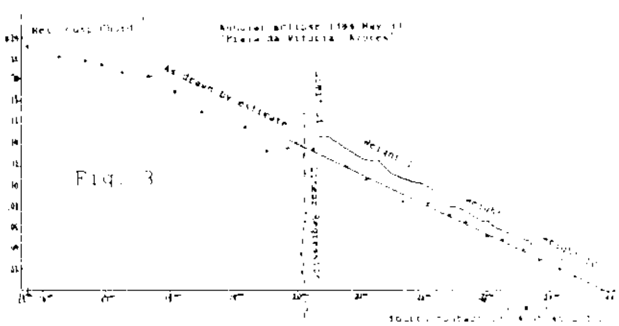
First: The partial eclipse of the Sun on 1982, July 20, occurring in Tisvildelunde shortly before sunset, with the Sun partly hidden behind trees as seen from the dome, thus preventing the use of my main instrument. Therefore, my travelling instrument of that time, a 6-cm Polarex refractor, was mounted on the roof of the residence to gain a clear sight towards the Sun during some ten minutes after first contact. On an eyepiece-projected image of the Sun, of some ten centimeters diameter, cusp chords were measured with a vernier caliper, set in advance, a little wider than the chord, and then timing by eye-and-ear the instants when the chord matched the jaws of the caliper – the clock being referred to UTC by time signals in advance and afterwards – thus as similarly as possible to an ordinary timing of a total occultation. In accordance with the first paper by Westbrooke, the length of each chord measured was divided by the length of the greatest (last measured) one of them, which was thus the unit in which all the chords were measured. The plot of those numbers squared, against the observed times, is shown in Fig. 1, which represents all but the last two observations. The next-to-last one, just beyond the edge, is pointed to by an arrow, while the very last one must have the ordinate value of precisely 1, according to the procedure described. The onset of curvature is distinctly visible, so only the observations in advance of the limit shown were taken into account.



Second: The annular eclipse of the Sun on 1984, May 30, as observed from the Azores. The procedure performed then, of taking a series of timed photos of the solar image as eyepiece-projected by a Celestron 90. Of course, the procedure had to be practiced in advance. While Mrs. Wieth-Knudsen focused, adjusted exposure, and aimed the camera at the solar image, and gave me ready-to-go signals, I operated the cable release, precisely to a second beat in a pair of headphones activated by the crystal clock, and recorded the time immediately afterwards, while she prepared for the next exposure. That practice was then arranged so as to be practicable, too, for testing the Minnaert method. A series of 36 exposures was taken on Kodacolor VR100 during fifteen minutes immediately after first contact - thus with an interval of about ½ minute, or less - exposure time $^1/_{500}$ sec. at f/11. A similar series in advance of fourth contact was carried out, using up the rest of the VR1000 roll started during the annularity $^1/_{1000}$ sec. at f/4 to f/6.

The chords were measured on the paper copies of the photos, using a rule divided in millimeters (tenths estimated), under a magnifier. The length of each chord was divided by the length, similarly measured, of the diameter of that particular solar image, parallel to the chord in question, in order to take into account the possibly slightly varying scale of the photos, and the fact that those solar images must, in principle, be slightly elliptical, due to the angle which necessarily must exist between the optical axes of the projection and camera lenses; so the lengths of the chords were expressed with the diameter of the solar image as the unit.





The plots of the results are shown in figures 2 and 3. Evidently, the scattering increases with increasing interval from the contact(s). This fact prompted the idea of performing the reduction, not only by equal weight by a simple application of the preprogramming of the calculator, but also by applying as described above, the weights indicated along the plots, which were estimated from the scatterings perceived. For the sake of completeness, even the data from Tisvildelunde, 1982, were also reduced with both weighted and unweighted treatment. Reductions are shown in Table 1.

Table 1.

Observed at	Partial eclipse 1982 July 20 Tisvildelunde first contact		Annular eclipse 1984 May 30 Praia da Vitoria, Azores first contact		fourth contact	
Chords applied (N)	7		20		13	
As adjusted by	equal weight	weights indicated	equal weight	weights indicated	equal weight	weights indicated
St. dev. of unit wt.	±6.5^s	±9.1^s	±7.83^s	±10.96^s	±6.33^s	±7.62^s
Derived UTC of contact	18^{h}50^{m}24.7^s	25.4^s	16^{h}57^{m}01.84^s	00.29^s	19^{h}24^{m}54.63^s	53.71^s
With std. dev.	±5.0	±4.4	±3.31	±1.80	±3.68	±1.85
UTC predicted	18^{h}50^{m}23.2^s		16^{h}57^{m}05.9^s		19^{h}25^{m}00.3^s	
For the annular eclipse, the slope, m =			2399^s/solar radius		-2109^s/s.r.	
With std. dev.			±29		±38	
(The correctness of the unit as (sec. of time)/(solar radius) is shown below)						
Hence the (absolute) value of m =			$\frac{2399^s}{946''}$		$\frac{2109^s}{946''}$	
Whence the angular velocity of the Moon with respect to the Sun $\frac{1}{m}$ =			$\frac{946''}{2399^s}$ = 0.394"/s		$\frac{946''}{2109^s}$ = 0.448"/s	
With std. dev.			+5		+8	
From the prediction theory we have:			0.372"/s		0.479"/s	

Regarding the unit of the slope, this must be: (seconds of time)/(unit of the squares of the chords). But remembering that in treatment of the annular eclipse all chords were measured with the diameter of the solar disk as unit, from Fig. 4 and its notations and approximations, we have

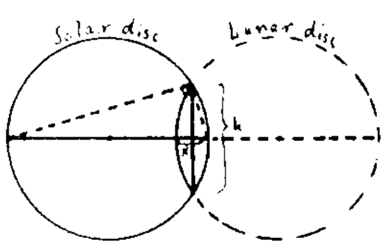


Fig. 4

$$(\frac{k}{2})^2 = \frac{x}{2}(1-\frac{x}{2}) .$$

But within the limit of linearity we may neglect $\frac{x}{2}$ as compared with the diameter, 1, of the solar disk, whence $k^2 = 2x\cdot 1$ which means that the unit of measure for k^2 must be half of the unit for x, i.e., must be equal to the radius of the solar disk – as a by-product not foreseen by that choice of unit of the chords – the solar radius was 946" during the eclipse, according to the *Astr. Alm.* whence the calculation above.

The contact times given in figures 2 and 3 are derived graphically; they agree within the standard deviations with those computed, as presented above, and will not be considered further.

What is to be learned from the results presented?

1st: From the st. dev.s of unit weight we learn that as far as a single measurement is concerned, the two methods of measuring, direct by vernier caliper, or photographically, are of almost equal quality.

2nd: When reduced by equal weight, the accuracy of the definitive contact times from the photos is somewhat improved, but not convincingly, as compared with the result from the jaws of the vernier caliper. No appreciable improvement is obtained by reducing the latter by weights.

3rd: An essential improvement is obtained when reducing the measurements from the photos by weights, which procedure is thus superior to the others – obviously because then many more observations can be made, with much shorter intervals, and much closer to the actual contact time, thus turning to account the superiority of as many observations as possible close to the contact, while the other are more-or-less merely used for 'directing the slope of the line'.

4th: The contact times observed seem to be in reasonable accord with the predictions by the data from the *Astr. Alm.*, and even to represent a reasonable improvement by observation, over the latter – in consideration of the st. dev.s of the former and all the more, as from the Azores each contact is observed earlier than predicted, by almost the same amount.

5th: It should be noted that in the partial eclipse of July '82, the greatest magnitude of which was 0.464, and where Tisvildelunde was near the limit of the eclipse, the exterior contacts were more tangential, and may thus be expected to have a greater st. dev. than those of the annular eclipse in '84, observed near the central zone.

Finally: May a further improvement be expected? With which precision defined, at all, are the events observed? From the angular velocity of the Moon with respect to the Sun, either as observed or predicted, we learn that in 1.8 second (which was the st. dev. obtained) the Moon moves less than one second of arc with respect to the Sun – and that is just the order of magnitude of Watts' limb corrections, while the Minnaert method assumes circular limbs for both the Sun and Moon. These considerations may imply further improvement if one can apply limb corrections to the point of intersection at each end of each notch measured – indeed a delicate matter.

Coupled with what has been said, examination of the four graphs, that from the first paper by Westbrooke and the first three figures here, the suspicion seems unavoidable that the distribution of the plots of the observations around the lines is no stochastic one, but rather an oscillation around the line.

Jean Meeus, who attended the presentation at ESOP IV, and who was so kind as to contribute to the discussion afterwards, pointed out that that was to be expected — with extended portions of the lunar surface below the mean limb, and other portions of similar extension above it, the actual radius of curvature may vary along the limb.

These considerations may perhaps also allow for the only discrepancy found, that of the angular velocities observed versus those predicted, which are far beyond the st. dev.s observed, and of opposite sign at the two contacts. Another consideration which may have contributed is that the transit was not precisely central, and the two disks did not have precisely the same radius, as assumed in Fig. 4.

[Ed: Dr. Wieth-Knudsen needs to obtain another TI59 calculator. Is there one among our readers who has one he would like to sell, or who can suggest another source? If so, please contact him at "Dorthens Huus"; Margot Nyholmsvej 19; Tisvildelunde pr. 3220 Tisvildeleje; Denmark.]

PAST OBSERVATIONS AND FUTURE PLANS FOR GRAZING OCCULTATIONS OF ANTARES AND SPICA

David W. Dunham

This is essentially a continuation and update to the article in *o.N.* 3 (16), 351. The star is Antares unless otherwise indicated.

1986 July 18: This southern-limit graze was observed by several small expeditions in California. Only the group south of Carmel had some trouble with patchy clouds. Using a 5-inch Schmidt-Cass, Steve Edberg obtained a color video recording of 8 events during the graze in San Diego, the first successful video of a bright-limb graze. Harold Povenmire led a large expedition that observed the graze northwest of Miami, FL. At least one usable videorecord was made, and several observers noted rapid flickering for many seconds. This path also crossed Bermuda, but it rained there. Many observers throughout the U.S.A. timed the total occultation. More information will be included in Stockbauer's summaries in this (p. 24) and future issues.

November 4: ILOC reports that my calculations of the northern limit across northern Japan agree with theirs to 0°12 of latitude, in spite of the low altitude.

1986 December 29: Anyone travelling to Israel, Egypt, or other parts of the Middle East will have a spectacular view as Antares reappears from behind the 6%-sunlit waning Moon this morning. The naked-eye view at and just after emersion will be reminiscent of the Islamic symbol. Anyone travelling to Luxor or other parts of southern Egypt might go a way down Lake Nasser, where a spectacular southern-limit graze will occur. The predicted profile is rugged, and the primary will be covered while events involving the secondary will occur. The desert climate means that the probability of clouds is low. I can provide details to anybody interested. I have sent details to the Astronomy Department at Cairo University, which is affiliated with Helwan Observatory.

1987 January 25: This last favorable Antares occultation in the U.S.A. until 1991 will be visible from most of California and part of southwestern Arizona. The event will occur before sunrise with the Moon 22% sunlit. The northern-limit graze will be on the sunlit limb about 18° from the north cusp, with the path passing near Eureka, northeast of Sacramento, near Mono Lake, Bishop, Death Valley, and Needles, CA, and near Gila Bend and Nogales, AZ. Note that an occultation by the asteroid (30) Urania is expected in the southwestern U.S.A. about 2½ hours before this event.

1987 February 18, Spica: This is the first occultation of Spica's short series, and the only dark-limb nighttime graze in the U.S.A. It offers an excellent opportunity to obtain more information about Spica's triplicity; the components seem to be too close or too faint for speckle work. The southern limit passes near Olympia, WA, and Flagstaff, AZ.

ASTBBS ENDS — IOTA OCCULTATION LINE STARTS

Joan Bixby Dunham

The ASTBBS is gone; see *o.N.* 3 (12), 244. There was interest in using ASTBBS, but not enough to justify the time and expense of running the bulletin board. We were considering our options when I short-circuited a disk drive on the Apple II+ while replacing the Apple power supply. The ASTBBS ended with a spark and a puff of smoke. The Apple II+ is still working, with the remaining disk drive. The ASTBBS needs two.

Starting immediately, an answering machine attached to (301)495-9062 will have current information on asteroid occultation updates, upcoming local graze expeditions, and other occultation news. Our other telephone line, (301)585-0989, also has an answering machine, but now with a much shorter message. Messages can be left for us on either phone number; those calling 495-9062 will have to wait for what can be a lengthy message to end first, however.

ASTRONOMY AND PERSONAL COMPUTERS

Joan Bixby Dunham

I intend this to be a column discussing the use of personal computers in astronomy. The topics could include; software available, reviews of software, books on the subject, newsletters on astronomical computing, suggestions on (or for) programming, and anything else that may be of interest.

What I write will have a strong bias towards MS-DOS computers, those similar to the IBM PCs, using the Intel 8088, 8086, or 80286 chips. This is not because of any inherent superiority of this PC type as opposed to others. It is because there is much more software available for the MS-DOS PCs, especially public domain software.

Public domain software: Public domain software and user-supported software are distributed by informal means rather than through stores. These programs are found on bulletin board systems, distributed by computer user groups, and obtained from Source or Compuserve. Public domain software is yours for the cost of a diskette (or the time to download it from a BBS), while users are expected to send software authors a nominal fee for user-supported software. My favorite source for public domain software is PC-SIG at 1030-D East Duane Avenue, Sunnyvale, CA 94806. Membership in PC-SIG is $20/yr ($35 for non-USA). They distribute software for MS-DOS machines only, and have over 500 diskettes available. Their programs are current, and their service prompt. You will find their ads in magazines catering to MS-DOS machine owners, like *PC World* or *PC TECH Journal*. I have met up with some sources considerably less useful than PC-SIG; rather than mention names I will just say to beware of outfits other than active user groups offering Apple II public domain software. I have found some that only have the same Apple II+ programs offered by Washington Apple Pi two and three years ago.

Whether public domain or commercial, there is not that much software written specifically for astronomy, and most of the commercial software is designed to teach astronomy. Very little is intended for observers; they are too specialized an audience. Sometimes it is difficult to determine from the descriptions of the software what is really being offered, and the only way to find out is to order it.

PC-SIG Astronomy Disk #1 (PC-SIG disk 538): This is an example of public domain and user-supported software. This diskette has 4 astronomy programs; Moonbeam on the lunar position, two sunset programs, and an optics program. It also has a program to plot hurricanes. The author of Moonbeam asked for $5, which I sent, and supplied a source listing of his Pascal code and a listing in ASCII of the Yale Bright Star catalog data he was using. I haven't tested the sunset programs or the optics program. Moonbeam seems to work well enough, once I understood that Moonbeam expects all digits of the year, so 1986 must be 1986, and not 86.

Everybody should get the *Floppy Almanac* from the USNO. This program gives information from much of the *Astronomical Almanac* to full precision. Versions available for 1986 and 1987 give information from the almanac for the Sun, Moon, planets, and stars. Four catalogs of stars are given; one with 200 bright stars, one with the FK4 stars, one with 233 compact extragalactic radio sources, and one with Messier catalog objects. Anyone familiar with using the *AA* will find this easy enough not to need the Users Guide for basic operations. There are no fancy graphics, no flashy sounds, just a nice solid program that does the job. The price is $20 for diskette plus software, and $4 for additional copies of the Users Guide. The software is in the public domain, which means it is legal to share with friends. Copies from the USNO, however, come with the Users Guide, which explains how to create special catalogs for use with the *FA*, and details about how the computations are performed.

The *FA* is available for PCs that can use MS-DOS. There are 3 versions, 1.3P for the standard DS/DD 5¼-inch MS-DOS diskette, 1.3C for 5¼-inch MS-DOS diskettes for PCs with coprocessor (8087 or 80287) chips, and 1.3P 3½-inch DS MS-DOS diskette for portable PCs. It will be available in December for the DEC Microvax II and on tape for IBM mainframe computers. The address for ordering it (by checks to U. S. Naval Observatory only) is: Nautical Almanac Office; Code FA; U. S. Naval Observatory; Washington, DC 20390-5100; U.S.A.

CORRECTION

J. Dommanget points out a mistake in *O.N.* 3 (14), 300. Translated into English, the name of the Koninklijke Sterrenwacht van België should read "Royal Observatory, Belgium," not "Royal Observatory, Brussels."

TWO TOTAL ECLIPSES DURING THE SAME MONTH

Jean Meeus

In *O.N.* 3 (16), 345, David Dunham writes: "It is very rare to have a total lunar and total solar eclipse during the same month; perhaps Jean Meeus can inform us how frequently this occurs."

I investigated this for a period of five centuries, namely between the years 1900 and 2400. However, I looked for an answer to the more general problem: how frequently is there a total solar and a total lunar eclipse occurring with an interval of half a lunation? I found that this occurs 33 times between the years 1900 and 2400, hence with a mean frequency of one every 15 years. These cases are mentioned in Table 1. A hyphen (-) after the date indicates a total lunar eclipse. The other eclipse of the couple is a solar eclipse, and its type is indicated as follows:

t = central, total eclipse

(t) = non-central, total eclipse

a-t = annular-total eclipse

Table 1.

1909	Jun 4 -	2003	Nov 9 -	2185	Jul 26 t
	Jun 17 a-t		Nov 23 t		Aug 11 -
1910	May 9 t	2033	Mar 30 t	2195	Jul 22 -
	May 24 -		Apr 14 -		Aug 5 t
1927	Jun 15 -	2043	Mar 25 -	2213	Aug 2 -
	Jun 29 t		Apr 9 (t)		Aug 17 t
1928	May 19 (t)	2044	Aug 23 t	2214	Jul 8 t
	Jun 3 -		Sep 7 -		Jul 22 -
1938	May 14 -	2050	May 6 -	2232	Jul 18 t
	May 29 t		May 20 a-t		Aug 1 -
1950	Sep 12 t	2061	Apr 4 -	2308	Jun 19 t
	Sep 26 -		Apr 20 t		Jul 4 -
1957	Oct 23 (t)	2072	Aug 28 -	2336	Jun 25 -
	Nov 7 -		Sep 12 t		Jul 9 t
1967	Oct 18 -	2073	Aug 3 t	2337	May 31 t
	Nov 2 (t)		Aug 17 -		Jun 14 -
1968	Sep 22 t	2090	Sep 8 -	2354	Jul 6 -
	Oct 6 -		Sep 23 t		Jul 21 t
1985	Oct 28 -	2091	Aug 15 t	2355	Jun 11 t
	Nov 12 t		Aug 29 -		Jun 25 -
1986	Oct 3 a-t	2167	Jul 16 t	2373	Jun 21 t
	Oct 17 -		Aug 1 -		Jul 5 -

It is remarkable that the distribution of these events is far from being uniform. There are 11 cases between A.D. 1900 and 2000, and 10 between 2000 and 2100. But there will be only three cases between the years 2100 and 2200, and another three during the following century.

Because the length of half a lunation (14.77 days) is almost exactly half a month, it will be no surprise that for half of the 33 events (to be exact, for 16 of them) both eclipses take place during the same month. Between the years 1900 and 2400 this takes place in the years and months mentioned in Table 2.

Table 2.

Jun 1909	Sep 1950	Apr 2061	Aug 2213
May 1910	Oct 1986	Aug 2073	Jul 2214
Jun 1927	Nov 2003	Sep 2090	Jul 2354
May 1938	May 2050	Aug 2091	Jun 2355

We see that four times it occurs in successive years, namely in 1909-1910, 2090-2091, 2213-2214, and 2354-2355. Moreover, the 16 cases are not distributed uniformly over the twelve months of the year: There is 1 case in April, 3 in May, 3 in June, 2 in July, 3 in August, 2 in September, 1 in October, and 1 in November, but none in December to March.

Finally, let us mention that in many cases, the total solar eclipse of a couple occurs under much more favorable circumstances than the eclipse of 1986 October 3. For instance, the eclipse of 1927 June 29 was total in England, where the duration of the totality was about twenty seconds.

SOLAR RADIUS NEWS

David W. Dunham and Paul D. Maley

1986 October 3, broken annular solar eclipse: Glenn Schneider, Computer Sci. Corp. and Space Telescope Sci. Inst., Baltimore, MD, obtained a time-resolved photographic record of this eclipse from a point in the centerline near maximum eclipse from a Learjet at 40,000 ft. This was east of southern Greenland; see *Sky and Telescope 72* (3), 238. At least three others in the jet also saw the brief eclipse. They sent Dr. Alan Fiala, USNO, a Reykjavik newspaper article reproducing some of their photographs showing Bailey's beads encircling the Moon, and describing the experience. We could not learn much from the Icelandic text. In a phone conversation, they told Fiala that their navigational accuracy was 0.1 mile and absolute timing accuracy 0.5 second, which is normally too coarse. However, this should be adequate for determination of a solar diameter from careful measurements of a blowup of the original film from a broken-annular eclipse, and will probably even be all right for determining an approximate correction to the relative ecliptic latitude that could be used to refine the predictions for next year's solar eclipses.

1986 November 13, transit of Mercury: I hope that some Eastern-Hemisphere IOTA members were able to time the contacts during this transit to help assess the impact of the black drop effect on determination of the solar radius from transit data. A. Fiala tells Dunham that the English solar physicist Dr. Parkinson travelled to Indonesia to time the transit at Bosscha Observatory.

1987 March 29, broken annular solar eclipse: See *o.N. 3* (16), 345 for information about Maley's plans for an IOTA expedition to observe this from Port Gentil, Gabon. Paul recently obtained a 1:100,000 map of the area, and discovered that a 1:25,000-scale map might also exist. Fiala's calculations confirm that the event will be broken annular, with beads encircling the Sun, at Port Gentil. The lunar radius will be nearly 1" larger relative to the solar radius than was the case in Georgia and the Carolinas during the 1984 May 30th eclipse, which should make this eclipse even better.

1987 September 23, annular solar eclipse: Again, see *o.N. 3* (16), 345 for Maley's address and phone, for those who might be interested in joining this IOTA tax-deductible expedition. In late September this year, Maley visited the Purple Mountain Observatory in Nanjing, China, and potential sites near both limits nearby. The Chinese astronomers are eager to cooperate with, and help with the arrangements for, the planned IOTA expedition. But first, a proposal needs to be submitted to the Chinese Academy of Sciences and approved by them. Maley has begun work on this. Hiroki Yokota, Institute of Space and Astronautical Science, Tokyo, Japan, sent us weather satellite photos taken at the same time of day around September 23rd of previous years. The possibility of observing from sites farther northwest in China, where weather prospects are better, is being considered.

1988 March 18, total solar eclipse: Maley is assessing the possibilities of observing this from the Philippines, Sumatra, or perhaps even Borneo. Yokota also has provided us with Japanese weather satellite photos appropriate for estimating cloud cover prospects for this eclipse.

FINDING THE TARGET STAR

Jim Stamm and Danie Overbeek

Probably the most difficult aspect of completing a successful asteroidal occultation or appulse observation is the finding of the target star. This can be especially frustrating for beginning observers, when the star is a typical 9th magnitude or dimmer. Here are two techniques that can simplify the process of locating the target star.

If the observer's scope is aligned to the pole, and is equipped with setting circles, the time required to find the star is usually minimum. It depends on the detail of the charts that are used. These finding charts are provided to IOTA members by David Dunham, Edwin Goffin, and others. Using these charts, the observer should draw circles around the target star - one that represents the diameter of his finder on the small-scale chart, and one that corresponds to the diameter of the field of view of his eyepiece on the larger-scale chart. Adding lines to the smaller-scale field that represent the cross hairs of the finder can also aid in locating the target star.

The procedure for finding the star is then simply to use the setting circles to aim your scope at the area of the event. Use the finder to adjust for the errors in setup and alignment, and then when you look into the eyepiece, a little fine tuning is all that may be necessary. [Ed: This works even if alignment to the pole is quite rough, and even if there is no finder. Aim the telescope at a nearby bright star and set the circles to the coordinates of that star. Then resetting to the coordinates of the target star should bring it well within the field of a low-power eyepiece.] Recognizing the star patterns within the circles on the charts becomes quite easy with a little experience.

One of the pitfalls of this method is that the charts may not show the stars precisely as they appear in the heavens. Cylindrical projection is often used in computer generation of star charts, while conic projection best represents what we see in the sky. Close to the celestial equator, there is no noticeable difference between the two projections, but if the star is more than 20° or so from the equator, the differences become noticeable. A cylindrical projection far from the equator needs to be shrunk horizontally, or 'squeezed' by a factor equal to the cosine of the declination. For instance, a 3-inch chart centered on declination 30° (north or south) will appear more realistic if it is reduced to a width of 2.6 (.866 × 3) inches. The height remains unchanged. [Ed: As observers might not wish to re-draw the charts, it is suggested that ellipses, rather than circles, be drawn, the east-west axis being expanded by a factor equal to the secant of the declination. While this will not give a true picture of the star field, it will show the area included in the field of view.]

Another limitation of computer-generated charts is that they often leave out many of the dim stars that form the patterns that are so helpful in recognizing the correct field. Dunham prefers to add stars from the True Visual Magnitude Photographic Star Atlas to his charts, and Goffin has added some dimmer stars to his more recent predictions, but nothing beats the real thing. Our suggestion is to locate the star well before the event, when your time is not severely limited, and then draw your own field. That way, you will have an accurate and readily recognizable star field to use on the night of the event.

Overbeek has used a variation of the star-hopping technique that he finds not only of help to novices, but also enjoyable for more experienced observers. "It really works!", is the often-heard testimony to this method. From a very conspicuous star, the observer is led step-by-step to an intermediate one — a star that is easy to find and/or confirm; one that is also west of the target star. From this point, the observer is instructed to offset his telescope north or south by a specific number of arc minutes. Then he waits a specific number of seconds, and the target star will be in the center of his eyepiece field.

The process is quite easy for the observer, for all he has to do is to determine the precise true field diameter as seen through the eyepiece, and to make sure that his offset is exactly north or south. The true field diameter is obtained by finding a star on the equator, and dividing the number of seconds that it takes for the star to drift (without drive) completely across the middle of the field, by four. The result is the true field diameter in arc minutes. If you are using an equatorially mounted scope, the north-south offset can be accomplished simply by moving in declination only. Otherwise, you can judge the north-south direction by watching the intermediate star drift across the field (the line that the star follows is an east-west line).

The person who provides the instructions for this method may have to be a bit creative. The intermediate star needs to be as close as possible to the target star, and on the west side, besides being easily seen or found. Some field stars need to be drawn in around the target star, so the preparer will need access to a suitable star atlas, or better yet, he should preview the actual field.

The intermediate star's coordinates are determined by careful measurement from a good large-scale star atlas, or more precisely by looking them up in a catalog. If a general star catalog is not available, the intermediate star might be listed as a double, variable, or bright constellation star in some list, such as is found in Burnham's *Celestial Handbook*, the R.A.S.C.'s *Observer's Handbook*, or Ottewell's *Astronomical Calendar*. Be sure that the epoch is approximately the same for both stars.

Once the preparer finds the coordinates for both stars, he simply determines the offset by finding the difference in declination, and the drift time by finding the difference in right ascension.

It is also very helpful to include some confirming clue in the description of the target star's field. For instance, "Look for three dim stars in a line about three minutes southwest of the target star," or "The target star is within a triangle of brighter stars, close to the eastern one."

If field stars cannot be included with the target star, then the observer should simultaneously monitor all of the stars that are close to the indicated brightness of the target star. If this method is executed properly, and an occultation does occur, then one of the stars will disappear.

Just a little practice at these observations will make you an experienced observer. Good luck.

OBSERVING TIME WITH THE HUBBLE SPACE TELESCOPE FOR AMATEUR ASTRONOMERS

David W. Dunham

On August 7th, Dr. Riccardo Giacconi, director of the Space Telescope Science Institute (STScI), announced at the Astronomical League's annual convention in Baltimore, that he was making available at least a few hours of his discretionary observing time on the Hubble Space Telescope (HST) for use by American amateur astronomers. Amateurs are encouraged to submit brief proposals for this time, to be reviewed by the Amateur Astronomers Working Group (AAWG), which consists of the presidents or representatives from major amateur astronomical organizations, including me for IOTA. More information about this is given in *Sky and Telescope* 72 (5), 520. Amateurs interested in submitting a proposal should obtain an application form and informational packet by sending $1.00 to the HST AAWG; c/o American Association of Variable Star Observers; 25 Birch St.; Cambridge, MA 02138. Make the check payable to the AAVSO. In *Sky and Telescope* 72 (4), 332, the announcement giving this information stated that the deadline for receipt of the completed application forms (which are essentially one-page preliminary proposals) would be 1987 March 31. But that announcement was based on a schedule drawn up by the AAWG in August. Since then, NASA has issued a new Shuttle manifest scheduling launch of the HST near the end of 1988, about half a year later than assumed in August. Amateur observing time can be scheduled no earlier than six months after launch, during which time HST will be tied up with tests, calibrations, and observing time already guaranteed to mission scientists. At the end of October, Ken Willcox, the Astronomical League's representative on AAWG, telephoned me to say that the March deadline would probably be changed to 1987 July. When I learn anything more, I will put it in the next issue of *O.N.* In the meantime, I understand that STScI was preparing a more elaborate and more informative packet than originally planned to be sent to those who sent $1 to AAVSO. The packets will be distributed by AAVSO as soon as they are ready. Amateurs will be asked to send their preliminary proposals (the applications) to one of the member groups of the AAWG, depending on the subject matter of the proposal. Occultation-related proposals (including those to make observations, such as of very close double stars, that would confirm or provide additional information about occultation discoveries) will be sent to IOTA's HST proposal coordinator: Paul Maley; 15807 Brookvilla; Houston, TX 77059; USA.

One of the requirements stipulates that the proposer must be a citizen of the U.S.A. Justification for this is that HST has been funded primarily by American taxpayers, and that STScI will pay travel expenses for winning proposers to be at STScI when their observations are made. Concern was expressed for resident aliens in the process of naturalization who also pay U.S. taxes, so it was decided that they would be accommodated. About 15% of HST's time will be used by European astronomers, since part of HST's development has been financed by Europeans. So possibly European astronomers would follow Dr. Giacconi's lead and make some small fraction of their time available to European amateurs.

In any case, IOTA encourages proposals from its foreign members. Foreign proposals that are accepted by IOTA will be assigned an appropriate American IOTA member as principal investigator, with the foreign member(s) listed on the proposal as co-investigators. But the foreign proposer will be given primary, or at least equal, status in the announcement and publication of any discoveries resulting from the observations made by HST in response to the proposal.

ABOUT ILOC'S WORK

Dietmar Büttner

Lunar occultation observers may have been puzzled by some items when examining residuals computed by the International Lunar Occultation Centre. Some of these esoterica should be discussed here. However, it should be stressed that this article is not intended to be fault-finding concerning ILOC's work, but to give observers some clarifications and explanation.

1. Some 1980 observations have been reduced at both HMNAO and ILOC. The two procedures did not result in duplicate O-C and LC/HW for the same observations. In both reductions, the same timing data, star numbers, and observer positions have been used. The differences between the two systems seem not to be in any systematic sense. Evidently, they are caused by: using a different lunar ephemeris (The Japanese Ephemeris at ILOC); using different star catalogs (H82 at ILOC); and different computer programs. Thus, any analysis of residuals by the ILOC is not comparable with HMNAO's analysis results. Mr. Senda, ILOC, agreed that a detailed comparison of the two reduction systems is very important. It has not been undertaken at ILOC until recently.

2. The angles K-R in the single computer prints with reductions of observations in 1980, 1982, and 1983 are wrong. Due to a programme error confirmed by ILOC, the position angle of the Moon's motion was always computed to be 57°. In the meantime, this error has been corrected. The values K-R in *Report of Lunar Occultation Observations, the Observation and Reduction in1983* (1986 March) are correct.

3. Reduction results of observations in 1983 have been distributed to the observers twice. The O-C in the single computer sheets do not coincide with the ones in the report mentioned above. As Akio Senda wrote, this is caused by using another system of observers' geographical positions (WGS 82) and another height of the geoid (GEM 10 B) in computing the data in the report.

4. As of 1986 July there was no possibility of reducing double star occultations correctly, as there is no double star catalog operational at ILOC. The same position for both components has been used in the reductions until now. Mr. Senda wrote that he hopes to add a double star catalog to the ILOC files in the near future.

5. Some observations of even bright stars reported to ILOC have not been reduced, whereas other observations made by the same observer on the same day have been processed! Akio Senda is doing his best to solve the mystery of observations disappearing in processing, as soon as possible.

6. The explanation of the quantity HW as 'vertical profile' in the reductions for 1980-1983 is a bit confusing. It would be better expressed as 'radial profile'. At my suggestion, the word 'vertical' is omitted in the explanation sheet distributed with the reductions for 1984. HW is the height from Watts' charts.

7. In the single computer sheets with reductions for 1983, the personal equation (PE) quoted by the observer, is given in seconds of arc. Surely, it should be in seconds of time.

8. Star magnitudes given in the reductions deviate from those in USNO's total occultation predictions in some cases. As Mr. Senda explained, the magnitudes in the reductions are SAO magnitudes. For non-SAO stars, the AGK3 magnitudes are printed.

9. Although ILOC computes residuals for grazing occultations, they are not needed, and suggests in the explanation sheet that they do not need to be considered! Thus, IOTA seems to be the only agency analyzing grazing occultation observations.

Occultation observers should not be discouraged from observing by reading this article. In any case, ILOC apologizes for the errors and irregularities and asks for continued cooperation in submitting observations. Repeating this here, I want to urge all single observers and groups to continue reporting observations to ILOC. Please support ILOC as fully as possible in order to help in making their work more sure in the future. This should be in the interests of both ILOC and observers.

In commenting on the negative aspects, we should not forget that there are positive ones as well, e.g., the report mentioned in (2) above. As it is a complete collection of observations made around the world in 1983, it is, in combination with *Report of Lunar Occultation Observations, the Lists of Telescopes and Observers* (1985 March), a very valuable help in comparing and analyzing occultation observations.

LUNAR OCCULTATIONS OF PLANETS

The maps showing the regions of visibility of lunar occultations of planets are reprinted by permission, from the Japanese ephemeris for 1987, published by the Hydrographic Department of the Maritime Safety Agency of Japan. In region 1, only the reappearance is visible; in region 3, only disappearance may be seen. Reappearance occurs at sunset along a dashed curve, while disappearance is at sunrise along a curve of alternating dots and dashes. We have added a legend to each map indicating the phase of the Moon at event time.

Events later than those shown will appear in a future issue of *Occultation Newsletter*.

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