Occultation Newsletter

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REPORTING TIMINGS OF NON-SAO STARS

If you time occultations of stars not in the SAO Catalog, using special predictions (such as the special Hyades and M67 passage predictions) which are computed and distributed by David Dunham, please report those particular timings to him, rather than to HMNAO.

FROM THE PUBLISHER

For purposes of determining when your subscription to *Occultation Newsletter* expires, consider this to be the last issue of 1976, rather than the first issue of 1977. We expect to publish four more issues during 1977. Practical considerations dictated the increased size of this issue; the increased size is not representative of future issues, despite the increased price starting with this one.

Occultation Newsletter is priced @ $1.00 per issue, or $4.00 per year (4 issues) including first class surface mailing, until further notice. Air mail delivery is available at added cost: add 16¢/year in Canada and Mexico; add $1.28/year in Central America, Colombia, Venezuela, the Caribbean Islands, Bahamas, Bermuda, St. Pierre and Miquelon; add $1.76/year in all other countries. All back issues, #1 through #9, are still available @ 50¢. #10 and later issues will be priced @ $1.00 as back issues. See IOTA NEWS for information about *Occultation Newsletter en Español*.

The foregoing applies only to separate, individual subscriptions. IOTA membership, including a subscription, remains @ $7.00/year for residents of North America (including Mexico) and $9.00/year for others, to cover the costs of overseas air mail. However, European and U.K. observers should instead join IOTA/ES, sending DM 10.-- (German marks) to Hans J. Bode, 3000 Hannover, Bartold-Knaust Str. 6, German Federal Republic. See IOTA NEWS for optional reduced IOTA membership dues for those in Spanish and Portuguese-speaking countries.

Please address all subscription, back issue, and IOTA membership requests to Berton L. Stevens, Jr., 4032 N. Ashland Ave., Chicago, IL 60613, U.S.A., but make checks and money orders payable to IOTA, or to International Occultation Timing Association, or to Occultation Newsletter.

IOTA NEWS

David W. Dunham

You probably have been wondering, with justification, when you would receive this issue of *Occultation Newsletter*. We are now somewhat more than one issue behind schedule, due to the fact that I still am supplying a major proportion of the most important material for this issue, and that the time I can work with occultations is limited, as explained in the last issue. Work and correspondence related to various ongoing projects to improve predictions of different occultation phenomena, discussed in this issue, have also kept me busy. Volunteers are desperately needed to help write some of the recurring sections of *O. N.* and for other projects described below, in order to maintain our publishing schedule better, and to improve and expand IOTA's services. So much material has accumulated for this issue that there is enough for two issues. [Ed: This was written before it was decided to double the size of #10.] The next issue [#11] will be distributed in a few weeks, and will include several abstracts of published papers concerning occultations, information and charts about passages of the moon through the Hyades cluster using Astrographic Catalog data (see PREDICTIONS OF PLANETARY OCCULTATIONS), and any material planned for this issue which could not fit [Ed: This plan has not changed.]. For the issue after the next one [#12], fixed deadlines are planned, so that we can better adhere to our quarterly schedule. The deadlines will be 1977 April 15 for material to be sent to those who are writing the various section articles, and 1977 April 29 for final submission of articles to the editor, H. F. DaBoll. Information about lunar occultations of planets and other solar system objects should be sent (by April 15) to Michael Reynolds, and reports of erroneous predictions, or of observations of unpredicted occultations, should be sent to David Herald, at the addresses shown in their articles in this issue. Material for the other recurrent sections should be sent to me at P. O. Box 488, Silver Spring, MD 20907, although in some (hopefully many) cases, I will send some of it to others (such as Raymond Finkleman, who also lives in Silver Spring, for occultation tally coupons). More volunteers are needed to write the recurring sections, but I expect to do IOTA NEWS and GRAZES REPORTED TO IOTA (at least, the table for that section, since I plan to continue to collect graze observations).

The first IOTA meeting will be held in mid-August in Boulder, Colorado, in conjunction with the National Amateur Astronomers Convention. Paper sessions and other scheduled activities will take place 1977 August 10-13 at the University of Colorado in Boulder. Accommodations will be available at the Kittredge Residence Halls located across the street from the Sommers-Bausch Observatory and the Fiske Planetarium. Room and board for 5 nights (Aug. 9-13), and meals for 4 days, will cost approximately $87 per person for single occupancy, $80 per person for double occupancy, and $50 per child under 13 years old. Alternately, nearby motels are available, and tickets may be obtained for individual meals at the cafeteria. The $18 preregistration fee is payable to the National Amateur Astronomers, of which IOTA will receive $0.75 for each registrant. Those planning to attend should send the fee to: Denise Nye, NAA Convention Registration, 5604 Bowron Pl., Longmont, CO 80501. Further convention information is available by sending a stamped self-addressed envelope to Denise Nye. A 2-hour IOTA business meeting is planned, probably early in the evening of August 11 or 12. An expedition might be organized to observe a graze of 5.1-mag. 68 Geminorum by the 6% sunlit waning moon in Wyoming on Aug. 12 (see *Sky and Telescope*, 1977 Jan., p. 71). Clubs and individuals who wish to submit astronomical displays should contact Merrill Manion, 1775 W. Kentucky Ave., Denver, CO 80223. Anyone interested in presenting a paper about occultations during the meeting should send me a proposed title, to ensure suitability and non-redundancy. One NAA notice has said to send such papers to Andrew Gassmann, NAA Papers Chairman in Castle Rock, Colorado, but they should instead be sent to me; he will send me information about any occultation papers which he receives. IOTA members who do not plan to attend the convention could send me a paper to be read at the meeting, if desired. Mr. Gassmann writes further about the arrangements: "We plan to devote blocks of time to subject matter, rather than schedule a group to a set time limit. I would need from you (for each paper) the title, author, approximate length, and a brief summary. This would be needed by about July 1 so we can get the convention program organized and

and into print. The final papers will be collected at the convention for the proceedings which will be published later. If you have any ideas or comments, please let me know.

I am now working with Thomas Van Flandern at the U. S. Naval Observatory, and others, to include predictions of occultations of several dozen minor planets, and of occultations of many faint stars in various star clusters and in fields which will be traversed by a totally eclipsed moon, in the USNO total occultation predictions. This will be an improvement over the relatively time-consuming and inefficient predictions computed with the University of Texas prediction program, and will ensure more complete coverage. Data for these special events will be included in the regular predictions for most observers for 1978. I will make special computer runs for the other observers for 1978, and for the rest of 1977 for most observers (especially active IOTA members). Similar predictions for M67 and M24 passages in Europe, Japan, and western Australia during late 1976 have already been distributed. If the coordinates of your station are not in USNO's files, you should send them in, since coordinates used for all USNO predictions must be in these files. For the 1976 events, I changed the observability code limit in some cases, in order to generate more predictions. If you would like a lower observability code limit for these special predictions than that used for your regular predictions, let me know. Computer time limitations may force some cutbacks in the special prediction coverage. David Herald is reducing Astrographic Catalog data to obtain equinox 1950 coordinates for hundreds of faint stars near M23 and in fields which will be occulted by the moon during the 1978 eclipses of March and September, for the special USNO predictions. It is also planned to include the already-existing data for M67 and M24, and to add Astrographic Catalog Data for the Hyades (see PREDICTIONS OF PLANETARY OCCULTATIONS) and several non-SAO stars from the Yale catalogs which have no Yale proper motions (see OCCULTATIONS OF BRIGHT NON-SAO STARS, *O. N. 1*, 58, #7).

Help is sought for certain computer tasks. We continue to have problems with the grazing occultation predictions. A few of the graze computors have moved or otherwise lost access to the computers they were using, and not enough new computors have become operational to provide adequate service. Most of the computors are students, who are often delayed in computing and distributing predictions by final exams and other academic pressures. Graze computors need access to large computers, with 32K words or more of core storage, such as an IBM 360/40, CDC 6400, PDP-10, or Univac 1108.

Standard-coverage total occultation prediction is a more modest computer job for which a volunteer is sought. Nicholas Esposito has done this job during the past three years, using input data identical to that in the *Sky and Telescope Occultation Supplement* provided on cards by HMNAO. Van Flandern and I have designed an improved system which will use cards generated by the USNO total occultation program for the same standard stations as given in the *Supplement*. These new standard-coverage predictions include planets and galactic-nebular objects down to an observability code limit of 3 (mag. 10.9 for the most favorable conditions) and stars to O-code limit 7 (faintest mag. 8.1), so that about 1.5 times as many events are included as are given in the *Supplement*. Sun and moon altitude are given, as are cusp and Watts angles useful for reappearances, data not included in the old coverage. Wayne Green, P.O. Box 16228, Jacksonville, FL 32216, plans to do the computations initially, but another volunteer is sought so that he can work on other important occultation tasks. When the program is operational, a note will be published in *Sky and Telescope* offering the service to anyone who sends accurate coordinates and a long, self-addressed envelope. The program is rather simple, involving only card input. Also, we don't need to be restricted to North America. Someone in Europe (or elsewhere) could use the program to provide a similar service for their continent. Hopefully, many observers who time fewer than about 20 events per year will get these predictions in the future, rather than the much more time-consuming USNO predictions. A volunteer for running this program should preferably have a stable address to which requests can be sent.

Since 1973, the *Sky and Telescope Occultation Supplement* has been published by Sky Publishing Corporation and distributed by USNO. For next year's *Supplement*, neither wants to do these jobs due to manpower limitations, although HMNAO still plans to prepare the tables and maps, as they have done for many years. It seems likely now that the material which has been included in the *Supplement* will be published in *The Observer's Handbook - 1978* of the Royal Astronomical Society of Canada. Since they already are publishing the data for the Canadian standard stations, it should not be too difficult to extend their coverage south to include the United States stations. It is possible that the Astronomical League also may publish this material. Although this means that the *Supplement* data, which covers only the United States and southern Canada, no longer will be available free, the standard-coverage predictions described above will be available without a payment being necessary.

It should be noted that the European Section of IOTA does not cover all of Europe, but does provide coverage for most of the continent, including the "I", "U", and "Z" regions. The northernmost and easternmost parts are in the "XE" and "R" regions, for which graze predictions are not distributed by Hans Bode, chairman of IOTA/ES in Hannover, Germany. The XE region includes the following areas: Norway north of a line passing through the Sognefjord and just south of Oslo: Sweden north of a line passing through Öland and the place where the border with Norway meets the sea; Finland; Estonia; Latvia; Lithuania; and northwesternmost Russia (Here and in the rest of this issue, we use "Russia" in the narrow sense, signifying the European part of the Russian Soviet Federated Socialist Republic. The Asian part of the R.S.F.S.R. is Siberia). The R region includes most of the rest of Russia and the Ukraine east of a line passing through Kiev and the Crimea.

The first issue of *Occultation Newsletter en Español* was distributed by the Institute of Astronomy of the Universidad Nacional Autónoma de Mexico last November, as mentioned in the last issue. Guillermo Mallén, Goya 64-11, Col. Mixcoac, Mexico 19, D.F., Mexico, is handling the duplication and mailing list, while Eduardo Przybyl, Ruta Nacional 34 (Norte) 388, 2300 Rafaela, Prov. de Santa Fe, Argentina is the editor and translator, with the help of other members of the Agrupación Amigos de Urania de Rafaela. The first edition is virtually an exact translation of the last issue of *O. N.*, while a publication distributed a few months earlier, without a name, was a translation of *O. N. 1*, #8. Future editions probably will contain some extra articles which are relevant mainly to observers in predominantly Spanish and Portuguese-speaking countries, while some *O. N.* articles not applicable to those areas will be omitted. Some of the other IOTA papers also are being translated into Spanish. Members of IOTA in these areas who do not need to receive the English-language *O. N.* (some of those who know English may want to continue to receive it to avoid the translation delay) henceforth need to pay only $3 to IOTA in order to receive grazing occultation and other special event predictions.

Living in the Washington, D.C. area, it is easier for me to find people who are fluent in foreign languages and can translate letters for me. Overseas observers should feel free to write to me in their language, especially for urgent matters. Spanish, Chinese, French, German, and Russian are most readily translated.

The Brazilians have beat us again in the field of general publications. Jorge Polman, Clube Estudantil de Astronomia, Colégio São João - Várzea, Caixa Postal 1174, 50.000 Recife, PE, Brazil, has published a mimeographed 19-page paper on using total and grazing occultation predictions, and completing observation report forms. It is effectively an updated and concise version of Luís Eduardo de Silva Machado's "Das Ocultacões de Estrelas pela Lua", and like it, Polman's paper is in Portuguese.

I have changed my place of work again, recently, but this time , I have only moved across the hall, to an office with a window. My telephone number at Computer Sciences Corporation is still 301, 589-1545, but the extension is now 596. My home phone is still 301, 585-0989. Concerning correspondence, you are more likely to receive a quick reply, and save me a little time, if you enclose a self-addressed postcard, self-addressed envelope (a long one if you want graze report forms), or a gummed address sticker. I don't need to be sent postage stamps - I have plenty of them - but would rather have one of the items mentioned above to expedite things.

Last November, the National Bureau of Standards in Boulder, Colorado, gave notice that they planned to discontinue transmitting time signals at certain of the WWV and WWVH frequencies. Most distressing for occultation observers was the planned elimination of WWV's 2.5-MHz broadcast, important during this time of sunspot minimum. The officers of IOTA wrote a letter to N.B.S. requesting that the 2.5 MHz transmissions be continued, as did several other IOTA members on their own. We had planned to urge *O.N.* subscribers to write to N.B.S. in this issue, but fortunately it is no longer necessary. In a notice dated 1977 January 7, N.B.S. announced that their WWV and WWVH transmissions at 2.5 MHz would continue unchanged, as would those at 5, 10, and 15 MHz.

Considering the services provided by HMNAO, USNO, and IOTA, the American Association of Variable Star Observers has decided that its Occultation Section is redundant, and consequently will disband it. They will recommend that their members contact us for occultation services. If you plan to observe an important occultation or a graze of a variable star, you may want to send a request to the A.A.V.S.O., 187 Concord Ave., Cambridge, MA 02138, asking what the magnitude of the variable is expected to be at the time of the event, especially for the large-amplitude Mira variables.

GRAZES REPORTED TO IOTA

David W. Dunham

Graze reports should be sent to my current address, P.O. Box 488, Silver Spring, MD 20907, U.S.A. As usual, if possible, a copy should also be sent to HMNAO. In general, I no longer will acknowledge receipt of observation reports, since an entry in the list of observed grazes serves this purpose. Of course, if you send me a report which is not listed, please let me know. However, I will acknowledge reports if either the report is not complete, or a self-addressed envelope or postcard is enclosed (I don't care if a stamp is not included), or a gummed address label is enclosed, or more report forms are needed (in which case, either a gummed address label or a long self-addressed envelope should be enclosed). During the I.A.U. General Assembly in France last August, an informal discussion of occultation work, especially plans for future work, was attended by workers from the national almanac offices involved. Workers from HMNAO voiced objections to the currently used IOTA graze report forms, noting that they delayed their reductions. The new graze report forms, from which the data can be keypunched directly, will overcome these problems. In the meantime, when possible, observers should send HMNAO reports using their forms; if the extended codes available on the IOTA forms are not needed for a particular observation, HMNAO's forms are also sufficient for IOTA. Also, it would be helpful for compiling lists like the one below if observers would report the star's magnitude, the % of the moon sunlit, and the cusp angle of graze from the predictions (many observers already do), quantities which are not requested on the current forms. Some observers have been reporting observing condition code 0 grazes, where no observations are obtained due to clouds or other causes. Having been on a number of clouded-out expeditions myself, I appreciate knowing about these efforts, but space does not permit listing them.

As mentioned in IOTA NEWS, we have continued to have some problems in getting out predictions in time. If you have not received predictions or profiles for a particular quarter and your travel radii are reasonably large, send a note to Berton Stevens, Jr., IOTA Secretary, 4032 N. Ashland Ave., Chicago, IL 60613. For North American observers, he can at least supply predictions for individual events, upon request, which you learn about from published maps, and we can see what problem the computor for your area has encountered, and can either help him or find someone else who can compute the regular predictions. Note that IOTA members do not need to pay for individual graze requests; there has been some confusion on this point by some new members. Those who have paid more than they need to are having their memberships extended by one or two quarters, as appropriate, to minimize financial transactions. Berton Stevens, Wayne Green, and I have been doing some work using Jean Meeus' prediction method and making other program changes which ultimately will result in a prediction program significantly more efficient than the one now being used. When it, and the double star files, are operational, it should be possible to improve IOTA's prediction service with fewer computors.

Yale Catalog star position shift calculations for grazes where the position source is Z.C. or G.C. were discussed on p. 74 of *O. N. 1, #8*, and in earlier issues. Wayne H. Warren, Jr., NASA Goddard Space Flight Center - Code 671, Greenbelt, MD 20771, phone 301, 982-4604 or 474-0814 (home), can now do these calculations for observers in eastern Canada, the northeastern and southwestern U.S.A., and overseas. John Phelps, Jr. will continue to do these calculations for observers in the U.S.A. and Canada north of latitude 38° N. and west of Ohio, while Robert Bailey will do them for the south-central U.S.A. and Mexico, and Thomas Campbell, Jr., for the southeastern U.S.A. Since Warren has the catalogs in his office, and has a program to do the calculations with his HP-67 calculator, he can do the calculations quicker than the others, and can serve as a backup for them, especially when time is short. As usual, a self-addressed envelope or postcard should be sent with any requests. AGK3 shifts for northern hemisphere Z.C. and G.C. stars are still available from me.

Two computer program errors were found using observations reported by Robert Sandy in October. I sent program changes and procedures for eliminating these errors to the computors late last year. One error caused the cusp angle on the ACLPPP profiles to be in error by as much as a degree for all waning-phase grazes for most observers. The other more serious error caused the graze height on the profile to be incorrectly computed. It was due to the interfacing between the graze program and ACLPPP when a graze track passed over one of the special "observatory" stations, which I believe are now present only in the C region (midwestern U.S.A.) predictions.

Three of the grazes in the list were observed in the Soviet Union. The one on 1974 September 11 was observed from Kiev University Observatory's comet sataion at Lesniki, 1.3 km from the predicted limit. The other two were expeditions from Kiev, using predictions computed at Kazan. The observations were made partly in response to a paper given by Dr. A. A. Nefediev and others at Engelhardt Observatory in Kazan, at the 19th Astrometrical Conference of the U.S.S.R., held in Moscow in 1972 June. They urged that photoelectric total occultation and visual grazing occultation observations be encouraged in the U.S.S.R. Predictions for grazes near 22 places in the Soviet Union involving about half of the stars in the Z.C. would be computed at Kazan. It is difficult for astronomers to obtain the necessary topographic maps, which are classified secret by the military. From discussions at the I.A.U. last August, I understand this is still a problem, although the observers from Kiev must have obtained maps adequate for predictions for the events they observed. Coordinates of observing stations are not included in the Soviet reports, as these apparently are also secret.

The graze of ZC 1234 on 1976 November 13 is the first relatively well-observed graze reported deep in the northern Cassini region. It showed that the actual limb is near the mean limb, and that both Watts data (about 2" below the mean limb) and an observation of a 7½-mag. star on 1974 Sept. 12 which indicated a 4"-high mountain, were wrong for the area. The position used for ZC 1234 is from the good-quality N30 catalog. Data were sent to the computors to incorporate the ZC 1234 observed data into the ACLPPP profiles for 1977, and the 1974 data, used for most of the 1976 ACLPPP profiles in that area, were removed. We had no problems with WWV reception during the graze, but according to the NBS Time and Frequency Services Bulletin No. 229, about 2 hours after the graze, there was an outage for over an hour at the key frequency of 5 MHz. The observations showed the need for multiple stations spread over a graze-height range of at least 2", and a reasonably bright star for good observations and good star position, for charting the Cassini regions. Grazes in the still poorly observed northern

Cassini region are still occurring, so hopefully more observations like those of ZC 1234 will be made this year. Another error in Watts' data is shown by the graze of ZC 3051 on 1976 October 3, when the librations were lat. +6°7 and long. -6°0. The observations showed that the valley at W.A. 175°4 is nearly 1"0 deeper than the ACLPPP profile showed. This will be incorporated into the ACLPPP data later this year.

60 observers manned 25 stations near Natori, Japan, for a graze of Spica on 1976 July 5, but they were clouded out. As reported in NEW DOUBLE STARS, most expeditions in the U.S.A. were more successful for the 1976 Aug. 28-29 graze. About 60 stations near Vero Beach, Florida, netted over 100 timings, according to expedition leader Harold Povenmire, making it the most successful of the year. Any observers who have not done so yet are urged to send him their timing reports as soon as possible so that the observation report can be completed. A movie of the nearly grazing occultation was obtained with an Air Force camera at Cape Canaveral. Thunderstorms ruined Paul Maley's expedition for the same graze near Houston, Texas. About two hours before the graze, the home of one of the observers was hit by a tornado. A bigger disappointment for the Houston observers was the rain which forced cancelation of their plans for a spectacular crescent-moon graze of β Capricorni during Thanksgiving evening. The southern-limit profile was rugged, promising many events for all 129 stations which would have been fully equipped. Another graze of the star near Houston in June is not so favorable.

The drama involved in grazes was well illustrated by my experience with the graze of ρ Sagittarii (ZC 2826; see also NEW DOUBLE STARS) on 1976 November 26. Snow fell as we drove across eastern Ohio, and a traveler's advisory was in effect when we reached Columbus. The weather forecast was poor, with broken clouds expected into Illinois, especially disconcerting since the moon altitude would be less than 10°. I telephoned Mike Flick in Cincinnati; we decided to join forces south of Indianapolis, where the weather prospects were a little better than near Dayton, Ohio. The southern half of the sky cleared completely as we drove across Indiana. After meeting the observers from Cincinnati, we selected an AM radio station to use for a time reference for those without short-wave radios and went to our stations. The temperature was below 20° F., quite cold for that time of year. I set up my equipment in the van at Joan's station, then drove to my planned site in the village of Fairland. When I got there, I saw that trees, buildings, lights, and people would pose problems, so I drove to an alternate site which was 0.3 mile south of a certain intersection and 3 miles from Fairland, though time was fast running out. Fortunately, abandoned railroad tracks crossed the road at the planned location, for good positional reference. I arrived only a couple of minutes before the graze was expected to start. I took the tele-

Mo	Dy	Star Number	Mag	% Snl	CA	Location	* Sta	* Tm	C C	Ap cm	Organizer	St	WA	b
1972														
1	30	Z08915	9.1	0E		Chicago, IL	1	2		15	Robert Hays			
1973														
2	13	0882	5.0	77+	-S	Chicago, IL	1	6		15	Robert Hays			
6	22	3320	5.3	69+	-N	B.Krinitcha,Ukrn.	1	7		8	A. Osipov			
9	6	2692	5.7	71+	S	Chodruchi,Moldavia	3	11		8	A. Osipov			
1974														
9	11	1010	8.0	33-	N	Lesniki, Ukraine	1	2		48	A. Zhitetski			
[10	21	2759	3.6	36+	9S	Croydon, U. K.	3	13			Norman Wright		169	-27]
10	21	2759	3.6	36+	9S	Petworth, U. K.	4	12		15	H. C. Nightingale?		169	-27
10	21	2759	3.6	36+	9S	Itchenor, U. K.	3	11		12	Patrick Moore?		169	-27
10	21	2759	3.6	36+	9S	Crawley, U. K.	2	4		20	J. Chapman?		169	-27
10	21	2759	3.6	36+	9S	Gravesend, U. K.	2	2		21	M. Absalorn?		169	-27
10	21	2759	3.6	36+	9S	Billingshurst,UK	11	26		20	Leslie Morrison?		169	-27
10	21	2759	3.6	36+	9S	Portsmouth, U. K.	4	8		15	R. W. Arbour?		169	-27
10	21	2759	3.6	36+	9S	Hayling Is., U.K.	2	7		15	E. Goddard?		169	-27
10	21	2759	3.6	36+	9S	Bognor Regis, UK	1	2		3	G. T. Buss		169	-27
1975														
10	25	0913	5.2	75-	-2S	Calabasas, AZ	1	1	7	15	Richard Nolthenius	4N	186	44
1976														
1	23	1853	4.9	63-	3S	Yohkaichi, Japan	1	1	6		(T. Hirose)			
3	5	0299	6.3	17+	9N	Kohriyama, Japan	3	14	7	5	(T. Hirose)			
3	10	0913	5.2	61+	N	Trumbull, TX	1	3	9	20	Paul Newman			
4	7	1040	6.2	44+	9N	Continental, AZ	1	20	7	15	Richard Nolthenius	2S	10	63
5	4	0985	6.9	20+	N	Gluckstadt, MS	1	0			Ben Hudgens	>10S		
5	7	Z09206	7.6	49+	9N	Rothville, MO	1	2	6	15	Robert Sandy	3N	9	74
5	9	1623	5.4	76+	8N	Kainan, Japan	4	22	8	6	Yasuo Yabu			
6	6	1671	7.6	57+	2N	Bucyrus, KS	1	1	7	15	Robert Sandy	0	3	58
6	20	Z00391	9.2	41-	2N	Lake Arrowhead,CA	1	3	5	15	Richard Nolthenius	4S	359	-29
7	22	Z03463	8.5	22-	-0N	Green Bay, WI	1	1	3	25	Berton Stevens, Jr.	9N	358	-30
8	4	2302	2.9	67+	8S	Sapporo, Japan	6	50	7	6	Toshio Hirose	0	171	-19
8	4	2303	5.1	67+	8S	Obihiro, Japan	8	36	7	5	Homichi Kimura			
8	5	2436	6.3	76+	-N	Gisborne,N.Zealand	1	1		20	B. A. Sinton			
8	8	2889	7.1	97+	22S	Lake Irvine, CA	1	7	7	15	R. Nolthenius	C2S	169	-58
8	18	0617	6.6	44-	3N	Toyohashi, Japan	3		8	5	Toshio Hirose			
8	19	0730	5.1	37-	-3S	Cotton Center, AZ	1	6	7	15	Richard Nolthenius	0	177	43
8	20	Z04575	7.4	28-	-	Shomberg, Ontario	1	3	5	25	Robert Pike			
8	20	Z04809	7.5	26-	-1	Colfax, CA	1	8	6	31	Bill Fisher			
8	21	Z06175	8.3	18-	-1S	Farmersville, IL	1	5	6	25	Berton Stevens, Jr.	4S	180	62
8	28	1925	1.2	15+	-1S	Bunkerville, NV	3	7	8	11	Walter Morgan			
8	28	1925	1.2	15+	-1S	Grand Canyon, AZ	2	4	8	15	Richard Nolthenius	0	181	21
8	29	1925	1.2	15+	S	St. Petersburg,FL	5	33	6	32	Thomas Campbell,Jr.	3S		
8	31	2259	6.7	32+	S	Yass, Australia	2	3	2	15	David Herald	C5S	168	-30
9	4	Z20376	9.0	81+	15S	Marana, AZ	1	6	5	15	Richard Nolthenius	C	169	-59
9	17	Z05452	7.9	44-	3N	Marley, IL	1	2		25	Berton Stevens, Jr.		353	62
9	18	1072	6.2	34-	4N	Sewalls Point, FL	2	4		25	Harold Povenmire		356	66
9	18	1106	3.6	31-		Moapa, NV	1	1	4	20	Walter Morgan			
9	28	Z15455	9.0	24+	9S	Tucson, AZ	1	11	6	15	Richard Nolthenius			
9	28	Z15478	6.5	24+	S	Mirage, CA	1	2	7	25	Keith Horne			
9	29	Z16378	8.1	34+	9S	Margate, FL	1	2		25	Harold Povenmire			
9	29	2573	7.3	42+	10S	Alberton,S.Africa	6	12	9	15	Jan Hers	C5S	168	-58
9	29	Z17761	7.3	44+	8S	Rafaela,Argentina	1	3		6	Eduardo Przybyl			
9	30	2629	6.3	46+	11S	Pleasnt Plains,AR	1	3	6	20	Homer DaBoll	7S	168	-51
10	3	3051	7.0	76+	9S	Tuscola, IL	4	17	7	15	John Phelps, Jr.	5N	175	-60
10	4	3187	6.2	85+	S	Kramer Jct., CA	1	4	8	20	Keith Horne			
10	13	0764	5.0	77-	5S	Louisburg, KS	3	8	7	15	Robert Sandy	0	189	50
10	13	0764	5.0	77-	5S	Tightwad, MO	1	2	8	25	Berton Stevens, Jr.	0	190	50
10	13	0764	5.0	77-	5S	Rolla, MO	2	4	8	20	Joseph Senne	0	190	50
10	14	Z04874	7.6	71-	5N	Harmony, IL	4	5	6	25	Homer DaBoll	C4N	355	60
10	14	Z04969	8.3	70-	6N	Elburn, IL	2	4	5	20	John Phelps, Jr.	C	356	60
10	14	0940	5.7	66-	2N	Ebenezer, Austrl.	1	5	5	6	Simon McMillan	C	0	52
10	16	1156	8.7	45-	1N	Downers Grove, IL	3	5	6	13	John Phelps, Jr.	C	359	71
10	16	Z07637	9.2	50-	5N	Sahuarita, AZ	1	3	5	15	Richard Nolthenius	C	353	70
10	16	Z07689	8.1	49-	-2S	Marana, AZ	1	2	7	15	Richard Nolthenius	0N	184	70
10	16	Z07757	8.9	48-	3S	Sahuarita, AZ	1	10	7	15	Richard Nolthenius	0N	188	70
10	17	1281	6.4	39-	N	Red Mountain, CA	2	3	9	11	Keith Horne			
10	17	1281	6.4	39-	-1N	Fort Scott, KS	3	3	7	15	Robert Sandy	8N	358	71
10	17	1281	6.4	39-	-2N	Rolla, MO	1	4	7	20	Joseph Senne			
10	18	1397	5.5	30-	S	Pocahontas, MS	1	3	5	25	Ben Hudgens			
10	23	Sun	-27	0	N	Benalla,Australia	1	1			Ian Grant			
10	23	Sun	-27	0	N	Cooma, Australia	1	26			Robert Price			
10	23	Sun	-27	0	N	Mt. Hudson, "	1	3			Bryon Soulsby			
10	23	Sun	-27	0	S	Mallacoota, "	1	22			David Herald			
10	23	Sun	-27	0	N	Narooma, "	1	8			John Newman			
11	1	Z23944	8.1	72+	11S	Picacho, AZ	1	20	6	15	Richard Nolthenius			
11	10	0871	6.9	89-	4S	Tucson, AZ	1	1	7	15	Richard Nolthenius			
11	13	1234	6.1	67-	7N	Belzoni, MS	2	7	7	25	Ben Hudgens	C	355	71
11	13	1234	6.1	67-	7N	Starkville, MS	1	5	7	15	Wayne Coskrey	C	355	71

Mo	Dy	Star Number	Mag	% Snl	CA	Location	# Sta	# Tm	C C	Ap cm	Organizer	St	WA	b
1976														
11	13	1234	6.1	67-	7N	Starkville, MS	1	5	7	15	Wayne Coskrey	C	355	71
11	13	1234	6.1	67-	5N	Faison, NC	5	9	7	25	David Dunham	C	355	71
11	13	Z08240	7.6	67-	6N	Chilton, WI	1	1	4	20	John Phelps, Jr.	C	351	73
11	14	1359	5.1	55-	6S	Hollywood, FL	3	16		20	Harold Povenmire			
11	16	Z10616	8.6	34-	-1S	Lafayette, IN	1	3	4	25	Berton Stevens, Jr.		176	57
11	19	Z12975	7.4	6-	2S	Grandy, MN	1	6	8	15	Rick Binzel			
11	19	Z12975	7.4	6-	3S	New Auburn, WI	1	6	6	20	James Fox	3S	179	12
11	19	Z12975	7.4	6-	3S	Greenville, WI	3	17	6	25	Homer DaBoll	10N	180	12
11	19	1971	5.8	6-	4S	Rice Lake, WI	1	4	8	20	James Fox	0	181	12
11	25	2826	4.0	16+	6S	Proctor, OK	6	20	8	5	Robert Sandy	0	170	-60
11	25	2826	4.0	16+	6S	Bunker, MO	1	2	7	9	Joseph Senne	0	169	-60
11	25	2826	4.0	16+	5S	Farmington, MO	1	7	8	20	Homer DaBoll	3S	170	-60
11	25	2826	4.0	16+	5S	Fairland, IN	5	33	9	6	John Phelps, Jr.	0	170	-60
11	25	2826	4.0	16+	5S	Marion, OH	1	4	4	15	Gary Ringler		170	-60
11	27	3199	6.8	43+		Anholt I.,Denmark	1	0	1	6	N. Wieth-Knudsen			
11	28	Z23681	8.0	46+	S	San Martin, CA	6	9	6	20	Gerald Rattley	15S		
12	12	Z09903	8.4	70-		Fremont, CA	1	3	7	25	James Ferreira			
12	14	Z11144	7.1	50-	3S	Thomasboro, IL	2	2	6	25	John Phelps, Jr.	3N	182	47
12	15	Z11853	8.5	38-	4S	Greenbush, WI	3	9	6	20	Homer DaBoll	7N	182	34
12	15	Z11857	9.0	37-	-1N	Picacho Peak, AZ	1	2	5	15	Richard Nolthenius	8N	354	31
12	16	Z12664	8.1	36-		San Jose, CA	1	1	5	20	James Van Nuland			
12	17	Z13534	7.5	17-	4S	Cleveland, MO	2	11	7	15	Robert Sandy	6S	182	0
12	24	3051	7.0	11+	3S	Fulton, CA	4	11	6	10	James Ferreira			
12	24	3051	7.0	11+	3S	Grass Valley, CA	4	30	8	10	Bill Fisher	2N		
12	25	3187	6.2	19+	4S	Priest Valley, CA	1	1	7	8	Douglas Dunham			
12	25	3187	6.2	19+	4S	Bowles, CA	9	36	9	25	Richard Nolthenius	2S		
12	26	Z24157	8.7	28+	5S	Westminster, CA	1	4	5	25	David Dunham	0	174	-48
12	26	Z24157	8.7	28+	5S	Orange, CA	1	2	7	15	Richard Nolthenius		174	-48
12	27	Z24817	8.5	37+	3S	Paxton, IL	2	8	6	20	John Phelps, Jr.	C	178	-39
1977														
1	5	1040	6.2	100+	56N	Springfield, VA	2	2	3	16	David Dunham			
1	26	Z01256	8.9	40+		Jacksonville, FL	1	1		32	Karl Simmons			
1	30	0718	6.1	76+	-N	Franktown, CO	4	14	8	20	Paul Asmus	2N		
2	2	1106	3.6	95+	-10S	St. Paul, MN	2	8	7	15	James Fox	0	179	69
2	10	Uranus	5.9	58-	4S	Drexel, MO	4	10	8	15	Robert Sandy	N	182	-11

scope and radio out, pushed the buttons on the radio and recorder, and began observing. Ten seconds later, the star disappeared at the first high mountain. Data from other stations showed that I missed no earlier events. I saw 16 contacts of the bright star with the dark limb of the crescent moon, making it one of the most spectacular grazes I have seen. All equipment worked. After the graze, we met John Phelps, who had driven down from Chicago and observed independently nearby. He agreed to measure the coordinates for all our stations, so he is listed as expedition leader. Robert Sandy is preparing a reduction profile of the results of all expeditions for this graze; more detail of the profile which we probably will incorporate into ACLPPP should result.

I observed two threshold grazes early in January. The first was for 7.5-mag. ZC 629 by a 90%-sunlit moon on January 2. The temperature was 15° F., with some wind, and at 15° altitude, the seeing was about as bad as I've ever seen. The star was seen a few times before the graze, but as it got close to the moon, although the cusp angle was 15°, it was lost and not seen again. The sky was very clear, but the glare and turbulence were too much. For the Jan. 5 graze of ZC 1040, the full moon was high in the sky and 174° from the sun. At this elongation and at the 56° cusp angle, the terminator would be about 3" from the limb. The dark separation really was evident, but the star was overwhelmed by glare from the moon, so that observation was nearly impossible, although the seeing and transparency were good.

If the star had been twice as bright, about mag. 5.5, the graze would have been seen readily with my 25-cm reflector, I believe. This also might have been surmised by David Herald's observations of ZC 2159 and 2160 last May under rather similar conditions, described on p. 88 of the last issue. These observations set some useful limits on what can be achieved with submarginal grazes.

A relatively dry flow of air from the Arctic has persisted in eastern North America this winter and past autumn. Although bad for farming, astronomers have benefited with more clear nights than usual. The colder-than-usual weather poses special problems for graze observers. Besides the ordinary precautions which one must take when traveling and observing during winter, tape recorders especially must be protected from the cold. When traveling to a graze, they should be kept in the heated passenger compartment of the car. The grease in a tape recorder left in the trunk of a car may freeze solid, making the recorder inoperative even after being worn under an observer's jacket with a cord around the neck for half an hour before the graze (this is a good way for keeping the recorder in working order while observing, assuming that it did not get too cold during the trip to the observing site). The observers for the graze of Spica in Nevada last August 28 had the opposite problem, observing from the desert during the hottest part of a summer afternoon. The temperature was 106° F., probably a record for a graze observation. Fortunately, the observers all had air-conditioned automobiles. [Ed: This may cause no problem in dry climates, but we can recall losing some easy timings because of condensation on our 41-cm mirror, which had been kept in air-conditioned surroundings until an hour or so before the telescope was assembled outdoors.]

Examination of the list of grazes will show that Richard Nolthenius is the first to succeed in observing three grazes in one night, on 1976 October 16. The first and third grazes were observed from the same location, while the second one was about 40 miles away. Time separation between the successive grazes was about two hours. The third turned out to be an unexpected double. A Houston triple-graze attempt last September was clouded out. Homer DaBoll, St. Charles, IL, and John Phelps, Orland Park, IL, independently made plans to observe three grazes in one night in Missouri, in late January. It was clear, but roads leading to the area were closed due to snow from a recent blizzard.

John Phelps sent me the most imaginative Christmas card I've received in a long time. It shows the three wise men, with the caption, ". . when they saw the star, they rejoiced exceedingly. ." (Matthew 2:10). John carefully typed in: ". . it would have been a long ride for a cloud-out. ."

During the graze of 1976 Sept. 29, Harold Povenmire reported "a large black snake was nearby." Good thing it didn't mimic WWV!

Based on later more comprehensive reports, the number of stations and timings for two expeditions should be changed: In *o. N.* #7, p.69, 1975/11/1, star 1815 at Bumble Bee, AZ, 2 stations, 17 timings; and *o. N.* #9, p. 86, 1976/6/18, star 3370, 3 stations, 7 timings. In *o. N.* #8, 1976/3/9, star 769 was observed at Beachwood, OH, not Beachwood, MO. If the name of the organizer is in parentheses, he reported the observations, but the actual organizer is not known and is probably someone else. The two graze observations by Robert Hays were recently found by reading some correspondence at USNO. USNO is currently not processing graze observations, so reports should not be sent there, but rather to me and/or HMNAO. The 1972 January 30 graze was during a total lunar eclipse.

[With the listings in this issue, the number of expeditions reported for the graze of ξ Sagittarii (ZC 2759) on 1974 Oct. 21 reaches 10 (see p. 24, #3 and p. 74, #8). The expedition shown in brackets is the one previously mentioned on p. 74; corrected figures are given. A question mark after the organizer's name indicates that we are not quite certain that he was actually the organizer. The information for the 8 expeditions newly reported was taken from the article "Grazing Occultation of Xi Sagittarii," *Journal of the B.A.A., 87,* 57 (Dec. 1976). Shifts seen by all expeditions are in agreement, but please refer to p. 24 (tabular listing and final paragraph of text of the article) for the shift and its interpretation.]

[A letter from James Fox contains some interesting comments about the Feb. 2 bright-limb graze of λ Geminorum (ZC 1106): ". . really fascinating to see the illuminated peaks projecting from the limb. I believe all the structure detail shown in the predicted profile was visible through the eyepiece. . . Nelson used a 6" at 250X so the star showed the first diffraction ring. His mount is driven. He is sure his times are accurate since he timed on the D or R of the diffraction ring. He claims the ring cuts in and out very sharply, just like a dark limb low power event, thereby avoiding irradiation effects. . ."]

PREDICTIONS OF PLANETARY OCCULTATIONS, David W. Dunham

The data in the list below, for occultations predicted by Gordon Taylor, HMNAO, are in the same format as the list of 1976 planetary occultations on p. 79 (#8):

1977 Date	U.T.	Object	SAO No.	Mag.	Epoch R. A.	1950.0 Dec.	Possible nighttime area of visibility
Jan 21	07^h04^m	Pallas	176953	9.4	$9^h\ 4^m.0$	-24°38'	Pacific O., Chile, Argentina
Jan 21	16 52	Pallas	176943	9.4	9 3.7	-24 34	New Zealand, Australia, Indonesia, India
Feb 28	22	Nysa	+19°888	9.6	8 38.6	+19 43	N. Africa, N. Atlantic O.
Mar 10	20 55	Uranus	158687	8.8	14 35.4	-14 44	W. Australia, Indonesia, Japan, Asia, Africa
Jul 8	21 41	Pallas	99401	8.3	10 58.5	+12 19	Eastern Brazil (see map)
Oct 3	10 28	Saturn	98871	8.3			North America

Unfortunately, due to the limited time I can work on occultations, this article is being written after the first two events, and will be distributed after the first three, or possibly four, events. However, in regard to the first two, since Pallas was magnitude 7.2 at the time, the combined brightness including the star was only 0.1 mag. brighter. Therefore, the drop in brightness when the occultation occurred could not reliably be noticed visually, but could be detected photoelectrically. Presumably, Gordon Taylor notified potential photoelectric observers in the areas about the events. I sent word about the occultation of SAO 176953 to Cerro Tololo, the only observatory with high-speed photoelectric capability in the possible zone of observation (La Plata and other Argentine observatories were north of this zone.).

James Elliot and other astronomers from Cornell University have made plans to observe the occultation of SAO 158687 by Uranus from the Kuiper Airborne Observatory over the Indian Ocean. They have shown that, in the far infrared, the spectral-type K-star is brighter than the strong methane absorption bands of Uranus. Consequently, a rather good signal-to-noise ratio can be achieved for studies of Uranus' diameter and atmosphere. The expected star diameter, 0".00058, will be covered by an object at Uranus' distance and with its velocity in $0^s.3$, so that photoelectric data should be recorded with at least this resolution for studies of probable spikes that will occur in the light curve, like the ones that have been recorded during occultations by Jupiter and Neptune. R. Greenberg, Planetary Science Institute, Tucson, Arizona, has examined the possibility of an occultation by one of Uranus' satellites, and has found that there will be none. The closest will be Miranda, whose shadow will pass 12,000 km north of the earth's center at 23^h34^m UT. This appulse will be visible from India, the Middle East, and Africa.

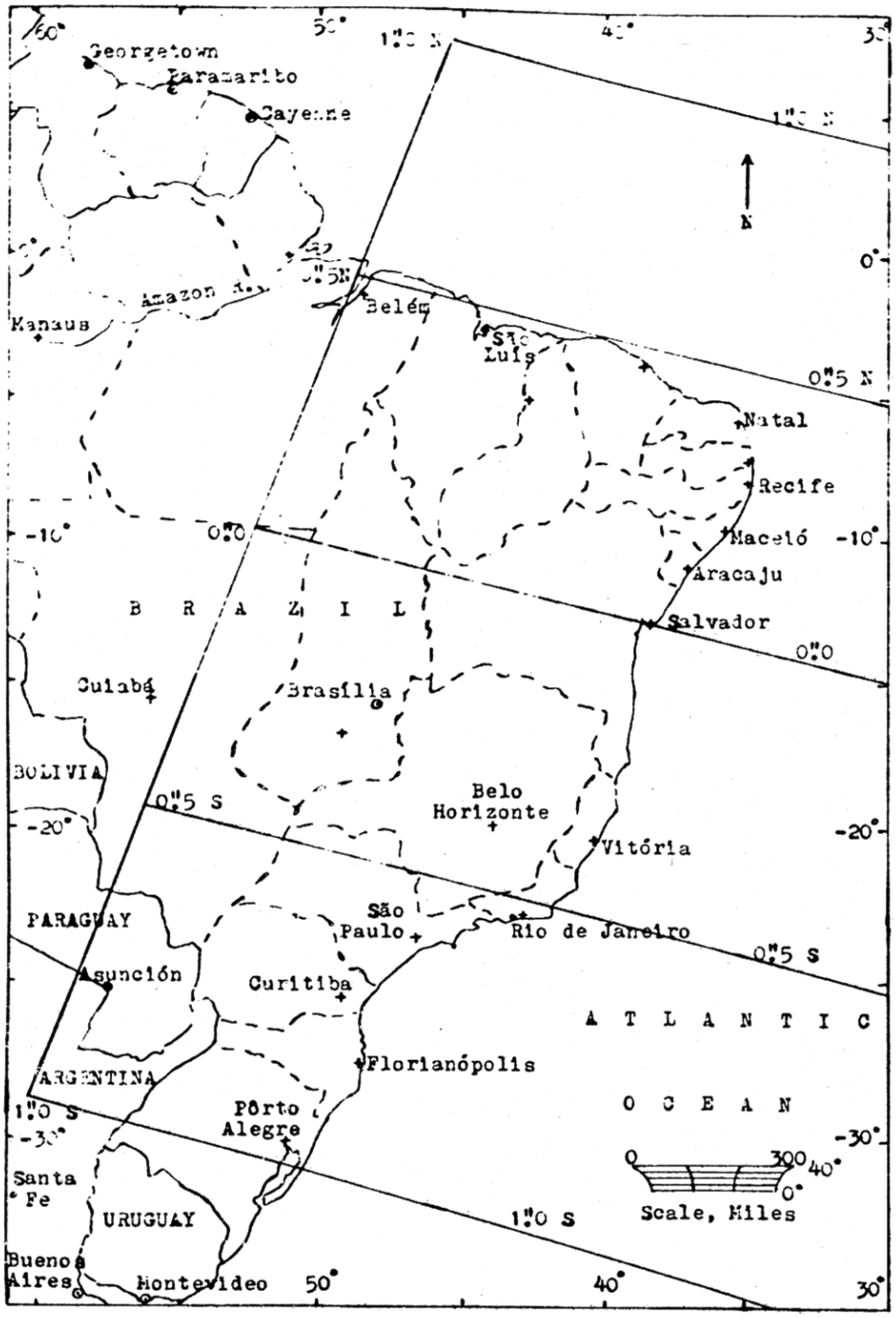
In an article on p. 20-22 of the December 1976 issue of *R Muscae*, Derek Wallentine pointed out that the possibilities of occultations of faint stars by minor planets are substantially increased when the objects pass in front of compact star clusters. He mentioned that 1792 Reni crossed NGC 2168 on 1976 November 18-22 and that 535 Montague traversed NGC 2168 on 1976 December 14-16. Dr. J. U. Gunter, Durham, North Carolina, has noted that 9½-mag. 44 Nysa will make its stationary-point turnaround from retrograde to direct motion in the Praesepe Cluster, with enhanced probabilities for occultations during late February and all of March. Gordon Taylor has found only one occultation during this time, given in the list above on February 28. The star involved is not in the SAO; the number given is the star's AGK3 number. I plan to compare numerous faint star positions from the Astrographic Catalogs (see below) with an ephemeris supplied by Gordon Taylor (who got it from the Institute of Theoretical Astronomy, Leningrad) for more occultations, and will distribute predictions for observable events, probably in the next issue of *O. N.*

The best occultation of a star by one of the first four minor planets is the one by Pallas on July 8. By then, Pallas' visual magnitude will be 9.1, so that combined with the star, the magnitude will be 7.9. The 1.2-magnitude drop at disappearance should be very noticeable visually. Pallas' diameter is expected to be 573 km, in which case, the duration of a central occultation will be $16^s.4$ and its angular diameter 0".28. Photoelectric observers should note that the diffraction fringe separation will be about 330 meters or 0".00016, which will be covered in $0^s.0094$ in the case of a central event. From data recorded at this time resolution, the diameter of the star could be determined. Observers should also watch for stepwise events indicating a close double, unlikely for this spectral type K0 star.

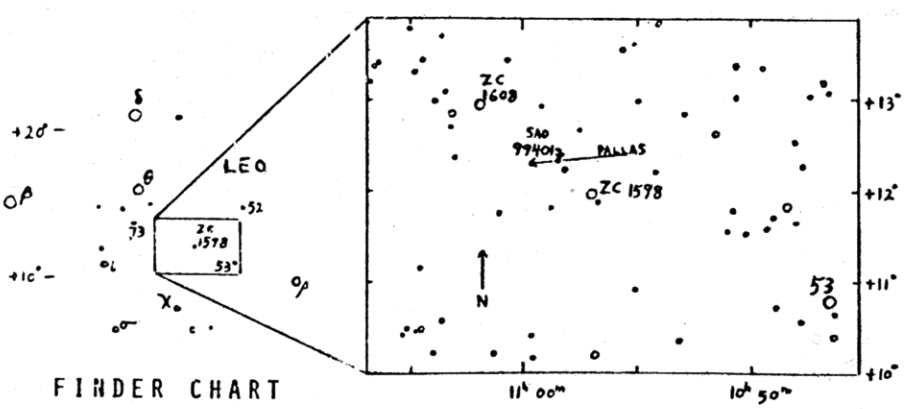
The map shows the possible region of visibility. The event should be visible somewhere from the populous eastern coast of Brazil, where the sun will be more than 18° below the horizon, and Pallas about 40° above the western horizon. The nearly east-west line passing through Salvador is the predicted line from which the central occultation will occur; but errors in Pallas' or the star's position could shift the actual path far to the north or south of this predicted line. Four other parallel lines show the central occultation path if the combined errors are 0".5 and 1".0 (resolved perpendicular to Pallas' motion) to the north and south. At the nearly north-south line passing near Belém and Asunción, the sun will be 6° below the horizon; twilight will be too strong to the west. The expected path width, using the above diameter of Pallas, is 574 km at the 1".0 N line, 595 km at the 0".0 line, and 708 km at the 1".0 line. Broken lines are the boundaries of Brazilian states, whose capital cities (not always named) are shown by +'s. Circled dots mark national capitals. The Mercator projection map scale varies with latitude; five horizontal lines show the scale at 10° (of latitude) intervals from 0° to 40°.

I hope that Brazilian observers will be able to organize well for this favorable event, which occurs on a Friday evening. Some observing stations should be established in cities where no known observers now live, especially between Recife and Rio de Janeiro, to give better coverage. Volunteers interested and able to coordinate observations on a national scale are sought. Also sought are improved astrometric data to enable computing a better prediction. At present, with a 1".0 error possible, there is only about one chance in seven that a given observer in eastern Brazil will see an occultation. Some improvement could be made soon by obtaining a current accurate position of the star with respect to the surrounding SAO stars. But an accurate position will not be possible until a few days before the event, when the minor planet and star can be photographed on the same plate, due to systematic star catalog errors. During the week before July 8, I hope that several plates can be exposed and measured, so that the combined prediction error can be reduced to less than Pallas' angular diameter, as was done at the last minute for the occultation of Kappa Geminorum by Eros in 1975. Either Gordon Taylor or I could compute a last-minute correction for the July 8 occultation from the astrometric observations, and telegraph or TELEX the expected shift of the path in arc seconds to the national coordinator(s). Local observers can use the map to interpolate where the last-minute path is expected to be. For example, 0".3 N would have it passing over Recife and 0".25 S would have it passing over Brasília. Also, keep in mind the estimated uncertainty, and the width of the path, for locating observers to obtain the best data.

A finder chart shows the location of SAO 99401 in eastern Leo. An arrow indicates the direction of motion of Pallas. The faintest stars on the large-scale chart are 9th magnitude; ZC 1598 and ZC 1608 are mag. 6.4 and



OCCULTATION OF SAO 99401 BY PALLAS, 1977 JULY 8



FINDER CHART FOR SAO 99401

RIGHT ASCENSION AND DECLINATION ON EQUINOX 1950

6.7, respectively. Incidentally, the occultation path crosses most of the Atlantic Ocean, but Pallas sets before it reaches the west coast of Africa.

I have been computing astrometric ephemerides of minor planets, as described on p. 85-86 of the last issue, and will soon send magnetic tape data to Gordon Taylor with accurate astrometric positions at daily intervals for several years into the future for 50 minor planets. During the assembly of the International Astronomical Union in Grenoble, France, last August, a working group of Commission 20 (Positions and motions of minor planets, comets, and satellites) was established to coordinate planetary occultation work internationally, mainly for astrometric support and the rapid dissemination of data. As mentioned above, accurate predictions usually are not possible until days before the event. Then, word must be distributed quickly. Gordon Taylor was named chairman of the working group; he is certainly the best qualified, with the most experience in this field, having predicted nearly all such occultations to date.

One way to increase the number of predictions of planetary occultations is to consider more stars. We have been limited to the SAO and AGK3 catalogs, which include stars down to nearly 10th magnitude with about 7 stars per square degree. During the past few years, workers at the Stellar Data Center in Strasbourg, France, have keypunched and analyzed the data in the Oxford, Paris, Bordeaux, and Toulouse zones of the Astrographic Catalog, which include stars to about 12th magnitude at a density 10 times that of the AGK3 catalog, from declinations +4° to +31°. These data, on four magnetic tapes, was obtained by IOTA and the U. S. Naval Observatory, with IOTA paying the postage from France. I am now working on it for the possible occultation by Nysa mentioned above, and also for lunar occultations of the Hyades. Work is also progressing at Strasbourg on the Algiers zone of the A.C., which will extend coverage to -2°, but no work is contemplated on zones farther south, except for selected areas being worked on by IOTA members.

Another approach is being taken by Fritz Benedict and Peter Shelus at the University of Texas. They plan to use my astrometric ephemerides to scan the Palomar Sky Survey glass plates with a microdensitometer to find possible occultations of faint stars. They have written a clever program for the PDP-11 minicomputer to drive the microdensitometer to find and measure the SAO stars on the plate, compute plate constants, and scan the predicted path of the planet for occultations of stars brighter than a preselected threshold.

PLANETARY OCCULTATION UPDATE

David W. Dunham

I have recently learned of another asteroidal occultation predicted by Gordon Taylor. On 1977 March 5 at 2^h 34^m U.T., minor planet 6 Hebe (diameter perhaps 190 km) is expected to occult the 3.6-mag. primary of Gamma Ceti as seen from Mexico, nominally between latitudes 17° and 20° north. However, prediction uncertainties are probably great enough that the event could occur in Central America or the U.S.A. Gordon Taylor plans to improve the prediction with a recent photographic observation soon.

A passage of 22 Kalliope through the Pleiades is described on p. 127 of the February issue of *Sky and Telescope*. I compared an accurate astrometric ephemeris of the minor planet with Eichhorn's highly accurate catalog of Pleiades stars to the 12th magnitude which was used for the special USNO P-catalog predictions for lunar occultations a few years ago. I found no occultations, the closest approach of Kalliope to any Pleiades star being 10".(horizontal parallax less than 4")

The lunar occultation of Uranus and of SAO 158687 in North America on February 10 have assumed special importance for possibly improving the relative positions of the two objects, which could be crucial for observation of the occultation of the star by Uranus in March. Preliminary astrometric observations indicate a 1" error in the star's position, more than an Earth diameter at Uranus' distance.

OBSERVATIONS OF PLANETARY OCCULTATIONS

David W. Dunham

On p. 85 of the last issue, an observation of an occultation of SAO 80046 by Saturn's satellite Iapetus by Strauss in southern Brazil is described. Prof. Jose Manoel Luis da Silva reports that observations from two locations in Curitiba, Parana, Brazil were also attempted. Observing conditions were good, but no occultation was seen. The northern limit of the occultation apparently passed between Curitiba and Porto Alegre.

According to predictions by both Gordon Taylor and me, the path of the occultation of SAO 153844 by Pallas on October 10 last year was expected to be just off the California coast, but with an uncertainty large enough that the event might be observed from land. The path also crossed Mexico, but after sunrise a short distance east of the Gulf of California. In *IOTA Special Bulletin #2*, distributed several days before the event to observers in western North America, I described what to expect during the event, and that an improvement in the prediction would be attempted. During the morning of October 8, Dr. Arnold Klemola exposed an astrometric plate with both the star and minor planet, at Lick Observatory. He measured and reduced the plate during the day, and phoned the results to me that evening. Working most of the night at the U.S. Naval Observatory, I assembled computer programs which used Klemola's data to compute a new path. The results were that both Pallas and the star were about 0"4 north of their expected places. Consequently, the original prediction was virtually unchanged, with still an uncertainty large enough that the event could be seen from California and Arizona. I made arrangements to use the Federal Telephone System at Goddard Space Flight Center the evening before the event, to contact many potential observers, telling them that there was a chance to record the occultation. Conditions were excellent at most of the major observatories in the Southwest, most of which attempted to record the event with high-speed photoelectric equipment. Unfortunately, none of them saw the occultation. Numerous visual observers similarly only saw the two objects merge with no occultation occurring. Dr. Clark Chapman, Planetary Science Institute, Tucson, Arizona, organized an expedition which observed the appulse near Kino Bay, Mexico, at about longitude 112° west, latitude +28½°. This was near the predicted northern limit, but they saw no occultation, although they were the southernmost observers. Richard Nolthenius and John Hayes observed the event from long. 110° 57' 36"2 W., lat. +32° 13' 43"9, height 2405 ft., in Tucson, Arizona. According to Nolthenius, "Weather conditions were perfect, with no detectable scintillation due to atmospheric turbulence. Transparency was also excellent. Hayes observed with an 8" f/6.5 Newtonian at 73 power while I used a 6" f/8 Newtonian at 96 power. At $12^{h}59^{m}29^{s}4$ UT (±0s2, p.e. 0s6 applied) I saw the combined object fade quickly by about 0.4 magnitude. Hayes commented immediately that the image did indeed look fainter; however, due to some problem with his vision at the time, he did not see the step fading. The object remained at this reduced brightness for the next 5 seconds. At $12^{h}59^{m}36^{s}$ $\pm 2^{s}$ I readjusted my telescope, after which I no longer could tell if the image was still at reduced brightness. During the next several minutes, no stepwise brightening was noticed by either of us. Hayes commented at 12^{h} $59^{m}41^{s}$ that as near as he could tell, the image still appeared to be at the reduced brightness, although it was no longer unambiguous. He confirmed that the image appeared fainter for at least several seconds after the 'D', but after that it was unclear as to whether it had brightened or not. He guessed that he probably would not have been able to see the anticipated stepwise brightening."

If Pallas' diameter is 573 km, a recent estimate, it would subtend 0"35 that night and a central occultation would last 19s6. The change in magnitude at an actual occultation should have been about 0.7. The path extended rather steeply from northwest to southeast, so Nolthenius was the northernmost observer with respect to it (the separation should have been nearly 0"8 at closest approach). The positional error should not have been so large as to put Tucson near the actual southern limit. At Kitt Peak, 50 km or 0"03 in the sky closer to the predicted occultation, Don Wells saw no occultation using photoelectric equipment. He writes, ". . . there was no difficulty at all in observing the appulse due to the dawn, although by 15 minutes later it might have been impossible. In addition, Gehrz observed the event visually with the 1.3-meter and not only did not see an occultation but also said that the images appeared distinct even when closest. The seeing was superb, and this suggests the centerline of the shadow was probably 0"5 or more away from KPNO, to the south, presumably."

James McMahon at China Lake, California, was about the same distance from the predicted line as Kitt Peak, and also reported no occultation. So Nolthenius' "D" was probably a temporary seeing fading, possible on even good nights, but we can not be certain that he did not see an occultation since no observations were made north (with respect to the path) of Tucson. A photoelectric attempt at Flagstaff failed, and nobody observed visually there. Variable clouds prevented observation at Las Vegas, Nevada, and skies were overcast in northern California and northward. In any case, during this occultation, the minimum three timings, made from at least two widely separated locations, needed to obtain a measurement of the diameter of Pallas, were not obtained.

Eduardo Przybyl, Rafaela, Argentina, reports that, during December, clouds and rain prevented observation of occultations of two AGK3 stars by 354 Eleonora predicted by Gordon Taylor and of the passage of 535 Montague across NGC 2168. An observation of the occultation of SAO 79100 by Saturn's satellite Rhea is described in the NEW DOUBLE STARS section.

OBSERVATIONS OF M67 PASSAGES

David W. Dunham

Three passages of the moon across the open cluster M67 in Cancer have been observed since the last issue of *O. N.* I computed and distributed predictions of occultations of numerous faint stars during these events to many observers, using the U.S. Naval Observatory's total occultation prediction program, rather than the less-efficient University of Texas prediction program used for last June's passage.

Observations of occultations of stars in and near M67 which I have received since last August 15th are summarized in the table, whose format is similar to the one on p. 88 of the last issue. Under % Sunlit, "+" denotes waxing phase (all observations dark-limb disappearances) and "-" signifies waning (all dark-limb reappearances). Under Telescope, the aperture in cm is given and L is for reflector, R refractor.

Richard Nolthenius' observation of the passage of 1975 October 28 is described on p. 70 of *O. N. 1, #7*; it sparked my interest in passages across clusters other than the Pleiades, Hyades, and Praesepe. But while going over reports of Soviet observations, I found that A. Zhitetski had timed occultations of 4 SAO stars near M67 one sidereal month earlier. Sincheskul's observations at Poltava during 1975 March 23 are remarkable considering the brightness of the moon; the telescope he used and the observing conditions must have been exceptionally good.

If Price's and Senne's observation reports had been received in time to be included in the table on p. 88 of the last issue, they would have ranked 4th and 7th, respectively. Hazy skies prevented more observations at Rolla. For the same reason, Robert Sandy was able to time only 1 event at Kansas City, Missouri (rather than the 2 given in the p. 88 table). So last June's passage remains the best observed, with 81 timings, 36 of non-SAO stars and 18 of non-BD stars, reported by 12 observers.

I was fortunate in obtaining, with Wayne Warren's help, permission to observe last September's M67 passage with the 91-cm Cassegrain reflector at Goddard Spaceflight Center's Optical Facility. Joan Dunham, Curtis McCraken and Rick Skillman provided valuable assistance. The value of using a large aperture was emphasized by the fact that Warren was able to time only 2 reappearances with a nearby 31-cm reflector. Skies were hazy, with patchy cirrus clouds, so that numerous events were missed which could have been timed if skies had been clearer. Also, nearly all timings were made at less than 20° moon altitude. Observing conditions were considerably worse due to the urban surroundings of the U.S. Naval Observatory, where Van Flandern observed. Poor conditions also hampered Nakamura and Wieth-Knudsen during the following two M67 Passages.

See Richard Binzel's article for a list of occultations across M67 and other galactic-nebular objects during the first half of 1977.

Date	% Sunlit	Observer	Telescope	Total	Non SAO	Non BD
1975 March 23	81+	B. Sincheskul, Poltava, Ukraine, USSR	20R	11	6	4
		V. Mazhorovski, Poltava, Ukraine, USSR	8R	3	0	0
		V. Vaselev, Leningrad, Russia, USSR	16R	3	2	1
		A. Zhitetski, Kiev, Ukraine, USSR	24R	2	0	0
1975 Oct. 1	23-	A. Zhitetski, Kiev, Ukraine, USSR	24R	4	0	0
1976 June 3	24+	Ronald Price, Garland, TX, USA	31L	9	8	5
		Joseph Senne, Rolla, MO, USA	20L	3	0	0
1976 Sept. 20	15-	David Dunham, Greenbelt, MD, USA	91L	15	11	10
		Wayne Warren, Greenbelt, MD, USA	31L	2	0	0
		Thomas Van Flandern, Washington, DC, USA	62L	1	0	0
1976 Oct. 17	36-	Katsuyuki Nakamura, Shizuoka, Japan	40L	1	0	0
1976 Nov. 14	59-	Antonio Salazar, San Fernando, Spain	15R	4	?	?
		N. Wieth-Knudsen, Tisvildeleje, Denmark	30L	4	?	?

POSITION ANGLES FOR OCCULTATIONS

David Herald

Occasionally there have been reports to IOTA of successfully observed occultations where the observed position angle of the event differed widely from the values listed in the USNO predictions. Almost invariably, in these reports, the actual time of the event corresponds very well with the predicted time. In these cases, it is almost certain that the apparent discrepancy is a result of either observational uncertainty or confusion as to which angle listed in the predictions is the appropriate one for the observer's method of determining angles. To avoid any confusion, if it exists, I give here the meaning of each of the four angles provided in the predictions, CA, PA, VA, and WA, together with an indication of when to use them.

PA. This is the "Position Angle" of the event, and is the fundamental angle derived from the prediction calculations. It is measured from the north point eastwards, 0° to 360°. It is exactly analagous to position angles for double stars. This angle is of most use for equatorially mounted telescopes.

VA. This is the "Vertex Angle". It, as with the PA, is measured anticlockwise from north through east. However, the zero point in the VA scale is at the apparent vertex of the moon as seen from the observer's site; i.e., from that point on the moon's limb farthest from the horizon. This angle is primarily for use with altazimuth-mounted telescopes, where the mounting makes the moon's vertex easy to locate.

CA. This is the "Cusp Angle". As the name suggests, it is the angle measured from the cusp of the moon. Convention decrees that it be referred to the nearest cusp (i.e., is never more than 90°), with the cusp identified thereafter. Usually it is N or S, but near new and full moon, it may be E or W. Also, it is positive against the dark limb, negative against the bright. This angle is very convenient to use, as the cusps provide a convenient reference point. However, near new and full moon, particularly full, it is extremely difficult to accurately locate the actual cusp, thus bringing a large degree of uncertainty into where one should look, particularly for reappearances or for very difficult events.

WA. This is the "Watts Angle". Used correctly, it overcomes the problems of the CA. Essentially, the Watts angle is measured anticlockwise, north through east, with the zero at the moon's north pole. Thus the Watts angle can be used to relate the location of the occultation directly to the moon's surface features. Most conveniently, this is done by marking, on a map of the moon, a scale starting with 0° at the north pole, through 90° at the lunar west [Ed: west in the IAU, rather than classical, sense] point (near Oceanus Procellarum) and so on through south and east (near Mare

LUNAR OCCULTATIONS OF MINOR PLANETS IN 1977

This information was prepared by H. M. Nautical Almanac Office, with % sunlit added by David Dunham, using data from the *American Ephemeris and Nautical Almanac*. Detailed predictions will be available later for users of large telescopes, especially for photoelectric observers.

Date	Approx. U. T.	% Snl	Minor Planet	Mag.	Nighttime Area of Visibility
Mar. 12	18^h	46-	Parthenope	11.4	Indonesia, New Guinea, N. Australia, and east to Fiji Islands.
Mar. 25	17	30+	Europa	12.2	S. E. England, Central Europe, South Western Asia.
Apr. 9	12	65-	Parthenope	11.0	South Pacific Islands (Cooke).
Apr. 24	18	32+	Eleonora	11.7	Cape, South Africa.
Apr. 29	00	74+	Hygiea	10.7	N. E. Canada as far west as Nova Scotia, Greenland, Western Europe, W. North Africa.
May 7	01	83-	Parthenope	10.5	South Atlantic, South Africa, Madagascar.
May 23	04	22+	Elektra	13.3	South Pacific Islands (Cooke).
May 26	13	54+	Hygiea	11.0	China, Japan, Philippine Islands, Borneo.
June 23	06	36+	Hygiea	11.2	Hawaii, West Coast Central North America.
June 26	18	74+	Metis	10.9	Antarctica.
July 24	05	54+	Metis	11.3	North Pacific - Hawaii to Mexico.
July 27	13	88+	Davida	12.2	Australia (except extreme N. Points), Tasmania, N. North Island New Zealand, and east to Fiji Islands.
Nov. 5	06	40-	Iris	10.0	Brazil
Nov. 14	19	17+	Laetitia	11.9	West Coast Central Southern Africa.
Dec. 7	19	13-	Psyche	12.5	North East Australia, New Guinea, Fiji Islands.
Dec. 13	00	8+	Laetitia	12.0	South West Canada, Western U.S.A.

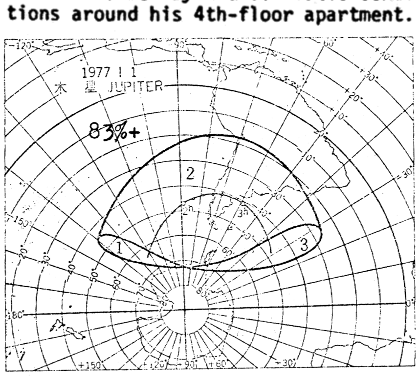
Crisium). The Watts angle for an occultation when referenced to the map then shows where the occultation will occur. All one has to do then is to locate features near that point. But a word of warning: To accurately estimate the location of the occultation point using this method, one should take into account, at least approximately, the lunar librations, which have the effect of moving the apparent locations of the features on the lunar disc. The librations are listed in the predictions. Space is too limited here to give a detailed explanation of how to do this. [Ed: but see *O. N. 1*, 18, second column (#2)]

LUNAR OCCULTATIONS OF PLANETS

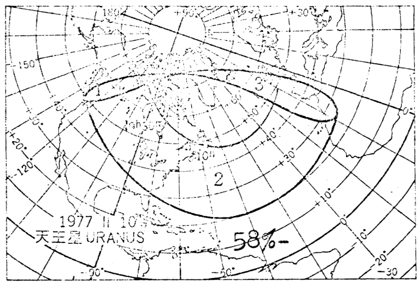
Michael D. Reynolds

1976 July 21 - Occultation of Jupiter and satellites Europa, Ganymede, and Io by the moon. Three observers, G. Blow, B. Menzies, and T. Stewart were able to make visual observations of the reappearances of Jupiter and its moons Europa, Ganymede, and Io. The observations were made near Auckland, New Zealand. The observers had hoped to record photoelectrically the reappearances of the moons, but were unable to do so, due to a number of difficulties. The map is on p. 72.

1977 January 1 - Occultation of Jupiter and satellites Callisto, Io, Europa, and Ganymede by the moon. Observers in two neighboring states of Brazil were able to make visual observations. At Rio de Janeiro, O. Tavares, O. Chaves, P. Alonso, and V. D'Avila observed the D of each of the five objects. At Atibaia, A. P. Martins observed the D of Callisto and the D and R of Jupiter, and B. A. Borghi observed the D of Callisto. At Campinas, M. F. Olivera observed the D of Jupiter, while the D and R of Jupiter and the D of Ganymede were observed by J. C. F. Lobo, J. C. R. Vieira, and R. Previtalli. Also at Campinas, J. Nicolini attempted to observe these phenomena, but was foiled by microclimatic conditions around his 4th-floor apartment.



1977 February 10 - Occultation of Uranus by the moon. With the number of expeditions planned for the Uranus occultation, some data should be collected. If you are able to observe the occultation, please send a copy of your report to me at 610 Florida Blvd, Neptune Beach, FL 32233. Include in your report (and all reports of occultations of planets, at least those sent to me) a list of all observers (let me know if you attempted the occultation and were clouded out, etc.), data collected, where the event was observed, the data, any "unusual" happenings (arrested by police, etc.), the event itself (Don't leave me guessing!). Good luck and good observing.



[The maps showing the regions of visibility of lunar occultations of planets are reprinted by permission from the Japanese Ephemeris for 1977, published by the Hydrographic Department of Japan.]

MORE ON A DIGITAL STOPWATCH

Richard P. Binzel

I recently purchased an electronic digital stopwatch from Edmund Scientific Co.(Cat. #1671, @ $49.95). Siliconix, Inc., is the manufacturer.

It reads in increments of $0\overset{s}{.}1$, and conforms to the stated accuracy specification of 0.002% (about $0\overset{s}{.}07$/hour). It has an operational specification down to -25° C. I checked it, outdoors at -18° C, recently, and also at -22° in a deep freezer, and found that it remained accurate.

One of the nicest features is the split function, which is in addition to the start, stop, and reset functions. The split function freezes the display while the internal timer continues. A second operation of the split button resets the display to the total elapsed time since the watch was originally started. Thus, once the watch is started in synchrony with a WWV signal, an observer could time an unlimited number of events using the split button, recording the event time immediately after each press of the button, and then repressing the split button to return the display to the actual time. I recently timed a six-event graze this way, because WWV reception was very poor.

The $49.95 price is not outside the price range of high quality mechanical stopwatches, and the price probably will drop, as has been the case with calculators and digital wrist watches. I recommend this stopwatch highly.

TIME OUT FOR TIMEKUBE

Mark Trueblood

According to Tom Harris at Radio Shack corporate headquarters, they are not now marketing Timekubes, but they will start selling them again next spring. They are having trouble getting crystals (thanks to the flood of CB orders), but they expect to start shipping from Taiwan on February 28, in time to have them on the shelf the first week in April. Two models will be available: 1) WWV on 5, 10, and 15 MHz, and 2) CHU (Canadian Time Service) plus two channels of WWV (probably 5 and 10, but I'm not certain). Each model will sell for $31.95, but the CHU model will only be available in New England. Those in other parts of the country who go on expeditions to New England can order the CHU version from the Boston warehouse: Radio Shack, 100 Mazzeo Dr., Randolph, MA 02368, ph. 617/963-7410. The 3-channel WWV model should be stocked in all store locations across the country, obviating the need for special order. Those with further questions should contact Tom Harris at Radio Shack, 2617 West 7th Street, Fort Worth, TX 76107, ph. 817/335-3711.

[Ed: Now that the N.B.S. has agreed to continue to broadcast time signals on 2.5 MHz, there is renewed motivation, for those capable and willing to do so, to put together their own version of the Timekube. See the article: C. Caringella, "Building a Three-Channel Time Receiver," *Popular Electronics*, *33*, #6, p. 33 (Dec. 1970). At today's prices, a complete 3-channel receiver can be assembled for about $25 to $30, including a metal case. Add about $5 to $6 per channel (two coils and a crystal) for each additional channel desired. An Elgin, Illinois-based group is designing a set updated from the 1970 original, and *Occultation Newsletter* will publish an article, including circuit diagram, when the new prototype has been completed.]

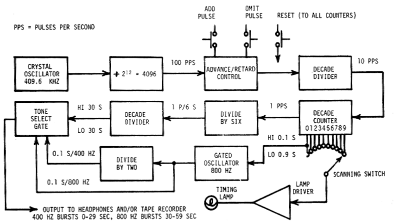
AUDITORY ELECTRONIC OCCULTATION TIMER

Clifford J. Bader

With the advent of crystal-controlled timepieces utilizing digital display, it has become possible to dispense with the inconvenient and unreliable radio time signal for both grazes and total occultations. Not only is the accuracy of such watches adequate (± $0\overset{s}{.}2$/day or better), but the error is systematic and easily accounted for; furthermore, the digital display makes possible setting and synchronization to better than $0\overset{s}{.}1$. For occultation timing purposes, the only problem in using such a timepiece is that of transferring the time to the tape or other medium used to record the event. I have solved this problem by constructing an electronic time-mark generator, which can be synchronized or corrected to within a few milliseconds of the standard, and which provides auditory tone bursts marking the seconds and half minutes. The tone bursts may be transferred to the tape along with the observer inputs, or may be utilized directly for eye-ear timing.

The timer uses complementary metal-oxide-semiconductor (CMOS) integrated circuit logic, which is now starting to appear at low prices on the surplus market, and which offers very low current drain and uncritical supply-voltage requirements. The unit includes an AC supply for line operation, but will work with any battery supply of 6 to 12 volts. No attempt is made here to show circuit details, which I will provide to interested parties if return postage is supplied.

A block diagram is shown. The time base is a crystal oscillator operating at 409.6 kHz. The basic clock frequency is divided by $2^{12} = 4096$ in a binary ripple counter, producing pulses at 10 ms intervals, and is then fed to control circuitry which permits the pushbutton addition or deletion of single clock pulses, in order to adjust the timing to that of the standard. Each time the "advance" button is depressed, one extra pulse is added between two of the regular clock pulses; when the "retard" button is pushed, one clock pulse is omitted. It is thus possible to adjust the timer forward or backward in 10 ms increments, which is about the minimum interval detectable by ear-ear, eye-eye, or eye-ear comparison. A decade divider further reduces the clock rate to 10 pulses/second. Another decade counter produces a one second interval and also provides ten sequentially activated outputs of 0^{s}1 each. The first (zero) output is used to gate the tone oscillator, which therefore produces a 0^{s}1 burst commencing on the second. All ten outputs can be switch-scanned to move the timing lamp flash to coincide with a recorded event or with a time standard. All counters are reset to zero by a pushbutton. Divide-by-six and divide-by-ten counters are cascaded to generate the minute. The output of the last counter is "high" for 30 seconds, and "low" for the next 30; it is used to select either the basic tone or the tone frequency divided by two. The gating is arranged so that the tone is low (about 400 Hz) during the first half of the minute and an octave higher (800 Hz) during the second half; this scheme provides the observer with minute and half-minute markers, and provides a continuous indication of which portion is in progress. The 0^{s}1 duration furnishes a crip beat and facilitates eye-ear interpolation.



Extreme frequency accuracy is not essential, since the accumulated error during an operating period can be determined readily, and corrections applied, or periodic advancement or retardation can be made. Consequently, no voltage regulation or crystal oven is included. Surplus low-frequency crystals are available at very low prices (75¢); the nearest available frequency is 409.722 kHz. The oscillator circuit has sufficient frequency-trim range to permit the desired frequency of 409.600 kHz to be reached, although even without trimming, the error of about + 1^s/hr is tolerable. The timer can be set to a radio or telephone time signal by ear comparison; this method is particularly accurate with the WWV format, since the count may be advanced in 10 ms steps until the tone burst just obliterates the seconds tick. Used in this mode, it also permits accurate measurement of digital watch error, since the timing lamp flash may be varied to coincide visually with the watch display and the tenth-second readout obtained from the scanning switch. When synchronizing to the watch without time signals, several options are available; the timing lamp may be set on zero and the watch error accounted for in the data reduction, or the timing lamp may be offset to compensate for the watch error. Alternatively, eye-ear synchronization may be used. In any case, the reset button is held down until the minute begins, and then released; the timer is then advanced to compensate for reaction time.

Originally built to supplement radio signals for eye-ear timing, and later modified to include the chronograph feature, the timer has accounted for some 150 total occultation timings and two grazes. With the addition of a digital watch, it has become the key to the utilization of a completely portable and uninterruptible time reference.

1977 OCCULTATIONS OF BRIGHT NON-SAO STARS, Richard P. Binzel

As was reported on p. 58 of *O. N. 1*, (#7), there are perhaps several dozen stars brighter than mag. 8.6 which have not been included in the SAO Catalog and hence are not included in the USNO total occultation predictions. The reason for their exclusion stems from lack of knowledge of their proper motions. However, they are all included in the Yale Catalogs. Although these stars have not yet been included in the USNO total occultation predictions, they have been assigned USNO reference numbers prefixed by the letter Q, and special predictions for the Q stars have been computed. Listed below are predictions for favorable (moon less than 70% sunlit) occultations of Q stars mag. 8.1 and brighter, for 1977. Observability codes were assigned without considering sun and moon altitudes.

1977 Date	U. T. /Ph	USNO Ref No	O	Mag	% Snl	SN AL	MN AL	CA	PA	Place
Jan 16	$19^h57^m.3$/R	Q00024	7	8.1	10-		8	61N	308	Tokyo, Japan
Jan 17	18 56.9/R	Q00036	7	8.0	4-	- 4	13	30S	220	Melbourne, Australia
Feb 14	01 01.7/R	Q00035	7	8.0	19-		11	64N	298	Pretoria, S. Africa
	01 12.9/R	Q00035	7	8.0	19-		8	82S	264	Capetown, S. Africa
	02 25.9/R	Q00036	7	8.0	19-		29	67S	249	Pretoria, S. Africa
Mar 12	09 05.8/R	Q00024	6	8.1	51-	-11	21	88N	276	Deer Lake, Newfoundland
Mar 13	00 32.2/R	Q00027	6	8.1	44-		24	46N	314	Capetown, S. Africa
	06 37.9/R	Q00034	6	8.1	41-		52	61N	299	Recife, Brazil
	06 54.2/R	Q00035	7	8.0	41-		37	74S	253	Buenos Aires, Argentina
Apr 9	07 18.5/R	Q00027	5	8.1	67-		65	31N	327	Buenos Aires, Argentina
Sep 20	11 34.5/D	Q00027	6	8.1	52+		44	56S	124	Melbourne, Australia
	11 48.8/D	Q00027	6	8.1	52+		35	83S	98	Brisbane, Australia
	16 40.5/D	Q00035	6	8.0	55+	- 9	82	62S	117	Pretoria, S. Africa
Oct 16	20 49.7/D	Q00023	7	8.1	21+	- 9	44	53N	55	Recife, Brazil
Oct 17	17 20.5/D	Q00027	7	8.1	30+		48	86N	84	Pretoria, S. Africa
	23 49.7/D	Q00035	7	8.0	32+		17	64S	113	Recife, Brazil
Oct 18	00 47.9/D	Q00036	7	8.0	33+		29	18N	15	Miami Springs, Florida

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GRAZE LAYOUT MEASUREMENT TECHNIQUES

H. F. DaBoll

Finding one's observing coordinates can be as simple as setting up on top of a landmark which appears on the topographic map of the area, and scaling the coordinates directly from the map. As there seldom will exist an ideally spaced group of surmountable landmarks, a multi-observer expedition usually has to employ some sort of ground measurements (but see D. A. Howe, "The Feasibility of Applying the Active TvTime System to Automatic Vehicle Location," *Navigation 21*, 9-15 (1974), which was reviewed by David Dunham, on p. 89) to refer the observing positions to mapped landmarks, at least one of which usually will be a straight road. If one has calibrated his pace or stride carefully, stepping off the distance is satisfactory, if the offset is not so great as to allow the accumulated error to grow too large. While an error of even up to 100 feet, including the error of the map, itself, may be allowable, most of us try to hold the measurement error to something like 5 to 10 feet.

In the "Geodetic Graze Program", accuracy criteria were more stringent. Map error was largely eliminated by referring positions directly to U.S. Coast and Geodetic Survey horizontal control station markers. Although we were not required to do so, my group once formed a 3-man survey crew, using transit and steel tape, to set out stakes directly related to the h.c.s., for an expedition of about 20 observers. Some of the stakes served as tables into which tacks were driven, at locations known to an accuracy at least 3 orders of magnitude better than was needed for even a geodetic graze. Predictably, the sky was clear enough to bring out all the observers, but with some streaks of cloud in the worst place.

For another geodetic graze expedition, we used a bicycle wheel (and front fork) whose circumference was accurately known, having been calibrated against a 200-foot steel tape only about one hour earlier. The wheel was used to mark off whole numbers of revolutions, and was supplemented by a 12-foot steel tape for fractional parts of revolutions measured along the road, and for offsets from the centerline. That night, the sky was as clear as I ever have seen it. All observers saw a miss.

The bicycle wheel technique is quite practical, either as a secondary standard for measuring, or as a means of interpolating between landmarks, but if one man is trying to do the layout by himself, he might have to carry a knapsack full of station markers along the route, and still would have to hike back to his car. Of course, the fine measurements, with the steel tape, may be neglected, for ordinary grazes.

An advantage of using a cable is that the electrical breakouts, for the observers' signaling devices, are located at predetermined intervals, so that if the cable is laid along a straight road, establishing the location of any breakout makes it possible to calculate the positions of all the others. There is also the associated disadvantage of relatively inflexible spacing of observers. The Milwaukee cable trailer is equipped with a wheel, flexible shaft, and mechanical counter arrangement for measuring from a landmark to a breakout, to a precision considerably smaller than one foot. Similar devices are available commercially, for mounting on passenger vehicles. As the wheel is neither powered nor braked, degradation of accuracy by slippage between wheel and road surface is negligible.

In the techniques discussed below, slippage can affect accuracy, but will not be assessed here, as this factor depends only on driving habits and on condition of tires and road surface. Indexing, or the ability to judge when the vehicle is exactly opposite a station marker or landmark, is neglected.

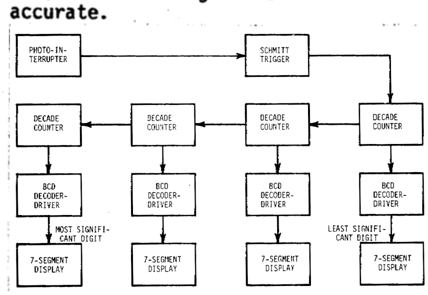
Two observers with an automobile are equipped to do a graze layout. At the first landmark, a chalk mark or piece of tape is put on one tire, so that the more athletic (or less agressive) of the two observers can audibly count whole revolutions as he trots alongside the car. It is not even necessary to calibrate the wheel, as long as a final landmark, near or beyond the end of the string of observing stations, is counted.

The ordinary odometer in the instrument panel of an automobile can be of help in deciding where to put station markers, but it is not accurate enough to use as the basis for calculating their positions. There are those who feel that it can be accurate enough if the stations are placed only at locations corresponding to certain relationships between the right-hand digit of the odometer (the tenths register) and the cut-out in which it appears, such as having the top of the figure appear to be just in contact with the top of the cut-out. My experience in checking this technique against accurate devices indicates that it is not unusual for the error to be between 50 and 100 feet.

Precision odometers, graduated in hundredths of a mile (and I think, hundredths of a kilometer) have been available, from time to time, as built-in options on some cars, and as accessories for others. David Dunham brought this to the attention of graze expedition leaders in 1972. I had one installed in the 1968 Pontiac Tempest which I drove until recently. The precision odometer went about 70,000 or 80,000 miles before I had to replace it. The replacement outlasted the Pontiac, but I did not bother to remove the odometer when selling the car, as the type of attachment of the speedometer cable to the instrument case is different in the newer cars. The accessory screw-on branch cable connection is not compatible with the clamp-on speedometer cable connections now used. Currently, I don't know of any source of accessory precision odometers, with either screw-on or clamp-on arrangement. Those who still have the instruments find them quite useful. With direct reading to a hundredth of a mile, one can estimate to a thousandth (about 5 feet). By taking 3 or 4 sets of readings on landmarks and station markers, and averaging the results, one can be pretty sure that the locations are known accurately enough. For measurement purposes, the readings should be considered to be in units of unknown length, to be used to interpolate between landmarks, rather than being accurate in terms of miles or kilometers; for help in deciding where to lay out station markers, the mile or kilometer values are good enough. Backlash in these devices can be considerable, so one must not back the car during a measuring run. Accuracy is significantly degraded by resetting to zero during a run.

More precise and accurate, although less convenient for layout purposes, is a mechanical counter attached to the hubcap of the car. The first such installation of which I am aware was completed by John Phelps, about two years ago. The rotating input shaft of the counter is made to lie along an extension of the axis of rotation of a wheel of the car. The shaft of the counter is usually off-center with respect to the mass of the counter. With the counter supported by the shaft, the wheel, hubcap, and shaft of the counter rotate together, and gravity keeps the counter itself in a roughly constant orientation with respect to vertical. The count goes up or down, depending on the side of the car chosen. My counter is probably typical, in having a single-thread worm drive a 12-tooth worm gear. As the ten integers of the least significant column are incised on a cylinder which is solidly attached to the worm gear, it takes 12 rotations of the car wheel to make a difference of 10 in the count registered. With my car, each unit change represents about 8.6 feet, and I can measure about 1.6 miles before having to add another digit to the left of the readout on my 3-digit counter. Again, one can estimate to a tenth of an integer, for precision of better than a foot and accuracy certainly better than 2 feet. As above, the readings should be used only for interpolating between landmarks, but with this device, a single set of careful readings should be adequate. Backing the car during a run is permissible, as backlash is insignificant in relation to the accuracy tolerance. Carefully resetting to zero during a run degrades accuracy only insignificantly, if at all. It is inconvenient to have to stop the car and step outside, in order to read the counter, which detracts from its utility in helping to pick positions for markers. With this device, and with the next one described, the shaft should remain attached to the hubcap only when making a run, to avoid excessive wear, corrosion, and accidental mechanical damage. This is an inconvenience, but by the same token, it is much easier to adapt the arrangement to a different car than it would be to transfer and reinstall a precision odometer.

Recently I have finished building and making dry runs with an electronic device which I feel will be more useful than any of the devices mentioned above. It is a solid-state counter, triggered photoelectrically. The car's cigar lighter receptacle is used as the 12-volt power source. The photoelectric remote unit is mounted on a hubcap, which is the base on which an axial shaft is mounted. A thin circular aluminum shield is mounted concentrically on the shaft. Bearings on the shaft support a housing which contains a commercially available interrupter-type infrared emitter-receptor combination. Within the housing, the outer portion of the circular shield rotates between the poles of the photoelectric device, and cuts off the light beam except when it reaches such orientations as to interpose some drilled holes between the poles. The counter will register as many counts per rotation as there are holes drilled in the shield at the appropriate radial distance. The housing could be allowed to maintain orientation by gravity, but there is a good possibility that pendulum action could produce some spurious counts when the car is braked to a stop, so I prefer to maintain orientation by connecting the housing to a fender, by means of some rubber bands and a padded C-clamp. The greatest source of inaccuracy of this device seems to me to be the possibility of adding two extra counts if the car is allowed to roll backward slightly, after coming to a stop; it will count only upward, whether the car is moving backward or forward. However, if one deliberately backs, and carefully notes the number of counts added while backing, and subtracts twice that number, the final figure still will be accurate.



I chose to drill 5 equally spaced holes in the shield, and to have a 4-digit display on the counter. Then each count represents about 17¼ inches, and the car goes about 2.7 miles before the counter recycles through zero. As there can be no interpolation between counts, the most likely location would be represented by the number displayed plus ½ count, with probable error of ¼ count, or about 4.3 inches. The probable error in a distance determined by subtracting one readout from another will be a little less than a third of a count, or about 5½ inches. As with the mechanical counter, the readings should be used only for interpolating between landmarks, but a single set of readings should be adequate. No inaccuracy is introduced by resetting to zero.

The cabinet in which the counting unit is mounted had to be modified to make it wedge-shaped, so that it can sit conveniently on the dashboard, where it is useful both in making the necessary measurements and as an aid to choosing observing station sites. The display, with its 0.3-inch figures, is very bright and easy to read under any lighting conditions except when bright sunlight falls directly on the numerals; a great improvement, in that respect, over both the precision odometer and the mechanical counter.

I chose to put together a straightforward system including 3 integrated circuits (decade counter, BCD decoder-driver, and 7-segment GaAsP display) for each of the 4 digits, plus a Schmitt trigger to sharpen the input pulses, rather than to use a strobe system, which would have been more complicated, but more economical of energy use as well as in cost of components. The bare-bones electronic parts (IC's, sockets, resistors, capacitors, and photoelectric device) cost about $40 at retail. Case, connectors, reset switch, and miscellaneous hardware added about $15. Prices mentioned include series 74 IC's, whose performance is guaranteed only from 0° to 70° C, as compared with -55° to +125° C, if series 54 IC's were used. As the counting unit is kept inside the car, almost on top of the defroster vent, it is not likely to be affected by low temperatures, and it is improbable that a cold hubcap-mounted unit will provide pulses so far from specifications as to affect the count. At a temperature of over 70°C, proper operation of a counter would be the least of my worries! I would be happy to furnish any details desired, including a circuit diagram, to anyone interested.

UPDATE TO 1975 NOVEMBER 18-19 ECLIPSE OCCULTATION TALLY

Raymond Finkleman

The observers listed below are acknowledged to have made occultation observations during the eclipse of 1975 November 18-19. Since their observations arrived too late for inclusion in the earlier article (*Occultation Newsletter, 1,* 87), the tally should be updated as follows:

Rank	Observer	Total	R's	Non SAO	Non BD
11.5	T. Z. Dworak, Fort Skala, Poland	5	2	0	0
14.4	M. Kurpinska, Fort Skala, Poland	4	1	0	0
14.6	J. VanderMeulen, Wognum, Netherlands	4	0	1	0
14.8	V. Kapkov, Kazan, USSR	4	0	0	0
15.5	M. Winiarski, Fort Skala, Poland	3	1	1	1
20.5	R. Boschloo, Almen, Netherlands	3	0	0	0
22.5	J. M. Kreiner, Fort Skala, Poland	3	0	0	0
36.5	V. Borovskic, Kazan, USSR	2	0	0	0
38.4	A. Kulak, Fort Skala, Poland	2	0	0	0
38.6	A. Mesherikov, Rizan, USSR	2	0	0	0
38.8	J. Mietelaski, Fort Skala, Poland	2	0	0	0
41.5	M. Shpekin, Kazan, USSR	2	0	0	0
48.5	Anonymous, $0^h\ 1^m\ 22^s.17$, 51° 13' 21".7	1	0	1	0
49.5	I. Chuginov, Kazan, USSR	1	0	0	0
	New totals for all 76 observers:	214	54	57	15

1975 TOTAL OCCULTATION TALLY

Raymond Finkleman

The 1975 Total Occultation Tally is the most comprehensive listing ever published. It includes 494 observers of 35 countries and a total of 8788 observations.

The data for the listing were consolidated from many sources with the assistance of several people. The major source of observers was the tape listing of observations received by Thomas Van Flandern from H.M.N.A.O. in November. The tape required quite a lot of reducing as stations were only identified by city and coordinates, and not by name. Van Flandern was able to machine match the H.M.N.A.O. tape with the U. S. Naval Observatory address and observer listings for half of the stations. Richard Nolthenius keypunched approximately 100 observers' coupons onto cards. The coupon program will be continued for the 1976 tally (A coupon is included with this issue.). In November, we received the Czechoslovakian Bulletin listing their total occultation observations and in December the Russian Bulletin was forwarded to David Dunham from Dr. A. Osipov, Kiev, Ukraine, U.S.S.R. MacDonald Observatory has a photoelectric total occultation observation program. The observations for 1975 were reported to us in two parts, "Photoelectric Measurements of Lunar Occultations VII: Further Observational Results" by John Africano et al, *Astronomical J., 80,* 689, and a pre-print supplied by Frank Fekel of the University of Texas. In December, Van Flandern received the Japanese observations on magnetic tape. The only observer identification able to be reduced from the tape was the observer's initial and first three letters of the last name. We attempted to determine the station and full name of each observer from a 1974 publication. Since some observers were not included in that article, there are a few Japanese observers who are not completely identified. Early in January we received the Polish observations listed in *Acta Astronomica* ("Occultations of Stars and Planets by the Moon Observed at the Cracow Astronomical Observatory in the Years 1974-1975" by A. Michalec, *Acta Astronomica, 26,* 387). Incidentally, that publication is the first major astronomical journal to reference *Occultation Newsletter,* for their 1975 November eclipse occultation observations.

The ranking of the observers is by the value of their observations. This was determined by the formula $V = D + cR$, where V = value, D = total number of disappearances observed, R = total reappearances observed, and c is a correcting factor. The correcting factor is the ratio of R/D for the complete listing. For this tally, one reappearance observation is the equivalent of 3.03 disappearance observations. If two or more observers have identical values, they are listed alphabetically. Observations identified by observatory only are listed after the named observers, alphabetically by city. For some observations we have only the coordinates of the station and/or their city, in which case they are listed after the observatories.

There is some coding within the list itself. If the name of the observer is included in quotes there is some doubt as to the observer identification (More than one observer at the site is possible.). If only the observatory or station name is given, there is probably more than one observer at that station. After the location there may be an asterisk indicating photoelectric observations. If not all observations were photoelectric, the number which were is after the asterisk. This number is followed by a comma and another number indicating reappearances recorded photoelectrically, if there were any. An unknown number of photoelectric observations is indicated by a quote mark after the asterisk. After the observer's name are given the city, state, province, republic, or country of his principal observing site. In some cases, the country is listed before the city. As noted earlier, some observers could be identified only by coordinates. Longitude is listed first (+ = west) in hours, minutes, and seconds of time, then latitude (+ = north) in degrees, minutes, and seconds of arc.

This is the first time that "Total Non-SAO Stars Observed" have been included in the listing. It should be noted that this column may be incomplete since non-SAO stars are not included on the tapes supplied by H.M.N.A.O. and the Japanese.

It is our hope in the future to use mainly the H.M.N.A.O. tape of observations for our tally. Therefore, observers are requested to get their 1976 observations to H.M.N.A.O. at least by April or May to be included on their tape listing. (Address: H.M. Nautical Almanac Office, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, Sussex, BN27 1RP, England)

The 1975 occultation count coupons were indispensable for preparing this tally. Observer identification may be included in H.M.N.A.O.'s data for 1976, in which case, there will be less need for the coupons; but we will likely still find them to be useful for resolving discrepancies, non-SAO counts, etc. Also, possibly starting with the 1976 tally, we may use the USNO value code total for the ranking rather than the simple increased weighting of reappearances which has been used. We plan to get the value code total through reduction calculations at USNO using the individual observation data available on the tape from H.M.N.A.O. So if you report all of your 1976 observations to H.M.N.A.O. soon, there is no need to report your USNO value code total, found by adding the value code in the USNO predictions for each of the events you observe, on the enclosed coupon.

Many thanks to Richard Nolthenius, Thomas Van Flandern and David Dunham for their assistance to me in the compilation of this comprehensive occultation tally.

RANK	COUNTRY		VALUE	TOTAL	R'S	NON ZC	NON SAO
1	UNITED STATES OF AMERICA	(116 OBSERVERS)	4747.81	2951	883	1879	124
2	JAPAN	(37 OBSERVERS)	1683.69	1002	335	606	0
3	UNION OF SOVIET SOCIALIST REPUBLICS	(61 OBSERVERS)	911.95	623	142	313	50
4	ENGLAND	(62 OBSERVERS)	816.79	654	80	325	8
5	DENMARK	(9 OBSERVERS)	732.54	468	130	290	1
6	RHODESIA	(6 OBSERVERS)	699.45	498	99	335	5
7	AUSTRALIA	(11 OBSERVERS)	459.59	425	17	311	25
8	NEW ZEALAND	(12 OBSERVERS)	396.16	270	62	141	1
9	SOUTH AFRICA	(9 OBSERVERS)	391.78	288	51	173	8
10	ARGENTINA	(2 OBSERVERS)	383.34	247	67	175	0
11	SPAIN	(11 OBSERVERS)	290.71	191	49	50	8
12	GERMAN FEDERAL REPUBLIC	(13 OBSERVERS)	283.47	198	42	102	1
13	BELGIUM	(17 OBSERVERS)	182.87	132	25	33	1
14	CZECHOSLOVAKIA	(33 OBSERVERS)	163.28	147	8	64	16
15	PHILIPPINES	(1 OBSERVER)	125.26	52	36	38	0
16	SWITZERLAND	(4 OBSERVERS)	112.56	80	16	36	0
17	MEXICO	(1 OBSERVER)	104.12	39	32	27	0
18	ITALY	(2 OBSERVERS)	98.84	50	24	31	0
19	CANADA	(8 OBSERVERS)	90.35	70	10	37	0
20	POLAND	(9 OBSERVERS)	83.56	51	16	19	1
21	NETHERLANDS	(10 OBSERVERS)	75.10	69	3	24	1
22	GERMAN DEMOCRATIC REPUBLIC	(6 OBSERVERS)	67.31	49	9	14	0
23	YUGOSLAVIA	(1 OBSERVER)	51.31	33	9	0	0
24	FINLAND	(4 OBSERVERS)	39.21	27	6	0	0
25	NORWAY	(8 OBSERVERS)	38.10	32	3	2	0
26	FIJI	(1 OBSERVER)	32.21	20	6	0	0
27	ISRAEL	(4 OBSERVERS)	27.07	23	2	1	0
28	PORTUGAL	(1 OBSERVER)	21.07	17	2	12	1
29	AUSTRIA	(2 OBSERVERS)	20.14	12	4	1	0
30	IRAQ	(1 OBSERVER)	16.07	12	2	2	0
31	SRI LANKA	(1 OBSERVER)	14.10	8	3	0	0
32	SCOTLAND	(4 OBSERVERS)	11.00	11	0	10	0
33	BRAZIL	(3 OBSERVERS)	10.07	6	2	1	0
34	REPUBLIC OF CHINA	(1 OBSERVER)	5.00	5	0	1	0
35	ANONYMOUS (COUNTRY UNKNOWN)	(23 OBSERVERS)	34.10	28	3	7	0
	R/D = 3.03			8788	2178	5060	251

RANK		OBSERVER	VALUE	TOTAL	R'S	NON ZC	NON SAO
1	N.P. WIETH-KNUDSEN	TISVILDELEJE, DENMARK	501.08	263	117	187	1
2	RICHARD NOLTHENIUS	TUCSON, AZ.	489.13	245	120	194	15
3	ROBERT HAYES JR.	CHICAGO, ILL.	446.70	231	106	161	18
4	T. TAKEMURA	KURASIKI, JAPAN	385.07	206	88	149	0
5	WILLIAM H. FISHER	COLFAX, CA.	371.56	164	102	100	0
6	SIR.HYDROGRAPHIC OBS.	SIRAHAMA, JAPAN*	364.93	194	84	138	0
7	JOHN KORINTUS	PALM BAY, FLA.	334.83	170	81	122	0
8	A. MORRISBY	CAUSEWAY, RHODESIA	318.58	168	74	113	0
9	JOHN AFRICANO	MCDONALD OBSERVATORY, TX*	259.00	259	0	194	23
10	B. SINCHESKUL	POLTAVA, UKRAINE, USSR*11	255.15	188	33	151	44
11	WALTER MORGAN	LAS VEGAS, NV	246.16	120	62	95	1
12	A. J. CAMPONOVO	MONTE GRANDE, ARGENTINA	229.54	140	44	93	0
13	ROBERT SANDY	KANSAS CITY, MO.	199.43	116	41	52	1
14	J. V. VINCENT	SALISBURY, RHODESIA	190.42	166	12	116	0
15	Y. SOMEYA	SIRAHAMA, JAPAN	188.26	115	36	73	0
16	SIM.HYDROGRAPHIC OBS.	SIMOSATO, JAPAN*	178.91	126	26	73	0
17	*G. M. IANNINI*	CORDOBA, ARGENTINA	153.80	107	23	82	0
18	H.F. COCHRAN	BROWNWOOD, TEXAS	143.70	103	20	65	0
19	H.F. CABOLL	ST. CHARLES, ILL.	139.40	58	40	39	1
20	RONALD CROSS	CHRISTCHURCH, NEW ZEALAND	135.19	66	34	27	1
21	ROBERT LASCH	GREEN VALLEY, AZ.	134.70	94	20	76	0
22	KUR.HYDROGRAPHIC OBS.	KURASIKI, JAPAN*	129.70	89	20	47	0
23	+00 04 20 +52 37 34	LEICESTER, ENGLAND	126.66	88	19	51	0
24	ERNESTO V. CALPO	MANILA, PHILIPPINES	125.26	52	36	38	0
25	JAN HERS	RANDSBURG, SOUTH AFRICA	116.42	92	12	58	3
26	N. WATANABE	SIMOSATO, JAPAN	111.08	48	31	36	0
27	M. D. OVERBEEK	EDENVALE, TVL, S. AFRICA**	104.56	72	16	49	0
28	G. M. MALLEN	MEXICO, D.F., MEXICO	104.12	39	32	27	0
29	*J. GUY MORGAN*	CAMBRIDGE, ENGLAND	103.31	85	9	61	0
30	SIMON MCMILLAN	HOLLAND PARK, AUSTRALIA	102.10	96	3	81	24
31	*REINHOLD SCHNEIDER*	STUTTGART, W. GERMANY	101.52	71	15	47	0
32	-00 49 40 +55 50 19	COPENHAGEN, DENMARK	101.35	81	10	54	0
33	A. ZHITETSKI	KIEV, UKRAINE, USSR	99.94	45	27	18	0
34	LIONEL E. HUSSEY	CHRISTCHURCH, NEW ZEALAND	95.91	43	26	25	0
35	NATHANIEL WHITE	FLAGSTAFF, AZ.*	95.00	95	0	0	0
36	A. MILTON	BORROWDALE, RHODESIA	93.28	77	8	55	4
37	FERDINANDO MOSSET	UDINE, ITALY	91.80	45	23	30	0
38	K. C. BLACKWELL	WESTHAM, ENGLAND	89.38	67	11	40	3
39	CLIFFORD J. BADER	WEST CHESTER, PA.	87.77	43	22	19	0
40	DAVID HERALD	CANBERRA, AUSTRALIA	87.14	79	4	63	1
41	MARK GINGRICH	OAKLAND, CA.	83.70	43	20	30	0
42	RICHARD BINZEL	WASHINGTON COURT HOUSE, OHIO	79.59	45	17	33	1
43	A. OSIPOV	KIEV, UKRAINE, USSR	77.56	45	16	25	0
44	HAROLD MARX	KORNTAL-MUNCHINGEN,W.GERMANY	73.42	49	12	33	0
45	JAMES VAN NULAND	SAN JOSE, CA.	70.14	62	4	33	1
46	O. KVARATCHILIA	ABASTUMAN, GEORGIA, USSR	68.35	48	10	41	0
47	DAVID DUNHAM	REDFORD, TEXAS	67.59	33	17	23	15
48	S. DOZYUN	SIMOSATO, JAPAN	67.45	41	13	32	0
49	L. FELIPE HURTADO	SAN FERNANDO, SPAIN	63.38	41	11	11	0
50	L. HURTADO	SAN FERNANDO, SPAIN	63.38	41	11	11	0
51	J. RUSSELL SMITH	WACO, TEXAS	62.00	62	0	49	0
52	JOSEPH ZODA	VIRGIL, ILL.	61.52	31	15	18	0
53	ROGER GILLER	ENGADINE, AUSTRALIA	61.07	57	2	38	0
54	P. DARNELL	RODOVRE, DENMARK	58.03	56	1	42	0
55	W. MALCOLM BROWNE	DURANGO, COLORADO	57.42	33	12	33	0
56	-01 13 54 -33 57 09	CAPE TOWN, SOUTH AFRICA	56.49	28	14	2	0
57	JAMES FOX	COTTAGE GROVE, MN	56.38	34	11	23	11
58	N. P. SCULLY	BULAWAYO, RHODESIA	56.10	50	3	24	0
59	W. H. ROBERTSON	SYDNEY, N.S.W., AUSTL.	53.07	49	2	28	0
60	L. QUIJANO	SAN FERNANDO, SPAIN	51.42	27	12	6	1
61	BELGRADE OBSERVATORY	BELGRADE, YUGOSLAVIA	51.31	33	9	0	0
62	BRUCE BLUNDELL	MANHASET, NY.	50.42	26	12	16	0
63	KLAUS KLEBERT	FELLBACH-SCHMIDEN, W. GERMANY	50.21	38	6	15	1
64	PAUL J. NEWMAN	PLEASANT VALLEY, TEXAS	49.31	31	9	19	0
65	-11 21 58 -45 54 47	DUNEDIN, NEW ZEALAND	49.03	47	1	28	0
66	JEAN BOURGEOIS	MONTIGNIES-LE-T, BELGIUM	48.49	20	14	10	0
67	FRANZ ZEHNDER	BIRMENSTORF, SWITZERLAND	48.24	34	7	20	0
68	JAMES BROOKS	CHATHAM, VIRGINIA	47.42	23	12	20	6
69	ALFRED WEBBER	CHADDS FORD, PA.	47.07	43	2	25	1
70	DOUGLAS HALL	LEICESTER, ENGLAND	46.17	36	5	17	0
71	K.E. MCNAMARA	MONTREAL, CANADA	45.14	37	4	25	0
72	RONALD E. ROYER	WRIGHTWOOD, CA.	44.38	22	11	14	0
73	ROBERT GERMANN	WALD, SWITZERLAND	44.21	32	6	14	0
74	MICKEY SCHMIDT	IRA, TEXAS	43.07	39	2	28	0
75	CHAS. A. KAPRAL	PARLIN, NEW JERSEY	42.28	26	8	12	0
76	ROBERT BAILEY	HOUSTON, TEXAS	42.10	36	3	25	0
77	F. MIHAIWA	KURASIKI, JAPAN	41.35	21	10	19	0
78	DAVID EVANS	MCDONALD OBSERVATORY, TX*	41.07	37	2	20	10
79	M. FEDYNIN	TOMSK, SIBERIA, USSR	41.07	37	2	11	0
80	BYRON W. SOULSBY	WESTON, A.C.T., AUSTRL.	41.07	37	2	28	0
81	MIKE KAZMIERCZAK	ATLANTIC BEACH, FL	40.38	16	11	11	0
82	HAROLD CARNEY	JACKSONVILLE, FLA.	37.24	23	7	12	3
83	C. GIBBON	UMTALI, RHODESIA	37.03	35	1	27	1
84	-01 52 23 -26 07 08	JOHANNESBURG, SOUTH AFRICA	37.03	35	1	27	0
85	M. THOMAS	DUNEDIN, NEW ZEALAND	37.00	37	0	29	0
86	A. SALAZAR	SAN FERNANDO, SPAIN	35.31	17	9	4	1
87	A. VAZQUEZ	SAN FERNANDO, SPAIN	34.21	22	6	6	0
88	L. SYGIA	ABASTUMAN, GEORGIA, USSR	32.31	14	9	12	0
89	ANONYMOUS	SUVA, FIJI	32.21	20	6	0	0
90	ANITA MCCONNELL	RIDGECREST, CA.	31.24	17	7	5	0
91	CHARLES R. JENKINS	VEREENIGING, S. AFRICA	31.10	25	3	20	0
92	MADRID OBSERVATORY	MADRID, SPAIN	31.00	31	0	5	0
93	*DONN MUKENSNABLE*	LA GRANGE PARK, ILL.	30.24	16	7	14	0
94	G. W. AMERY	READING, BERKS., ENGLAND	30.14	22	4	7	0
95	WILLY VERHAEGEN	WETTERSON, BELGUIM	30.14	22	4	9	1
96	K. G. SEARS	KEYPORT, NEW JERSEY	30.03	26	1	14	0
97	HARUKI ABE	OSHAMANBE, HOK, JAPAN	29.17	14	5	6	0
98	-09 56 24 -35 20 13	CANBERRA, AUSTRALIA	29.00	24	0	24	0
99	H. TOMIOKA	HITATI, IBARAGI, JAPAN	26.13	22	3	5	0
100	BART BENJAMIN	PEORIA, ILL.	27.21	15	6	1	0
101	LUCIANO PAZZI	NIGEL, SOUTH AFRICA	27.10	21	3	13	4
102	MERV JONES	MARYBOROUGH, AUSTRALIA	27.00	27	0	19	0
103	HAROLD POVENMIRE	SATELLITE BEACH, FLA.	27.00	27	0	13	0
104	BERTON STEVENS	CHICAGO, ILL.	26.29	10	8	9	2
105	BRADLEY TIMERSON	NEWARK, N.Y.	26.14	19	4	10	0
106	-11 21 58 -45 52 26	DUNEDIN, NEW ZEALAND	26.00	26	0	14	0
107	*JAMES MCMAHON*	RIDGECREST, CA	25.24	11	7	2	0
108	M. KURPINSKA	FORT SKALA, POLAND	25.21	13	6	4	0
109	ROBERT CLYDE	STREETBORO, OHIO	25.14	17	4	4	0
110	MCDONALD	TOWNSVILLE, AUSTRALIA	25.03	23	1	14	0
111	WAYNE CLARK	ST. LOUIS, MO.	25.00	25	0	19	0
112	DAVID PETTITT	CARLISLE, CUMBRIA, ENG.	25.00	25	0	19	0
113	CLAY SHERROD	N. LITTLE ROCK, ARK.	25.00	25	0	16	0
114	A. KANTOROV	TOMSK, SIBERIA, USSR	24.21	12	6	0	0
115	P. VOZAR	BANSKA BYSTRICA, CZECH.	24.00	24	0	13	2
116	J. POGODA	OLOMOUC, CZECHOSLOVAKIA	23.03	21	1	17	1
117	ANONYMOUS	RONNE, BORNHOLM, DENMARK	23.03	21	1	3	0
118	STEVE J. ZVARA	WHITTIER, CA.	23.00	23	0	17	0
119	+00 00 16 +51 20 33	CROYDON, ENGLAND	22.07	16	2	6	0
120	T. YAT.	JAPAN	21.14	13	4	12	0
121	CLYDE A. REID	SELKIRK, MANITOBA, CANADA	21.10	15	3	1	0
122	-01 39 50 +60 09 20	HELSINKI, FINLAND	21.10	15	3	0	0
123	J. OSORIO	VILA NOVA DE GAIA, PORTUGAL	21.07	17	2	12	1
124	VIC MATCHETT	INDOOROOPILLY, AUSTRALIA	21.00	21	0	16	0
125	P. B. WITHERS	READING, BERKS., ENG.	21.00	21	0	17	0
126	JOHN COTTON	DALLAS, TX	20.14	12	4	10	10
127	M. WINIARSKI	FORT SKALA, POLAND*2,1	20.14	12	4	3	1
128	ANONYMOUS	DERBY, ENGLAND	20.14	12	4	3	0
129	E. G. MOORE	PALMERS GRN, LONDON, ENG.	20.00	20	0	14	0
130	*C. MORSE*	MAIDENHEAD, ENGLAND	20.00	20	0	8	0
131	T. Z. DWORAK	FORT SKALA, POLAND	19.14	11	4	5	0
132	CARL SILBER	GMUNDEN, AUSTRIA	19.14	11	4	0	0
133	F. PAVLAS	HOLESOV, CZECHOSLOVAKIA	19.10	13	3	3	0
134	G.BLOW,AUCKL.OBSRVTY.	AUCKLAND, NEW ZEALAND*1	19.00	19	0	0	0
135	THOMAS D. WHELAN	NEW PLYMOUTH, N. ZEALAND	18.03	16	1	11	0
136	MARY KING	FERGUSON COVE, N.S.	17.17	7	5	0	0
137	G. APPLEBY	HERSTMONCEUX, ENGLAND	17.14	9	4	3	3
138	A. CHIESHKOV	KIEV, UKRAINE, USSR	17.14	9	4	4	0
139	K. KENMOTU	SIMOSATO, JAPAN	17.14	9	4	7	0
140	ROBERT WALKER	SAYRE, OKLAHOMA	17.07	13	2	3	0
141	MENACHEM ALON	YAVNE, ISRAEL	17.03	15	1	1	0
142	R. W. MIDDLETON	BRIGHTL'GSEA, ES, ENG.	17.03	15	1	7	0
143	MICHAEL WILSON	MILWAUKEE, WISCONSIN	17.03	15	1	8	0
144	I. CHUGINOV	KAZAN, TATAR, USSR	17.00	17	0	8	3
145	D. SCHMIDT	HVIZEN N.H., THE NETHERLANDS	17.00	17	0	5	0
146	V. MASIR	KIEV, UKRAINE, USSR	16.17	6	5	4	0
147	ELISABETH AHNERT	SONNEBERG-THUR., E. GERMANY	16.10	10	3	1	0
148	M. SHPEKIN	KAZAN, TATAR, USSR	16.10	10	3	2	0
149	MICHAEL ABDUL-AHAD	BASRAH, IRAQ	16.07	12	2	2	0
150	N. BRYNILDSEN	HORTEN, NORWAY	16.07	12	2	1	0
151	R. RUTTEN	EINDHOVEN, NETHERLANDS	16.07	12	2	8	0
152	N. TAI.	JAPAN	16.07	12	2	1	0
153	GARY FERLAND	MCDONALD OBSERVATORY, TX*	16.00	16	0	16	0
154	+07 46 14 +34 05 18	WHITTIER, CA	16.00	16	0	12	0
155	V. TCHACHENKO	KHERSON, UKRAINE, USSR	15.14	7	4	0	0
156	S. BELYEV	ODESSA, UKRAINE, USSR	15.10	9	3	0	0
157	+00 01 11 +51 04 23	CRAWLEY, ENGLAND	15.10	9	3	0	0
158	+00 00 43 +51 05 56	CRAWLEY, ENGLAND	15.10	9	3	0	0
159	ANONYMOUS	VIRUM, DENMARK	15.03	13	1	3	0
160	REX I. DE SILVA	COLOMBO, SRI LANKA	14.10	8	3	0	0
161	A. HOUSKA	TURNOV, CZECHOSLOVAKIA	14.10	8	3	0	0
162	E. REUSSER	ENNETBADEN, SWITZERLAND	14.10	8	3	0	0
163	Y. SIMIZU	SIMOSATO, JAPAN	14.10	8	3	1	0
164	KRUGER, SANDIG	POTSDAM, GERMAN DEM. REP.	14.07	10	2	0	0
165	-01 40 13 +60 10 23	HELSINKI, FINLAND	14.07	10	2	0	0
166	HERMAN WILLAERT	GISTEL, BELGIUM	14.03	12	1	0	0
167	M. J. HENDRIE	COLCHESTER, ESSEX, ENG.	14.00	14	0	6	0
168	K. G. STEINERT	DRESDEN, GER. DEM. REP.	14.00	14	0	12	0
169	ANONYMOUS	KOLDING, DENMARK	14.00	14	0	0	0
170	LESLIE V. MORRISON	HERSTMONCEUX, HAILSHAM, ENG.	13.10	7	3	7	0
171	WM. G. CLEAVER	MADISON, CT.	13.03	11	1	3	0
172	HERBERT A. LUFT	OAKLAND GARDENS, NY	13.03	11	1	4	0
173	ANONYMOUS	TOTNES-DEVON, ENGLAND	13.00	13	0	1	0
174	TOM CAMBELL	TEMPLE TERRACE, FLA.	12.14	4	4	2	0
175	-00 17 30 +50 19 3	BELGIUM, HAM	12.14	4	4	4	0
176	C. WOLTER	FELLBACH-SCHMIDEN, W. GERMANY	12.10	6	3	0	0
177	S. KANEKO	SAKURA, TIBA, JAPAN	12.07	8	2	2	0
178	EDWARD HALBACH	MILWAUKEE, WI.	12.03	10	1	8	0
179	*M. HAVKIN*	BIRMINGHAM, ENGLAND	12.03	10	1	2	0
180	K. J. PALLETT	LONDON, ENGLAND	12.03	10	1	4	0
181	RONALD PARMENTIER	GREEN BAY WISCONSIN	12.03	10	1	10	0
182	WALT BURES	OMAHA, NEBRASKA	12.00	12	0	3	0
183	S. KOLMAN	ZIAR N. HRONOM, CZECH.	12.00	12	0	5	0
184	V. MAZHOROVSKI	POLTAVA, UKRAINE, USSR	12.00	12	0	8	0
185	HEINZ PACHALI	NEUKOELLN, BERLIN, GERMANY	12.00	12	0	2	0
186	-10 03 56 -33 51 12	AUSTRALIA, SYDNEY	11.10	5	3	0	0
187	PAUL AHNERT	SONNEBERG-THUR., E. GERMANY	11.07	7	2	1	0
188	S. PATTINSON	S. CROYDON, ENGLAND	11.07	7	2	1	1
189	C. R. G. TURK	PINELANDS, CAPE, S. AFRICA	11.07	7	2	2	0
190	ROGER DUTY	MARCINELLE, BELGIUM	11.03	9	1	4	0
191	R. BUSCHLOO	LAREN, NETHERLANDS	11.00	11	0	5	0
192	V. KARKOV	KAZAN, TATAR, USSR	11.00	11	0	4	0
193	F. VAN LOO	IZEGEM, BELGIUM	11.00	11	0	1	0
194	+05 06 56 +38 47 M	U.S.N.O., SPRINGFIELD VA.	11.00	11	0	0	0
195	E. KARKOSCHKA	STUTTGART, GERMANY	10.07	6	2	3	0
196	WALTER NISSEN	ARLINGTON, TEXAS	10.07	6	2	4	0
197	VICTOR SLAPINSKI	ARLINGTON, VA.	10.07	6	2	0	0
198	ROY CAPLE	MILLARD HGH, QUEENS, N.Y.	10.03	8	1	2	0

RANK		OBSERVER	VALUE	TOTAL	R'S	NON ZC	NON SAO
199	ALVIN FLESHER	BALTIMORE, MD.	10.03	8	1	5	0
200	GEOFFREY KIRBY	WEYMOUTH, ENGLAND	10.03	8	1	4	0
201	WILLIAM D. YOUNG	ARLINGTON, VA.	10.03	8	1	5	0
202	EDWIN ELLIOTT	KANSAS CITY, MO.	10.00	10	0	5	0
203	V. GOLOBEV	GORNOTAUZHNI, SIBERIA, USSR	10.00	10	0	0	0
204	J. H. READING	RUSHDEN, NRTHANTS, ENG.	10.00	10	0	4	0
205	WILLIAM S. SKEEN	BRENTWOOD, CA.	10.00	10	0	7	0
206	JOZEF VAN CAMP	HOVE, BELGIUM	10.00	10	0	0	0
207	L. BRUNDLE	HAYWARDS HEATH, ENGLAND	9.07	5	2	5	0
208	U. ONISHENKO	DONETSK, UKRAINE, USSR	9.07	5	2	0	0
209	MICHAEL J. MORROW	EWA BEACH, HAWAII	9.00	9	0	5	0
210	F. J. OLIVER	GUILDFORD, SURREY, ENG.	9.00	9	0	7	0
211	K. VANEK	OLOMOUC, CZECHOSLOVAKIA	9.00	9	0	4	4
212	V. VASILIEV	LENINGRAD, RUSSIA	9.00	9	0	5	2
213	ANONYMOUS	LEIDEN, NETHERLANDS	9.00	9	0	1	0
214	V. FENCHAK	UZHGOROD, UKRAINE, USSR	8.07	4	2	0	0
215	ROBT. A. MCCUTCHEON	CHARLOTTESVILLE, VA.	8.07	4	2	0	0
216	WALTER I. NISSEN	ARLINGTON, VA.	8.07	4	2	3	0
217	KRAJCIR	HLOHOVEC, CZECHOSLOVAKIA	8.03	6	1	4	2
218	ROGER LAUREYS	DIEPENBEEK, BELGUIM	8.03	6	1	3	0
219	Z. SUZ.	JAPAN	8.03	6	1	0	0
220	-00 50 31 +51 27 5	EILENBURG, GERMAN DEM. REP.	8.03	6	1	0	0
221	V. BOROVSHIC	KAZAN, TATAR, USSR	8.00	8	0	3	0
222	P. HAZUCHA	HLOHOVEC, CZECHOSLOVAKIA	8.00	8	0	2	0
223	LARRY MILLS	KANSAS CITY, MO.	8.00	8	0	1	0
224	ANONYMOUS	HORSENS, JUTLAND, DENMARK	8.00	8	0	1	0
225	A. MOROSOV	TOMSK, SIBERIA, USSR	7.07	3	2	0	0
226	HANS-JOACHIM BODE	HANNOVER, W. GERMANY	7.03	5	1	2	0
227	P. DROSDOV	YENISEYSK, SIBERIA, USSR	7.03	5	1	0	0
228	A. EFIMOV	ULYANOVSK, RUSSIA	7.03	5	1	0	0
229	A. MESHERIKOV	RYAZAN, RUSSIA	7.03	5	1	2	0
230	F. ONO	SIRAHAMA, JAPAN	7.03	5	1	2	0
231	ROBERT PIKE	MISSISSAUGA, CANADA	7.03	5	1	4	0
232	-00 31 34 +45 07 58	ITALY, RIVALBA, NR. TURIN	7.03	5	1	1	0
233	-00 19 18 +52 14 29	NETHERLANDS, UITHOORN	7.03	5	1	0	0
234	GEORGE HAYSLER	AUSTIN, TX	7.00	7	0	7	0
235	V. KIRPATOVSKI	KHARKOV, UKRAINE, USSR	7.00	7	0	1	0
236	S. KOVAGIN	GORKI, RUSSIA	7.00	7	0	0	0
237	Y. MOY.	JAPAN	7.00	7	0	0	0
238	H. ONO.	JAPAN	7.00	7	0	0	0
239	BEV.-BEGG. OBSRVTCRY	DUNEDIN, NEW ZEALAND*1	7.00	7	0	4	0
240	ANONYMOUS	RINGSTED, DENMARK	7.00	7	0	0	0
241	C. BUGDANOV	RYAZAN, RUSSIA	6.07	2	2	0	0
242	JERRY SEARCY	LAS VEGAS, NV	6.07	2	2	2	0
243	M. ZHODANI	UZHGOROD, UKRAINE, USSR	6.07	2	2	0	0
244	JOAN DUNHAM	REDFORD, TEXAS	6.03	4	1	4	1
245	V. HAREVIC	YENISEYSK, SIBERIA, USSR	6.03	4	1	0	0
246	S. HUTINODE	SIMOSATO, JAPAN	6.03	4	1	3	0
247	CHET PATTON	BUCHANAN, MICHIGAN	6.03	4	1	2	0
248	GERRY SAMOLYK	MILWAUKEE, WI.	6.03	4	1	2	0
249	G. SEK	FORT SKALA, POLAND	6.03	4	1	0	0
250	+00 02 53 +51 24 50	ASCOT, ENGLAND	6.03	4	1	0	0
251	-02 18 16 +31 40 7	ISRAEL, ASHKELON	6.03	4	1	0	0
252	-00 02 24 +51 20 56	MAIDSTONE, ENGLAND	6.03	4	1	4	0
253	R. BONINSEGNA	MARCINELLE, BELGIUM	6.00	6	0	1	0
254	JOHN CHURCH	PRINCETON JCT., N.J.	6.00	6	0	2	0
255	GEORGE FORTIER	BAIE D'URFE, CANADA	6.00	6	0	5	0
256	JEZIK	HLOHOVEC, CZECHOSLOVAKIA	6.00	6	0	4	0
257	N.K. MCKINNON	PANAMA CITY, FLA.	6.00	6	0	0	0
258	JEAN MEEUS	ERPS-KWERPS, BELGUIM	6.00	6	0	1	0
259	R. RAZNIK	ULYANOVSK, RUSSIA	6.00	6	0	1	0
260	JOZEF REYNDERS	HASSELT, BELGIUM	6.00	6	0	0	0
261	MIKE REYNOLDS	JACKSONVILLE, FL	6.00	6	0	6	0
262	M. SAS.	JAPAN	6.00	6	0	0	0
263	K. SHUTYEVA	KHARKOV, UKRAINE, USSR	6.00	6	0	2	0
264	XAVER WILLI	OBEREHRENDINGEN, SWITZ.	6.00	6	0	2	0
265	-11 21 54 -45 54 40	DUNEDIN, NEW ZEALAND	6.00	6	0	3	0
266	-00 02 07 +51 14 56	MAIDSTONE, ENGLAND	6.00	6	0	2	0
267	R. BRYANT	BAKERSFIELD, CA	5.03	3	1	3	0
268	JEFF GREEN	REDFORD, TEXAS	5.03	3	1	3	1
269	A. JONES	GILLINGHAM, ENGLAND	5.03	3	1	1	0
270	T. OTU.	JAPAN	5.03	3	1	0	0
271	S. RAYNER	WEYMOUTH, ENGLAND	5.03	3	1	1	1
272	+04 55 24 +45 30 4	CANADA, MONTREAL	5.03	3	1	1	0
273	V. DZHAPEASHVILI	ABASTUMAN, GEORGIA, USSR	5.00	5	0	3	0
274	V. HAUT	CHEB, CZECHOSLOVAKIA	5.00	5	0	0	0
275	DAVID HOLGH	SO. PLAINFIELD, N.J.	5.00	5	0	2	0
276	K. L. LIU	TAIPEI, REPUBLIC OF CHINA	5.00	5	0	1	0
277	ORNULF MIDTSKOGEN	NORWAY, TRANBY	5.00	5	0	0	0
278	S. NOGUTI	KAWARA, HUKUOKA, JAPAN	5.00	5	0	0	0
279	C. F. PERKALL	WEST PALM BEACH, FLA.	5.00	5	0	2	0
280	J. PABLOS QUIROS	MADRID, SPAIN	5.00	5	0	3	3
281	D. STRACHAN	PALMERS GRN., LONDON, ENG.	5.00	5	0	2	0
282	I. G. WARWICK	LONDON, ENGLAND	5.00	5	0	4	0
283	-00 49 56 +55 44 28	DENMARK, COPENHAGEN	5.00	5	0	0	0
284	+00 12 43 +55 57 23	SCOTLAND, EDINBURGH	5.00	5	0	4	0
285	-00 01 22 +51 13 22	ENGLAND, HACLOW, KENT	5.00	5	0	1	0
286	-00 17 27 +51 10 50	BELGIUM, HOPCKEN	5.00	5	0	0	0
287	-01 12 7 -33 05 56	S. AFRICA, LANGEBAAN	5.00	5	0	1	0
288	+00 02 50 +51 31 44	ENGLAND, MAIDENHEAD	5.00	5	0	1	0
289	-00 24 29 +62 12 25	NORWAY, ORSTA	5.00	5	0	0	0
290	J. BARATA ARAUJO	RECIFE, BRAZIL	4.03	2	1	0	0
291	TERRY BOONE	SAN ANTONIO, TX	4.03	2	1	2	0
292	BUKST*F	MILWAUKEE, WISCONSIN	4.03	2	1	2	0
293	J. OLIVER	BRONSON, FL*	4.03	2	1	2	0
294	P. PAVLENKO	KHARKOV, UKRAINE, USSR	4.03	2	1	0	0
295	JORGE POLMAN	RECIFE, PERN., BRAZIL	4.03	2	1	1	0
296	GARY RINGLER	CLEVELAND, OH	4.03	2	1	2	2
297	SAM SACK	HIGHLAND PARK, NJ	4.03	2	1	1	1
298	JAN-ERIK SOLHEIM	TROMSOE, NORWAY	4.03	2	1	1	0
299	EBERHARD SPLITTGERBER	SONNEBERG-THUR., E. GERMANY	4.03	2	1	0	0
300	T. VINCENT	SALISBURY, RHODESIA	4.03	2	1	0	0
301	THOMAS L. WEBBER	AUSTIN, TX	4.03	2	1	1	0
302	+00 07 30 +50 44 30	ENGLAND, BOURNEMOUTH	4.03	2	1	2	0
303	-00 38 24 +52 25 1	HANNOVER, GERMAN FED. REP.	4.03	2	1	0	0
304	-00 40 11 +52 36 29	HANNOVER, GERMAN FED. REP.	4.03	2	1	0	0
305	-00 40 13 +52 37 3	HANNOVER, GERMAN FED. REP.	4.03	2	1	0	0
306	+05 00 46 +40 09 52	U.S.A., PHILADELPHIA, PA.	4.03	2	1	0	0
307	I. EDANCHUK	CHERNIGOV, UKRAINE, USSR	4.00	4	0	1	0
308	D. GALICH	LVOV, UKRAINE, USSR	4.00	4	0	0	0
309	MARK HERPSTRITT	ST. MARY'S, PA.	4.00	4	0	1	0
310	JOE HORVATH	LYDICK, INDIANA	4.00	4	0	3	0
311	F. KHARADZE	ABASTUMAN, GEORGIA, USSR	4.00	4	0	1	0
312	F. KRAVSOV	LESNIKI, UKRAINE, USSR	4.00	4	0	2	1
313	J. M. KREINER	FORT SKALA, POLAND	4.00	4	0	3	0
314	K. OGA.	JAPAN	4.00	4	0	0	0
315	K. OTM.	JAPAN	4.00	4	0	0	0
316	D. SCOTT	PANAMA CITY, FL	4.00	4	0	1	0
317	KARL SIMMONS	JACKSONVILLE,FLA.	4.00	4	0	3	0
318	R. SLATTER	BANSTEAD, LONDON, ENG.	4.00	4	0	0	0
319	RICHARD SWEETSIR	JACKSONVILLE, FL	4.00	4	0	4	0
320	J. C. VANDER MEULEN	WAGNUM, NETHERLANDS	4.00	4	0	4	1
321	E. YALOKOV	GORKI, RUSSIA	4.00	4	0	0	0
322	LARRY YOKSH	OVERLAND PARK, KANSAS	4.00	4	0	0	0
323	+00 12 31 +55 57 12	SCOTLAND, EDINBURGH	4.00	4	0	4	0
324	-00 17 29 +50 59 38	BELGIUM, HUMBEEK	4.00	4	0	0	0
325	+00 11 7 +54 01 53	ENGLAND, LANCASTER	4.00	4	0	0	0
326	+00 00 1 +51 35 40	ENGLAND, LONDON N.	4.00	4	0	0	0
327	+00 00 58 +51 30 46	ENGLAND, LONDON UNIV. OBS.	4.00	4	0	0	0
328	-00 17 52 +51 06 0	BELGIUM, WAARLOOS	4.00	4	0	0	0
329	R. DORFTIL	SENCOOK, NH	3.03	1	1	0	0
330	I. GORUSHAK	UZHGOROD, UKRAINE, USSR	3.03	1	1	0	0
331	LON HAMMARGREN	LAS VEGAS, NV	3.03	1	1	1	0
332	M. HAREVIC	YENISEYSK, SIBERIA, USSR	3.03	1	1	0	0
333	N. LOSITSKA	KIEV, UKRAINE, USSR	3.03	1	1	0	0
334	V. LOSITSKI	KIEV, UKRAINE, USSR	3.03	1	1	0	0
335	A. MICHALEC	FORT SKALA, POLAND	3.03	1	1	0	0
336	ROBERT MELFORD	CLARENDON HILLS, ILL.	3.03	1	1	1	0

RANK		OBSERVER	VALUE	TOTAL	R'S	NON ZC	NON SAO
337	JOHN PEANNENSTILL	MILWAUKEE, WI.	3.03	1	1	1	0
338	MARGARET STEWART	GOLD RUN, CA	3.03	1	1	0	0
339	V. URIK	UZHGOROD, UKRAINE, USSR	3.03	1	1	0	0
340	-01 34 59 +60 19 37	FINLAND, HELSINKI	3.03	1	1	0	0
341	+04 55 43 +45 42 34	CANADA, MONTREAL	3.03	1	1	0	0
342	P. BETLEM	NETHERLANDS, ELSLOO	3.00	3	0	0	0
343	DAVID M. BRIERLEY	MALVERN, ENGLAND	3.00	3	0	0	0
344	I. BROADBANK	WEYMOUTH, ENGLAND	3.00	3	0	2	0
345	M. BRUBACK	LILLESTROM, NORWAY	3.00	3	0	0	0
346	P. DRABEK	GOTTWALDOV, CZECH.	3.00	3	0	0	0
347	P. ELLIS	HERSTMONCEUX, ENGLAND	3.00	3	0	1	0
348	L. HEILIG	JACKSONVILLE, FL	3.00	3	0	3	0
349	T. HIS.	JAPAN	3.00	3	0	0	0
350	ROBERT JAMES	MILWAUKEE, WI.	3.00	3	0	3	0
351	S. KRAVCHUK	KIEV, UKRAINE, USSR	3.00	3	0	1	0
352	RICHARD LASHER	LAKE PARK, FLA.	3.00	3	0	2	0
353	A. LOSUK	VORONEZH, RUSSIA	3.00	3	0	0	0
354	BOHUMIL MALECEK	VALASSKE MEZIRICI, CZECH.*1	3.00	3	0	0	0
355	G. MARSHALL	JOHANNESBURG, S. AFRICA	3.00	3	0	1	1
356	J. MIETELSKI	FORT SKALA, POLAND	3.00	3	0	2	0
357	A. MOVCHAN	KIEV, UKRAINE, USSR	3.00	3	0	1	0
358	A. NOVAK	TEPLICE, CZECHOSLOVAKIA	3.00	3	0	1	0
359	OCENAS	BANSKA BYSTRICA, CZECH.	3.00	3	0	1	1
360	M. PUSHNENKO	KHABAROVSK, SIBERIA, USSR	3.00	3	0	0	0
361	J. RIPERO	MADRID, SPAIN	3.00	3	0	2	1
362	N. SMIRNOVA	KAZAN, TATAR, USSR	3.00	3	0	1	0
363	GORDON TAYLOR	COWBEECH, ENGLAND	3.00	3	0	3	0
364	P. VINGERHOETS	ANTWERPEN, BELGIUM	3.00	3	0	0	0
365	M. YAT.	JAPAN	3.00	3	0	0	0
366	-00 19 37 +52 20 33	NETHERLANDS, AMSTERDAM	3.00	3	0	0	0
367	+00 04 40 +51 28 53	ENGLAND, ASHAMPSTEAD	3.00	3	0	0	0
368	-00 41 37 +59 49 53	NORWAY, ASKER	3.00	3	0	0	0
369	+00 07 46 +50 44 44	ENGLAND, BOURNEMOUTH	3.00	3	0	3	0
370	-00 12 60 +51 12 45	BRUGGE, BELGIUM	3.00	3	0	0	0
371	+00 00 15 +51 19 6	CROYDON, ENGLAND	3.00	3	0	0	0
372	-02 19 15 +32 04 12	ISRAEL, GIVATAYIM	3.00	3	0	0	0
373	-00 37 46 +52 25 35	HANNOVER, GERMAN FED. REP.	3.00	3	0	0	0
374	-00 21 13 +52 11 2	NETHERLANDS, SOESTDIJK	3.00	3	0	1	0
375	+00 06 4 +53 40 34	ENGLAND, WAKEFIELD	3.00	3	0	0	0
376	J.A.B. ARACIJU	RECIFE, BRAZIL	2.00	2	0	0	0
377	A. AVKOHCHUK	KIEV, UKRAINE, USSR	2.00	2	0	0	0
378	R. BLISSETT	LONDON, ENGLAND	2.00	2	0	0	0
379	M. BOGDANOV	SARATOV, RUSSIA	2.00	2	0	0	0
380	G. BUSS	ARUNDEL, ENGLAND	2.00	2	0	0	0
381	P. CADA	SLANY, CZECHOSLOVAKIA	2.00	2	0	2	0
382	J. AZCONA CRESPO	MADRID, SPAIN	2.00	2	0	1	1
383	S. IZU.	JAPAN	2.00	2	0	0	0
384	P. KASTOVSKY	VALASSKE MEZIRICI, CZECH.	2.00	2	0	0	0
385	A. KULAK	FORT SKALA, POLAND	2.00	2	0	2	0
386	DANE MORGAN	LAS VEGAS, NV	2.00	2	0	0	0
387	C. PITHER	WEYMOUTH, ENGLAND	2.00	2	0	0	0
388	C. REID	ARUNDEL, ENGLAND	2.00	2	0	0	0
389	J. SILHAN	CESKE BUDEJOVICE, CZECH.	2.00	2	0	1	0
390	J. SMUDLA	GOTTWALDOV, CZECH.	2.00	2	0	1	1
391	S. SOBIN	DONETSK, UKRAINE, USSR	2.00	2	0	0	0
392	M. STEBBAGE	MAIDSTONE, ENGLAND	2.00	2	0	0	0
393	DON STOCKBAUER	VICTORIA, TEXAS	2.00	2	0	2	0
394	A. T.	RYAZAN, RUSSIA	2.00	2	0	0	0
395	O. TOK.	JAPAN	2.00	2	0	0	0
396	Y. TOM.	JAPAN	2.00	2	0	0	0
397	A. UTD.	JAPAN	2.00	2	0	0	0
398	E. VOVCHIK	LVOV, UKRAINE, USSR	2.00	2	0	0	0
399	B. C. WATTS	CLEETHORPS, LINCS, ENG.	2.00	2	0	0	0
400	H.J. WIDDOP	MONTREAL, CANADA	2.00	2	0	1	0
401	-00 19 12 +52 21 9	NETHERLANDS, AMSTERDAM	2.00	2	0	0	0
402	+00 07 25 +50 43 44	ENGLAND, BOURNEMOUTH	2.00	2	0	2	0
403	+00 00 43 +51 06 21	ENGLAND, CRAWLEY	2.00	2	0	0	0
404	-10 07 4 -32 53 54	AUSTRALIA, NEWCASTLE N.S.W.	2.00	2	0	0	0
405	R. W. ARBOUR	BISHOPSTOKE, ENGLAND	1.00	1	0	1	0
406	JOHN BAUMERT	CHAPEL HILL, NO. CAR.	1.00	1	0	1	0
407	L. BERONIKOV	SARATOV, RUSSIA	1.00	1	0	0	0
408	JOHN BIRETTA	GREEN HILLS, OHIO	1.00	1	0	0	0
409	J. BOCEK	JINDRICHUV HRADEC, CZECH.	1.00	1	0	0	0
410	J. RODRIGUEZ BRAVO	MADRID, SPAIN	1.00	1	0	1	1
411	DAVID R. BROWN	FAYETTE, MISSOURI	1.00	1	0	1	0
412	CHROMEK	BANSKA BYSTRICA, CZECH.	1.00	1	0	0	0
413	I. COHEN	K. YAVNE, ISRAEL	1.00	1	0	0	0
414	C. CONRAD	JACKSONVILLE, FL	1.00	1	0	1	0
415	F. DUJKA	GOTTWALDOV, CZECH.	1.00	1	0	1	1
416	DOUGLAS DUNHAM	LOS ALAMITOS, CALIF.	1.00	1	0	0	0
417	T. EIJ.	JAPAN	1.00	1	0	0	0
418	U. FRIDELV	LVOV, UKRAINE, USSR	1.00	1	0	0	0
419	'JACK FRILLMAN'	DAYTON, OHIO	1.00	1	0	0	0
420	WAYNE GREEN	ATLANTA, GA	1.00	1	0	1	0
421	RONALD HUERNER	MILWAUKEE, WI.	1.00	1	0	1	0
422	A. HUZ.	JAPAN	1.00	1	0	0	0
423	B. INNERNY	WEYMOUTH, ENGLAND	1.00	1	0	0	0
424	'W. J. JASCHEK'	VIENNA, AUSTRIA	1.00	1	0	1	0
425	R. KALLEBERG	TROMSO, NORWAY	1.00	1	0	0	0
426	M. KAW.	JAPAN	1.00	1	0	0	0
427	P. KASYKIM	CHERKASSI, UKRAINE, USSR	1.00	1	0	0	0
428	M. KNITSCH	HANNOVER, W. GERMANY	1.00	1	0	0	0
429	M. KOPACEK	CESKE BUDEJOVICE, CZECH.	1.00	1	0	0	0
430	K. KUB.	JAPAN	1.00	1	0	0	0
431	A. KUDLOY	KIEV, UKRAINE, USSR	1.00	1	0	0	0
432	M. LANDA	SLANY, CZECHOSLOVAKIA	1.00	1	0	1	0
433	A. MAMAKOV	KAZAN, TATAR, USSR	1.00	1	0	0	0
434	M. PASCUAL MARTINEZ	MADRID, SPAIN	1.00	1	0	0	0
435	J. MASON	ARUNDEL, ENGLAND	1.00	1	0	0	0
436	M. MATYSEK	GOTTWALDOV, CZECH.	1.00	1	0	1	1
437	U. MICHILOV	SARATOV, RUSSIA	1.00	1	0	0	0
438	M. MULLER	EILENBURG, CZECH.	1.00	1	0	0	0
439	B. NEMCEK	ZIAR N. HRONOM, CZECH.	1.00	1	0	1	1
440	E. NIR.	JAPAN	1.00	1	0	0	0
441	K. ONO.	JAPAN	1.00	1	0	0	0
442	C. OST	HANNOVER, W. GERMANY	1.00	1	0	0	0
443	E. OTTO	EILENBURG, CZECH.	1.00	1	0	1	1
444	A. POKLADOV	DONETSK, UKRAINE, USSR	1.00	1	0	0	0
445	PETER REYNOLDS	JACKSONVILLE, FL	1.00	1	0	1	0
446	M. ROSCOE	JACKSONVILLE, FL	1.00	1	0	1	0
447	K. RUDNICKI	FORT SKALA, POLAND	1.00	1	0	0	0
448	P. SARUCH	SLANY, CZECHOSLOVAKIA	1.00	1	0	0	0
449	M. SEDLACEK	UHERSKY BROD, CZECH.	1.00	1	0	0	0
450	V. SINCHESKUL	POLTAVA, UKRAINE, USSR	1.00	1	0	1	0
451	Z. SKODA	VALASSKE MEZIRICI	1.00	1	0	0	0
452	P. SPURNY	KUNZAK, CZECHOSLOVAKIA	1.00	1	0	0	0
453	J. TEPLY	BRUUMOV, CZECHOSLOVAKIA	1.00	1	0	0	0
454	C. VAUGHN	JACKSONVILLE, FL	1.00	1	0	1	0
455	VOJTA	BANSKA BYSTRICA, CZECH.	1.00	1	0	1	1
456	J. WALMSLEY	NEW PLYMOUTH, N. ZEALAND	1.00	1	0	0	0
457	WILLIAM WESTBROOKE	SAN FRANCISCO, CA.	1.00	1	0	0	0
458	JERRY WIANT	MCDONALD OBS., TEXAS*	1.00	1	0	0	0
459	ROBERT J WOOD	COCOA, FLA.	1.00	1	0	0	0
460	NORMAN WRIGHT	LONDON, ENGLAND	1.00	1	0	0	0
461	-11 38 55 -36 55 47	NEW ZEALAND, AUCKLAND	1.00	1	0	0	0
462	+00 07 3 +52 28 58	ENGLAND, BIRMINGHAM	1.00	1	0	0	0
463	+00 07 39 +50 44 43	ENGLAND, BOURNEMOUTH	1.00	1	0	1	0
464	+00 00 59 +51 05 26	ENGLAND, CRAWLEY	1.00	1	0	0	0
465	+00 12 50 +55 55 55	SCOTLAND, EDINBURGH	1.00	1	0	1	0
466	+00 12 59 +55 55 57	SCOTLAND, EDINBURGH	1.00	1	0	1	0
467	-01 39 27 +60 09 54	FINLAND, HELSINKI	1.00	1	0	0	0
468	+04 38 18 +44 24 0	CANADA, NEAR MONTREAL	1.00	1	0	0	0
469	-00 41 49 +63 25 35	NORWAY, TRONDHEIM	1.00	1	0	0	0
470	-00 17 26 +50 48 12	BELGIUM, UCCLE	1.00	1	0	0	0
471	-11 37 16 -39 00 46	NEW ZEALAND, WAITARA	1.00	1	0	0	0
	TOTALS FOR 23 ANONYMOUS UNRANKED STATIONS ARE		34.10	28	3	7	0
		R/O =	3.03	8788	2178	5060	251

ERRONEOUS STAR POSITIONS FROM OCCULTATIONS

David Herald

In the future, I will be investigating all reports of occultations where the observed time of occultation was outside the predicted range value given in the USNO predictions. I request that reports of all such timings be sent directly to me. My address is P.O. Box 254, Woden, A.C.T. 2606, Australia. When referring to a star, please provide the SAO or ZC number, not the Z number, as crossreferencing from the Z number is somewhat inconvenient.

Reports recently received are summarized below. "Diff" is the difference between the observed and predicted times, in the sense: observed minus predicted.

The source for 93378 is the Yale catalogue. The AGK3 position for this star agrees with Yale to better than 0".1.

The source of 96985 is the GC; however both the ZC and AGK3 are in excellent agreement with it. Przybyl commented that although light cloud was present, the disappearance was instantaneous, and the star was not seen during the next three minutes. With the agreement of the AGK3 with the others, it would seem that the cloud was, in fact, responsible.

161754 is taken from the GC. Yale gives a similar position, but lists a significant positive proper motion in RA, whereas the GC is slightly negative. This results in the Yale position giving a worse time. [Ed: Our own timing of SAO 161754 on Aug. 7, at St. Charles, was 2ˢ.2 early, tending to confirm an error in star position, but also indicating that part of the problem may be in the limb corrections.] Likewise, 158573 is also from the GC, and Yale and ZC positions agree well. Attention should be paid to these two stars in the future, to see if similar discordances occur again.

Finally, Robert Sandy comments that although 162442 disappeared inside his accuracy range, he heard from Wayne Clark that it fell outside his when he observed the same event. The HMNAO residual for Sandy's observation was -2".09, which is somewhat larger than their maximum expected residual of 1".50. 162442 is taken from the GC. The only reliable comparison is from Yale, which however does not list a proper motion for the star. Assuming the GC proper motion is approximately true, the Yale position is 0".8 greater in RA, which reduces the residual to an acceptable amount. By using the GC and Yale positions to compute the proper motion, the 1976 position of the star in RA is 1".7 greater than the raw GC position, indicating that the true explanation is an incorrect proper motion in the GC, the true figure being +0ˢ.0020.

1975/6 Date	Observer	SAO #	Acc	Diff
Oct 12	R. Sandy, USA	162442	4^s	$+ 3^s$
Oct 12	W. Clark, USA	162442	4	+ 6
Mar 6	A. Camponova, Argentina	93378		+30
Apr 8	E. Przybyl, Argentina	96985		-86
Aug 7	R. Sandy, USA	161754	2	- 4
Aug 30	R. Sandy, USA	158753	5	+ 8

ERRATUM

Vol. 1, No. 9, p. 88. In the table of erroneous total occultation predictions, July 9, for diff. of $+17^s$, read $+ 7^s$.

ANALYZING HMNAO RESIDUALS

Clifford J. Bader

One of the frustrating aspects of being an amateur total occultation observer is the lack of knowledge as to just what one's observations mean. Timings are made, sent off to HMNAO, and reductions come back; without detailed knowledge of the reduction process, the observer is hard put to utilize them in any manner except to check for too many residuals beyond the ± 1.5 seconds of arc which HMNAO gives as an acceptable limit. There are, however, some statistical inferences to be made, the calculation of which can while away cloudy evenings and revive flagging interest. A further, apparently unexplored, possibility is the amateur exchange of statistical data, which might help some observers pinpoint special location or timing problems, and which would certainly spur interest and sense of participation. Many calculators have features which make the necessary numerical work easy.

Since the main motive of analysis by the uninformed observer is to evaluate his timings, it is necessary to redefine the residuals to correspond with time rather than angular separation. As a first step, since HMNAO uses a negative residual to indicate coverage by the moon, it is necessary to change the sign of either the disappearance or of the reappearance residuals for consistency with early or late timings. On the philosophy that a positive residual should imply a late timing (i.e., observed later than calculated), the sign of the disappearance should be changed. Because the correspondence between time and angular separation is a complex function of position on the limb and other variables, the resulting data (which may be defined as "angular seconds late" or "angular seconds early") will be consistent in sign with, but not necessarily proportional to, actual time differences, and will be useful for comparisons between various observers.

A natural way to proceed, after changing the disappearance signs, is to calculate the algebraic average (i.e., the mean) of the residuals. In my case, for 109 timings over the period 1973-1975, the mean was + 0.108 arc seconds. This result, although of somewhat dubious significance, at least offers the encouragement that all is not in vain and that no gross systematic error is involved.

The next logical step is to compute the variance, which may be simply defined as the average of the squares of the residuals, less the square of the mean. The square root of the variance is the standard deviation, which is a measure of the spread of the residuals and which has special significance if the form of the distribution is known. The 109 timings noted above yielded a standard deviation of 0.60 arc seconds. Also, the number of timings with residuals corresponding to given standard deviation multiples yielded a reasonable approximation to a normal distribution, i.e., 68% within ± 1 standard deviation of the mean, 95% within ± 2 standard deviations, etc. This result is consistent with HMNAO's ± 1.5 seconds, which falls at 2.5 standard deviations; 99% of the observations would be expected to fall within these limits, and in fact, only one fell outside.

How significant is the + 0.108 arc second mean? From the Central Limit Theorem of probability, the means of groups of N samples chosen from a parent distribution form a normal distribution about the parent mean, with a variance of 1/N times the variance of the parent distribution. The variance of the parent distribution, although not exactly known, is reasonably approximated by the observed variance over 109 samples; thus $0.60/\sqrt{109}$ = 0.057 arc seconds is the predicted standard deviation of observation-group means, and 0.108 ± 0.114 arc seconds is a 95% confidence interval for the true mean residual. Neglecting such small differences as 0.006 arc seconds, and considering that the positive and negative extremes are equally likely, the confidence that the true mean is positive approaches 98%.

If one is willing to gamble with less favorable odds, there is a 68% confidence that the true mean residual is between + 0.108 + 0.057 = + 0.162 and + 0.108 - 0.057 = - 0.051 arc seconds. From here on, the argument degenerates into statistical quibbling; the central fact is that my angular-time residuals tend to be positive, with an average on the order of 0.1 second of arc, and vary in Gaussian fashion with a standard deviation of 0.6 second. If matters continue along this course, 1000 observations will reduce the 95% confidence interval of the mean only to ± 0.038 seconds of arc instead of 0.114 seconds; thus, linearly aging observers cannot hope to much improve their square-root-dependent confidence intervals!

As noted before, the angular residual-time relationship is complex. On the average, something like 0.4 seconds of arc per second of time is a reasonable guess. Thus, the approximate + 0.1 second of arc is equivalent to about 0.25 second of time, moon ahead of schedule or observer timing late. The former condition could imply error anywhere in the whole time/position system, including the observer's geographical location; since the moon's shadow, on the average, moves roughly 3000 ft/sec across the earth at 40° latitude, 0.25 second of time corresponds to some 750 feet of geographical difference. The mean residual is mainly affected by longitude error; latitude errors contribute principally to the variance.

Here, some comparisons between observers would be useful. I would be very embarrassed to find such an error in my map reading, and am loath to believe that my timings run late by a full quarter second; similar results by other observers would help dispel the lingering doubt, as would some indication from the professionals as to where the whole system stands.

It would be most interesting for a number of readers to publish their means and standard deviations for specified time periods. The number of observations on which the analysis is based should be indicated, in order to permit a confidence estimation. If the timings total appreciably less than 100, the parent variance may differ significantly from the observed variance and a more involved statistical treatment will be necessary. Also, the confidence interval will become excessively broad. I would be most pleased to exchange statistics with interested observers, and believe that *O. N.* would be an ideal vehicle for such an interchange. [Ed: If Mr. Bader is willing to to prepare short articles, at intervals, putting the data in tabular form, we can work out something.]

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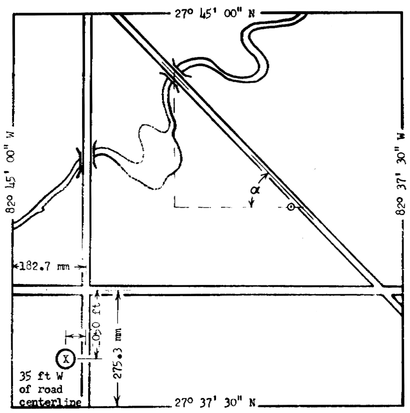
ACCURATE GEOGRAPHIC COORDINATES

Thomas H. Campbell, Jr.

For timing data to be of real scientific value, it is extremely important to determine the geographic coordinates of an occultation timing station accurately. Determining such coordinates to ± 0."1 of latitude and longitude, from a 7½-minute USGS topographic quadrangle map, may sound like a meticulous, time-consuming task. Really, it is not difficult, and takes only a few minutes using the system described below. The map representation is used to illustrate a hypothetical case. My tools are a thin transparent millimeter scale, an illuminated 2X magnifier, and a calculator.

Procedure:

1. Identify the two map borders nearest to your landmark. In this example, the road intersection is the landmark. The two map borders represent your reference longitude and latitude.



2. Convert your reference longitude and latitude from degrees, minutes, and seconds of arc, to degrees and seconds only, making them more convenient to work with, when calculating.

A. Reference longitude 82° 45' 00" is equal to 82° 2700".

B. Reference latitude 27° 37' 30" is equal to 27° 2250".

3. Place the 0 millimeter mark of the scale directly over the reference longitude. Make sure the scale is placed squarely on the map. Look through the magnifier and scale to find the intersection of centerlines of the crossroads, and read the distance to that point to 0.1-millimeter precision (This is the direction in which I prefer to measure, but some people argue that they can interpolate the scale reading more accurately if the 0 mark is centered between the two lines representing the road, and the reading taken at the reference longitude or latitude.). Assign a (-) sign to the measurement in this example, as the intersection is east of the reference longitude. Similarly, measure the distance from the reference latitude north to the intersection. Assign a (+) sign because it is north of the reference latitude. These sign conventions hold for North America, but may differ for east longitude and south latitude.

A. Intersection is -182.7 mm from the reference longitude.

B. Intersection is +275.3 mm from the reference latitude.

4. Convert the millimeter measurements into seconds of longitude and latitude.

A. Seconds of longitude from reference to intersection:

$$\text{Sec of } \lambda = -182.7\,\text{mm} \times \frac{150'' \text{ of } \lambda}{171.7\,\text{mm}} =$$

-159.61 seconds of longitude.

B. Seconds of latitude from reference to intersection:

$$\text{Sec of } \phi = +275.3\,\text{mm} \times \frac{150'' \text{ of } \phi}{192.1\,\text{mm}} =$$

+214.97 seconds of latitude.

(The system used above is known as the factor-label method. You can be sure the equation is set up properly when all the labels cancel except the one you are solving for. Then it is just a matter of arithmetic operations on a calculator.)

5. As station X is far from the reference point, the best way to locate it is to measure the distance with a steel tape or precision odometer, and convert that distance to seconds. Don't use a pair of dividers to locate the station on the map using the marginal distance scale; that invites error.

A. Seconds of longitude from centerline of road: Sec of λ =

$$35\,\text{ft} \times \frac{1\,\text{inch}}{2000\,\text{ft}} \times \frac{25.4\,\text{mm}}{1\,\text{inch}} \times \frac{150''\ \lambda}{171.7\,\text{mm}}$$

= 0."39 longitude.

B. Seconds of latitude from centerline of road: Sec of ϕ =

$$-1056\,\text{ft} \times \frac{1\,\text{inch}}{2000\,\text{ft}} \times \frac{25.4\,\text{mm}}{1\,\text{inch}} \times \frac{150''\ \phi}{192.1\,\text{mm}}$$

= -10."47 latitude.

6. Geographic coordinates:

82° 2700."00	reference longitude
-159.61	to crossroad
82° 2540.39	crossroad longitude
+0.39	to station
82° 2540."78	or 82° 42' 20."8 W
	and
27° 2250."00	reference latitude
+214.97	to crossroad
27° 2464.97	crossroad latitude
-10.47	to station
27° 2454.50	or 27° 40' 54."5 N

Never use a folded map if you expect to get accurate results. Creases cause a map to shrink. Use only maps that have been stored flat or rolled. Use the 150" latitude and longitude marks on each map, to get the factors for converting millimeters to seconds of latitude and longitude, rather than using a constant conversion factor; particularly important in the case of longitude, since the linear equivalent of a unit of longitude varies approximately as the cosine of the latitude. Maps may differ slightly, especially if they are old, and have shrunk in size.

The example above is valid in the case of roads which run directly north-south or east-west. In the case of a straight road which angles across the map, with the station several hundred feet from a landmark, you will have to form an imaginary right triangle. The road is the hypotenuse. Refer to the illustration. The E-W distance is equal to the length of the hypotenuse times the cosine of α. The N-S distance is equal to the length of the hypotenuse times the sine of α. After determining the above distances in feet, follow steps 1 thru 6 above to determine the geographic coordinates.

In determining geographic coordinates, the objective is to so minimize errors that the only appreciable remaining error is the error of the map itself.

OCCULTATIONS OF GALACTIC-NEBULAR OBJECTS

Richard P. Binzel

Included in the 1977 USNO total occultation predictions are listings of occultations of various "Galactic-Nebular" (GN) objects. The list of GN objects includes various open and globular clusters brighter than mag. 10.0, two diffuse nebulae (M8 and M20), the Crab Nebula and the Saturn Nebula. These GN objects have been assigned USNO reference numbers prefixed by the letter G. Previous information on occultations of GN objects appeared in *O. N. 1,* 70 and 76 (#'s 7 and 8).

Several favorable occultations of GN objects will occur during the first half of 1977. The moon will make three passages across a 7.3 mag. globular cluster, M9; a rich 4.6 mag. open cluster, M24; and another open cluster, M67, 6.1 mag.; along with two passages across the 6.5 mag. open cluster M25. Other GN objects occulted in the first half of 1976 include M23, a 6.9 mag. open cluster; 9.0 mag. M73, another open cluster; and NGC 7009, the 8.4 mag. planetary nebula better known as the Saturn Nebula.

In the table below, the upcoming occultations for the first half of 1977 are listed for each GN object with the date and approximate hour (U.T.), the percent sunlit of the moon, and the approximate region of visibility for each event. The table lists only the favorable upcoming events, with the moon's illumination and the relative sun and moon altitudes being determinants in the classification of events as favorable.

The 1950 right ascension of M67 (USNO Ref. No. G00012) used to compute all USNO total occultation predictions for 1977, including the ones from which the table below was prepared, was $8^h 43^m.3$, but the value is actually $8^h 48^m.8$. As a result, the actual occultation of G00012 will occur about 15 minutes later than the time given for it in the table below and in all USNO total occultation predictions for 1977. The error will be corrected in the predictions for 1978, and also for the fictitious "star" which marks the center of M67 in any 1977 special predictions of occultations of the numerous non-SAO stars from the Astrographic Catalog which David Dunham computes and distributes.

1977 Date	Approx. U. T.	% Snl	Nighttime Area of Visibility
M9 (mag. 7.3, GB, diameter 2'.4)			
Jan 16	19^h	10-	W. Australia
Feb 13	2	29-	S. Africa
Mar 12	8	52-	W. South America
M24 (mag. 4.6, OC, diameter 4'.0)			
Jan 17	18	4-	E. Australia
Feb 14	1	19-	S. Africa
Mar 13	7	40-	S. America
M67 (mag. 6.1, OC, diameter 15'.0)			
Mar 30	16	76+	Japan, Philippine Islands, Siberia
Apr 27	0	54+	Canada, Eastern third of U.S.A.
May 24	8	32+	Alaska, Hawaii
M25 (mag. 6.5, OC, diameter 40')			
Mar 13	14	38-	Alaska
Apr 9	19	61-	Japan
M23 (mag. 6.9, OC, diameter 25')			
Apr 9	5	67-	S. America
M73 (mag. 9.0, OC, diameter 5'.0)			
May 9	16	55-	Japan
NGC 7009 (mag. 8.4, PL, diameter 0'.7)			
May 9	19	54-	Australia

NEW DOUBLE STARS

David W. Dunham

The table lists additions and corrections to the special double star list of 1974 May 9 not listed in previous issues. The columns and general format are the same as in previous issues. Under the method column M, "I" signifies discovery by interferometry. The two doubles in Virgo so indicated were observed by speckle interferometry with the 4-meter reflector at Kitt Peak, as reported in Information Circular No. 70 of the I.A.U.'s Commission on double stars. At the I.A.U. General Assembly in Grenoble last August, there was increasing interest in close binaries discovered during occultations among double star astronomers. ZC 1772 is a spectroscopic binary with a separation of perhaps 0".009. This is an order of magnitude smaller than the separation of the components seen by speckle interferometry, but it was probably the spectroscopic pair that was resolved. Parallax errors make spectroscopic separations very uncertain in most cases, as was shown by β Capricorni. If ZC 1772 were triple, the component seen by speckle interferometry is bright enough that it should appear in the spectrum as a third line.

Sincheskul gives the following 1950 right ascensions and declinations for the three anonymous (non-BD) stars at the bottom of the list: 1, $5^h57^m52^s$, +23°54'; 2, $7^h13^m32^s$, +21°51'; and 3, $21^h28^m00^s$, -12°27'.

218 possible and probable new double stars listed in *Union Observatory Circular* No. 95 were identified and keypunched by Donald Stockbauer a few months ago. The list is mainly a compilation of anomalous occultation observations made in South Africa during the 1920's and 1930's. A listing of these doubles was sent to the graze computors in November; the new double star codes will appear in all USNO total and grazing occultation predictions for 1978 onwards. This brings us significantly closer to completion of IOTA's double star project, which will result in a list of all known and suspected stars in the SAO Catalog which can be occulted by the moon being sent to all members. Only one more major list needs to be incorporated; the spectroscopic binaries listed in Wilson's radial velocity catalog. It should be possible to prepare most of that list by computer. The data needed to do the job have been sent to Wayne Green, who plans to use the computers at the University of North Florida in Jacksonville for the project. The separate lists will then need to be merged into one master list in one format arranged in SAO-number order. Wayne Warren, at Goddard Space Flight Center, recently completed thorough checking and correcting of several errors in the Stockbauer visual double star list data which were found by computer tests. Observational data supplied by Charles Worley at USNO was essential for this task, begun by Gary Ringler several months earlier. Adding reference information to the computer data, mainly dates and discoverers, will be the last job, which will have to be done largely by me. It also appears necessary to set up a double star occultation observation file, as we are getting an increasing number of cases of two or more widely separated (in time and location) observations of occultations of the same star. These data should all be more readily available than they are now.

β Capricorni remains the most interesting multiple system currently being occulted. Photoelectric occultation observations obtained at McDonald Observatory during 1976 September and November essentially confirm the data reported for this star (SAO 163481; ZC 2969) on p. 60 of *O. N.* #7. Photoelectric records of occultations of this star obtained at other observatories is sought. I do not know of any photoelectric records of occultations of β Capricorni's distant 6th-magnitude companion, ZC 2968 Richard Nolthenius' observation, reported below, indicates a possible new close component of this star; his estimate of the brightness of the visual companion is considerably fainter than Harold Povenmire's 1975 December estimate. The MAG3 value listed is an average of their estimates. A massive attempt to observe a graze of ZC 2969 is mentioned in GRAZES REPORTED TO IOTA.

Preliminary reports of results of last July's occultation of β Scorpii were reported at the I.A.U. General Assembly in Grenoble, France. David Evans noted that 11 diffraction fringes were evident in the data for the primary obtained with the 208-cm Struve reflector at McDonald Observatory, the most he has seen in any occultation record. The trace is even good enough to show the presence of the spectroscopic D component only 0".001 away. Data on all five known components of the system were obtained with 3 telescopes at McDonald. James Elliot notes that he was able to completely separate the AB component from the C component in the diaphragm at Mt. Hopkins Observatory, so that good-quality data were obtained for both systems. Photoelectric observations were also obtained at Table Mountain Observatory, California. All data are now being digested at the University of Texas, to obtain the best possible astrometric information about the system. The analysis indicates a separation of 0".45 for the AB pair, with B at mag. 5.8. Analyses for such separations must be done with care, since they are ten times smaller than the resolution of Watts' charts for determining local lunar slopes, yet more than ten times the approximately 40 meters of lunar limb whose slope can be determined from the recorded diffraction pattern.

Dr. Paul J. Edwards, University of Otago; P.O. Box 56; Dunedin, New Zealand, reported photoelectric observations of the occultation of β Scorpii obtained at Dunedin and Auckland in 1975 September. A third attempt in Wellington was clouded out. The output from the photometer was recorded on cassette tapes, which are being analyzed at Dunedin. This system was set up for amateur photoelectric observations of variable stars in New Zealand with Dr. Edwards the coordinator.

The last occultation of β Scorpii in the series which ended last August 4 was observed by Toshio Hirose and several other Japanese observers. They traveled by train and ship over 1000 km north from Tokyo to Hokkaido Island to observe the southern-limit graze near Sapporo. They did not know about the B component beforehand, but Haruhiko Ono, one of the observers, showed later that it explained the dimming phenomena recorded by some of the observers, including himself. The expected separation of B from A projected onto their position angle of graze (183°) was 0".3. As no pair of their observers was separated by near this amount of graze height, no significant improvement in the separation could be obtained; their observations are consistent with the data available from the July 8th event discussed above and on p. 83-85 of the last issue. When an accurate separation and position angle are available from the July data, they can be used to better define the lunar profile observed near Sapporo. This is because each observer was effectively at two graze heights, one for each component. Another group of Japanese observers farther east on Hokkaido recorded the graze of the C component (ZC 2303). Analysis of the observations of the two expeditions could result in improved values for the separation and position angle of C from A, independent of the lunar profile, whose uncertainties cause difficulties in the interpretation of photoelectric total occultation observations for such large separations.

The duplicity of SAO 79100 was detected not during a lunar occultation, but during an occultation by another moon, Rhea, a satellite of Saturn. Analysis of the observations is reported in an article by Gordon Taylor and others in *Astronomy and Astrophysics, 50,* p. 121. The photoelectric observations were made with a 30-cm Cassegrain at the Sierra Nevada Observatory of the University of Granada, Spain. One difficulty was that the equipment was not intended for use on rapidly varying objects and a 10-second time constant was built into the amplifier to help smooth out scintillation effects. Nevertheless, due to Rhea's great distance, the projected separation was determined to 0".001! Artificial occultations permitted calibration of the rate of deflection of the chart recorder pen, so that event times could be recovered to 0.5 sec.

Most of the new doubles in the list are from publications of occultations observed in the U.S.S.R. during 1973, 1974, and 1975, kindly sent to me by Dr. A. Osipov at Kiev. The main center for Soviet occultation activity seems to be in the Ukraine, where the most experienced observers are more likely to notice phenomena indicating possible duplicity. Large numbers of observations are also reported from Engelhardt Observatory in Kazan, Tatar Republic, and Abastumani Observatory in the Georgian S.S.R. Significant numbers of observations are made at many longitudes in the Soviet Union, Including across Siberia. This certainly helps the worldwide coverage of occultation work. The duplicity of ZC 651 was noted by Sincheskul on 1975 February 19, one month before Robert Sandy independently discovered it during a graze (*o. N. 1, #4*, p. 36). This adds further confirmation to the idea that the companion was not recorded photoelectrically at McDonald in 1975 March because their record stopped too early. I noted possible duplicity of ZC 1429 during a graze on 1974 April 4, but it was also noted in Poland and Kiev four months earlier. Their data have been used in conjunction with mine in the list below. There has been confirmation of a few other doubles, such as δ Scorpii, and an occultation of SAO 77219 observed in Kiev in 1974 indicated to me that this visual double had been left out of my lists.

A list of photoelectric observations made by Eitter and Beavers at the University of Iowa's Fick Observatory has yielded several entries in the list. They list two observations of the probable close triple system μ Arietis (SAO 93062, ZC 399), which can be compared with four photoelectric records obtained at Hamburg Observatory. The closest pair of observations of the 6 are events one month apart, one observed at Hamburg in 1973 January and a nearly grazing event at Fick Observatory a month later. Combining the two yields a separation of 0".49 in position angle 263°, for the close pair. Significantly rapid orbital motion doesn't permit satisfactory interpretation of the observations (this underscores the need for data obtained at two or more widely separated observatories for the same occultations). For nearly grazing events, such as the 1973 February observation at Fick, Watts' charts might be used to calculate the local lunar slope needed to obtain the modified position angle of projection. But Watts' charts are really too coarse for such small separations; the lunar slope for separations less than about 0".1 can be determined better from accurate photoelectric timings at two nearby telescopes, or from the fringe spacing of one well-observed diffraction pattern. The evidence for the faint close third star now also seems strong.

The results for the 1973 January occultation of SAO 76425 (ZC 598) obtained at Fick and McDonald Observatories were combined to obtain a separation of 0".033 in P.A. 142°. Japanese photoelectric observations of this star were made one month before and one month after this occultation, so their mean epoch for a combined solution is the same. They got rather different values, 0".095 in 214°. The position angle difference for their observations was only 20°, so their solution is rather weak; small orbital motion could have a large effect. Eitter and Beavers' Fick-McDonald solution, besides being nearly simultaneous, also had the advantage of a large position difference. Fick observations of SAO 76103 and 146239 showed no convincing evidence for duplicity, although other photoelectric observations do. 76103 was observed the same night by McGraw, Moffat, and me at Tonantzintla (the star is in the Pleiades), where the position angle was nearly perpendicular to that at Fick Observatory. The observations would therefore be consistent if the actual separation and position angle were nearly equal to the projected values observed at Tonantzintla.

Several observers of the 1976 August 29 grazing occultation of Spica in Florida noticed dimming phenomena and some events occurring in steps, adding confirmation for the companion discovered during the graze of Spica in 1975 November in Australia (both were southern-limit events). Richard Nolthenius did not notice the companion during his daytime observations of the same graze in Arizona; he feels that he would have seen the secondary if it were brighter than mag. 3.5. It probably will be possible to estimate the separation and position angle from the Florida graze observations when they are all available. I do not know of any successful photoelectric observations of the occultation, which took place in daylight for most of North America.

The information about the companion of ZC 1853 was obtained from Alistair R. Walker's article, "The Angular Diameter of Psi Virginis," *Monthly Notices of the Royal Astron. Soc., 173,* 29P. The main interest of the article is the diameter of the primary, found to be 0".0061 ± 0".0003, but the star also happened to be an unexpected double. The article gives a very good discussion of the astrophysics of the system, but unfortunately gives no positional information other than the projected separation. Especially, the position angle of the occultation event is not given; the list value is only an estimate for a nearly central occultation for this part of the moon's orbit. I do not have time to compute the position angles for all new occultation doubles, although hopefully in the future when the double star data are better organized, it will be possible to do this automatically with data available at USNO for all events involving possible doubles. In the meantime, observers are asked to please provide as complete as possible information about suspected double star events, especially the star's SAO number, ZC number (if any), the position angle of the event, the estimated duration (time between steps) of the event, and, if possible, relative magnitude estimates.

BD +12° 1926, noted as double by Ron Price during a near-graze disappearance on 1976 June 3, is one of the brightest members of M67. I observed a reappearance of the star during the M67 passage of 1976 September 20, but did not notice duplicity. Smaller resolutions can be achieved as grazing conditions are approached. Probably neither neither the geometry nor the atmospheric conditions were as favorable in September as they were in June for Mr. Price.

During the occultation of ZC 146 on 1976 December 29, both Robert Sandy and Larry Yoksh, observing from sites in Kansas City about 13 miles apart, noticed the bright star disappear in steps. Richard Nolthenius noticed nothing unusual during the same occultation in San Diego, and the companion was not evident in a photoelectric record obtained at McDonald Observatory through clouds. ZC 146, ZC 1147, and some of the other stars given in the list will be occulted several times during 1977; observers should check their predictions and attempt observations which could add confirmation or denial to the suspected duplicity of these stars.

During the spectacular graze of ρ Sagittarii (ZC 2826) last November, most of the contacts I observed were sharp. However, I saw four sudden fading phenomena as the star moved along a rather flat but hilly part of the profile which produced 12 other contacts in little more than a minute. Most other observers of the graze noticed no dimmings, all events being sharp. I am rather convinced that the fadings I saw were due to diffraction as the star passed very close to lunar hills; isolated gradual (not stepwise) events seen during other very favorable grazes can be similarly explained. So one must be careful when interpreting graze observations, where the resolution is so good that diffraction effects can be noticed visually at some contacts. Very favorable occultations and grazes of ZC 2826 will occur during March and October this year in North America.

In a letter published in the 1976 August issue of the *Journal of the British Astron. Association*, G. W. Amery, Occultations Co-ordinator for the Lunar Section of the B.A.A., noted that all anomalous behavior at lunar occultations must be due to either stellar, lunar, or terrestrial causes, and that coordinated observations could help answer these questions. Stellar duplicity was noted as a probable cause in many cases. Fading occultations has been adopted as an official Lunar Section project, and literature searches for early observations have been planned. I have communicated with Mr. Amery, who has supplied more comprehensive observational data about the probable duplicity of ZC 2774 (SAO 162133), which indicates a separation of about 0″05 projected in P.A. 19°.

A possible companion at least 30" away from ZC 2079 was noticed during a graze in South Africa, as reported on p. 85 of the last issue. Wayne Warren could find no evidence for such a star brighter than about 15th magnitude when he examined the Palomar Sky Survey print of the vicinity of ZC 2079.

NEW ZODIACAL SPECIAL DOUBLE STARS, 1977 JANUARY 30

SAO/BD	ZC	M	N	MG1	MAG2	SEP	PA	MAG3	SEP3	PA3	DATE, DISCOVERER, NOTES
75755	0459	P	K	7.1	8.1	0″1	77°				1973 Dec 8, J. Eitter and W. Beavers, Ames, IA
76475			E								Correct double star code error in Stockbauer list
76545		T	K	8.9	8.9	0.1	90				1973 Mar 10, A. Zhitetski, Kiev, Ukraine, USSR
76726	0712	T	K	9.5	9.5	0.1	90				1975 Apr 15, A. Zhitetski, Kiev, Ukraine, USSR
76909		T	K	9.2	9.2	0.25	90				1973 Apr 7, B. Sincheskul, Poltava, Ukraine, USSR
77038		P	K	9.4	10.3	0.19	250				1973 Jan 16, J. Eitter and W. Beavers, Ames, IA
77219		V	A	8.8	10.8	4.5	165				A.D.S. 4105. Not in previous lists
77971	0923	T	K	7.7	7.7	0.1	90				1973 Apr 8, A. Dobrovolski, Odessa, Ukraine, USSR
78168	0954	T	K	6.9	6.9	0.1	90				1973 Apr 19, A. Zhitetski, Kiev, Ukraine, USSR
78592		T	X	10.0	10.0	0.1	90				1974 Mar 3, B. Sincheskul, Poltava, Ukraine, USSR
78733		P	X	8.9	9.0	.034	127				1972 Oct 27, J. Eitter and W. Beavers, Ames, IA
78953		T	V	9.5	9.5	0.1	270				1973 Oct 18, A. Zhitetski, Kiev, Ukraine, USSR
78992	1069	T	K	8.8	8.8	0.1	90				1973 Apr 9, A. Osipov, Kiev, Ukraine, USSR
79031	1077	T	Y	4.5	4.5	0.1	90	11.7	99″	348°	1973 Dec 11, I. Edanchuk, Chernigov, Russia, USSR (2nd*; ADS 5742)
79040		P	V	9.4	10.0	0.14	144				1972 Sept 30, J. Eitter and W. Beavers, Ames, IA
79100		P	V	10.2	10.5	.039	89				1974 Aug 29, A. Roland Quintanila, Sierra Nevada Observatory, Spain
79321		T	X	9.8	9.8	0.1	90				1973 Mar 13, B. Sincheskul, Poltava, Ukraine, USSR
79403	1129	P	L	5.9	6.4	.001		7.5	″047	124	1972 Nov 24, Eitter and Beavers, Ames, IA (3rd*; spec. bin. & ADS 6089)
92486		P	X	8.6	9.8	0.49	5				1972 Dec 16, J. Eitter and W. Beavers, Ames, IA
92493		T	K	9.6	9.6	0.1	270				1975 July 3, A. Zhitetski, Kiev, Ukraine, USSR
93046		P	K	9.3	10.9	0.13	288				1973 Feb 10, J. Eitter and W. Beavers, Ames, IA
93051		P	K	9.2	11.3	0.27	118				1973 Feb 10, J. Eitter and W. Beavers, Ames, IA
93386	0480	T	K	8.1	8.1	0.1	90				1975 Feb 18, M. Fedynin, Tomsk, Siberia, USSR
96178		T	K	9.2	9.2	0.1	270				1975 Sept 28, A. Zhitetski, Kiev, Ukraine, USSR
97016	1147	T	V	5.4	7.0	0.15	236				1976 Oct 16, R. Sandy, Kansas City, MO
97084		T	K	9.8	9.8	0.1	270				1974 Sept 12, A. Zhitetski, Kiev, Ukraine, USSR
97210		G	V	9.4	10.0	0.04	20				1976 Oct 16, R. Nolthenius, Suharita, AZ
97348	1190	T	Y	7.9	7.9	0.1	90	11.1	15.9	20	1975 Mar 22, A. Efimov, Ulyanovsk, Russia, USSR (2nd*; ADS 6440)
97442		T	K	9.0	9.0	0.2	90				1975 Mar 22, B. Sincheskul, Poltava, Ukraine, USSR
97843	1271	T	X	6.2	7.0	3.	90				1976 Apr 29, E. Przybyl, Rafaela, Argentina
109627	0146	T	K	5.2	5.2	0.25	29				1976 Dec 29, R. Sandy, Kansas City, MO
109763		T	X	9.2	9.2	0.2	67				1976 Dec 2, J. Van Nuland, San Jose, CA
109923		P	K	9.0	10.0	.034	202				1976 Nov 5, J. Africano, McDonald Observatory, TX
117851	1429	T	X	7.6	7.6	0.05	80				1974 Jan 10, M. Winiarski, Fort Skala, Poland (see *O. N., 1*, #1, p. 5)
118103		P	L	9.4	9.5	0.06	299	10.5	0.27	299	1972 May 20, J. Eitter and W. Beaver, Ames, IA
138721	1772	I	V	4.4	5.4	.118	150				1976.04, H. McAlister, Kitt Peak National Observatory, AZ
139005		T	V	9.6	9.6	0.2	88				1976 Aug 1, R. Sandy, Kansas City, MO
139033	1853	P	V	5.0	8.3	.040	110				1975 May 21, A. Walker, Sutherland, South Africa
139189	1891	I	T	4.8	5.8	.485	142	9.4	7.1	343	1976.04, H. McAlister, Kitt Peak Nat. Observatory, AZ (2nd*; ADS 8801)
146045		G	V	8.5	9.5	0.4	150				1976 Nov 1, R. Nolthenius, Picacho, AZ
158995		T	K	8.7	8.7	0.05	60				1976 Sept 26, H. Povenmire, Indian Harbour Beach, FL
159752		T	X	9.3	10.5	0.25	348				1976 Sept 28, R. Nolthenius, Tucson, AZ
161153	2629	P	T	7.2	8.5	.024	321	7.3	1.0	195	1976 Sept 30, J. Africano, McDonald Observatory, TX (2nd*; ADS 11127)
161190		T	X	8.3	9.5	0.12	304				1976 Sept 30, R. Nolthenius, Tucson, AZ
161400		T	K	9.4	10.1	0.2	228				1976 Nov 24, R. Nolthenius, Tucson, AZ
161436		T	K	8.5	9.0	2.5	274				1976 Sept 3, R. Sandy, Kansas City, MO
162611		T	K	9.6	9.9	0.15	228				1976 Nov 25, R. Nolthenius, Tucson, AZ
163192		T	Y	9.1	9.1	0.25	90	9.0	16.8	135	1974 Sept 25, B. Sincheskul, Poltava, Ukraine, USSR (2nd*)
163460		T	K	9.4	10.1	0.15	250				1976 Nov 26, R. Nolthenius, Tucson, AZ
163471	2968	T	Y	7.2	7.2	0.05	91	9.0	0.8	84	1976 Nov 26, R. Nolthenius, Tucson, AZ (2nd*; ADS 13717)
163532	2975	T	K	7.8	7.8	0.05	20				1976 Nov 26, R. Nolthenius, Tucson, AZ
163848	3029	T	K	7.7	7.7	0.1	90				1973 Oct 6, S. Fokas, Uzhgorod, Ukraine, USSR
184634		T	X	8.4	8.4	0.1	53				1976 Aug 5, R. Sandy, Kansas City, MO
+23°1311		T	X	9.0	9.0	0.25	90				1973 Mar 12, B. Sincheskul, Poltava, Ukraine, USSR
+21°1317		T	X	10.1	10.1	0.15	0				1974 Mar 3, B. Sincheskul, Poltava, Ukraine, USSR
+12°1926		T	V	10.0	10.0	0.05	30				1976 June 3, R. Price, Garland, TX (star is in M67)
-19°4904		T	X	9.8	10.7	0.05	309				1976 Sept 30, R. Nolthenius, Tucson, AZ
-19°4920		T	X	10.1	10.3	0.91	230				1976 Sept 30, R. Nolthenius, Tucson, AZ
Anonymous-1		T	K	10.8	10.8	0.25	90				1973 Apr 8, B. Sincheskul, Poltava, Ukraine, USSR
Anonymous-2		T	K	10.6	10.5	0.25	90				1973 Mar 13, B. Sincheskul, Poltava, Ukraine, USSR
Anonymous-3		T	K	10.3	10.3	0.25	90				1973 Jan 7, B. Sincheskul, Poltava, Ukraine, USSR