Occultation Newsletter

Volume I, Number 8 June, 1976

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Editor and Compositor: H. F. DaBoll, 6 N 106 White Oak Lane, St. Charles, Illinois 60174, U. S. A.

IOTA NEWS

David W. Dunham

Payment for IOTA membership renewal is due by 1976 July 1 for most members, as the association begins its second year. If your payment is due, a notice about this is enclosed. Receipt of predictions for the second half of 1976 is not assured until payment is received. Dues will remain $7.00 for residents of North America (including Mexico) and $9.00 for others, to cover the costs of overseas airmail. Observers in Europe and the United Kingdom should instead join the European section; see below for details. Postal rate increases and inflation have increased costs, especially for *Occultation Newsletter*, but these increased costs have been offset by the fact that we haven't been able to produce as many publications as we had planned. The Miami Valley Astronomical Society (Dayton, OH) has offered some use of their printing facilities for IOTA publications. This will decrease our expenses when details are worked out.

One year is too short a term, so we plan to keep the same officers, at least until a year from now, when we will hold our first elections.

Hans J. Bode, 3000 Hannover, Bartold-Knaust-Str. 6, German Federal Republic (telephone: 0511/424696), has been distributing graze predictions gratis to observers in Europe and the United Kingdom during the past several years. Increased interest and costs have made it necessary for him and the Astronomische Arbeitskreis Hannover to form a European Section of I.O.T.A. (IOTA/ES) which European and British observers will have to join, by sending Mr. Bode a payment of DM 10.-- (German Mark), in order to continue receiving graze predictions. A notice about this has already been distributed by Mr. Bode to his observers. A.A.H. will also duplicate and distribute *Occultation Newsletter* and other relevant I.O.T.A. publications to IOTA/ES members, who therefore do not need to join the U.S.-based IOTA. It is possible that IOTA/ES dues may have to be raised slightly later to cover all costs, but in any case observers will be saved considerable expense by eliminating transatlantic airmail postage costs.

Eduardo Przybyl, Rafaela, Argentina, has offered to translate IOTA publications pertinent to Latin America and Iberia into Spanish, and arrangements have been made to duplicate it in, and distribute it from, the Instituto de Astronomia of the Universidad Nacional Autonoma de Mexico in Mexico City. Motonobu Tonomura and Toshio Hirose have plans for an IOTA section in Japan.

My address will most likely change during the last part of June. Continue to use 2976 Linwood Ave., Apt. 2; Cincinnati, OH 45208 as my address, and no other address, until informed otherwise; mail will be forwarded.

All current IOTA members will be sent the basic use of graze predictions and profiles paper, and a list of addresses of current members, when they are ready. When I started to write the use of graze predictions paper, I soon realized that a lot more had to be included than I expected. It will be written as a section of the long-delayed IOTA graze manual. Teaching an evening college course this quarter has cut further into my time, so that I've hardly been able to keep up with correspondence. This situation is getting worse, so that some letters will go unanswered, and replies to others considerably delayed. Help with correspondence is sought from more experienced IOTA members who would be willing to answer some letters (as an IOTA Corresponding Secretary), which would help free my spare time to work on the publications. For the above reasons, the photoelectric occultation index has also been delayed.

Many coupons reporting 1975 total occultation counts have been received. In general, observers timed substantially more totals during 1975 than during 1974. Publication of the counts will be delayed until at least the 1976 October issue to allow time for more overseas publications with observation lists to be received.

FROM THE PUBLISHER

We are sorry to be late, again, our dateline being June, instead of April.

At the time of this writing, we are not sure whether this issue will be printed and mailed in St. Charles, IL, or in Dayton, OH (see IOTA NEWS), but it seems probable that future issues will be printed and mailed in Dayton.

Note that arrangements are being made for distribution of *O.N.*, or special editions of *O.N.*, in certain areas outside the U.S.A. (see IOTA NEWS). However, the U.S.A.-based edition will still be available to anyone, on the old personal subscription basis. The basic price includes first class surface mailing: 50¢ per issue thru Vol. I, No 9; later issues will be priced at $1.00 each, until further notice. If someone were to order a one-year subscription (four issues) starting with Vol. I, No. 9, the basic price would be figured as 1 @ $0.50 + 3 @ $1.00 = $3.50. 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.

Note that the foregoing applies only to separate, individual subscriptions to the newsletter. For IOTA membership, which includes a subscription, see IOTA NEWS.

Back issues of *Occultation Newsletter* are still available at 50¢ each.

Please address all membership, subscription, and back issue 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.

ERRATA

As also noted in NEW DOUBLE STARS, in the last paragraph in the second column on p. 60, the first sentence should read: Another star to watch is β Capricorni (Z.C. 2969, SAO 163481).

On p. 63, column 1, the 14th line from the bottom should read:
saddle-stitched binding allows it to

On p. 67, the caption of the second profile should read:
GRAZE OF 21 SAGITTARII,
1975 OCTOBER 11, KATY, TEXAS

On p. 68, column 3, line 10 should read:
siders the graze of χ Virginis (Z.C.

STILL MORE ELECTRONIC STOPWATCHES

Rick Binzel has called our attention to page 83-8 of the most recent Edmund catalog (# 762), which lists electron-

1/10 second digital stopwatches, with stated accuracy of + 0.002%, at $49.95 and (with split action) $79.95, and a split action timer reading to 1/100-second, with stated acuuracy of ± 0.001%, at $149.95. Again, we would be happy to publish a brief report by an actual user.

LUNAR OCCULTATIONS OF PLANETS

Mike Reynolds

Recent Observations:

1975 September 11 - Jim Elliot, Cornell University, reports attempts to photoelectrically record occultations of Neptune from Mt. Stromlo, Australia, and from the Boyden Observatory in South Africa. The attempt at Mt. Stromlo was completely clouded out. At Boyden, skies were partly cloudy, so that data useful only for a timing were obtained.

1976 January 13 - Occultation of Ceres by the moon. Jorge Polman's attempt to observe and time the favorable event, at Recife, Brazil, was foiled by a thunderstorm.

Upcoming Events:

Following is a list of potential occultations of minor planets by the moon, for the remainder of 1976. Detailed predictions will be sent to IOTA members who might be able to observe them. The list was prepared by Donald Davis, of the Planetary Science Institute, Tucson, AZ.

U.T. Date & Time		Asteroid	Mag*	% Snl	Possible Location
June 15	16^h	7 Iris	10.4	86-	Russia, China, Japan
July 3	3	63 Ausonia	12.0	37+	northeastern Siberia
July 24	0	4 Vesta	8.2	75+	Mideast, Russia
October 1	22	89 Julia	11.4	65+	England
November 4	22	80 Sappho	10.3	95+	South Africa
November 8	20	22 Kalliope	10.8	96-	Europe, Russia, South Africa, India
December 4	6	245 Vera	12.5	94+	United States, Mexico, Hawaii
1977 Jan. 2	11	471 Papagena	10.9	92+	Europe, England, Russia

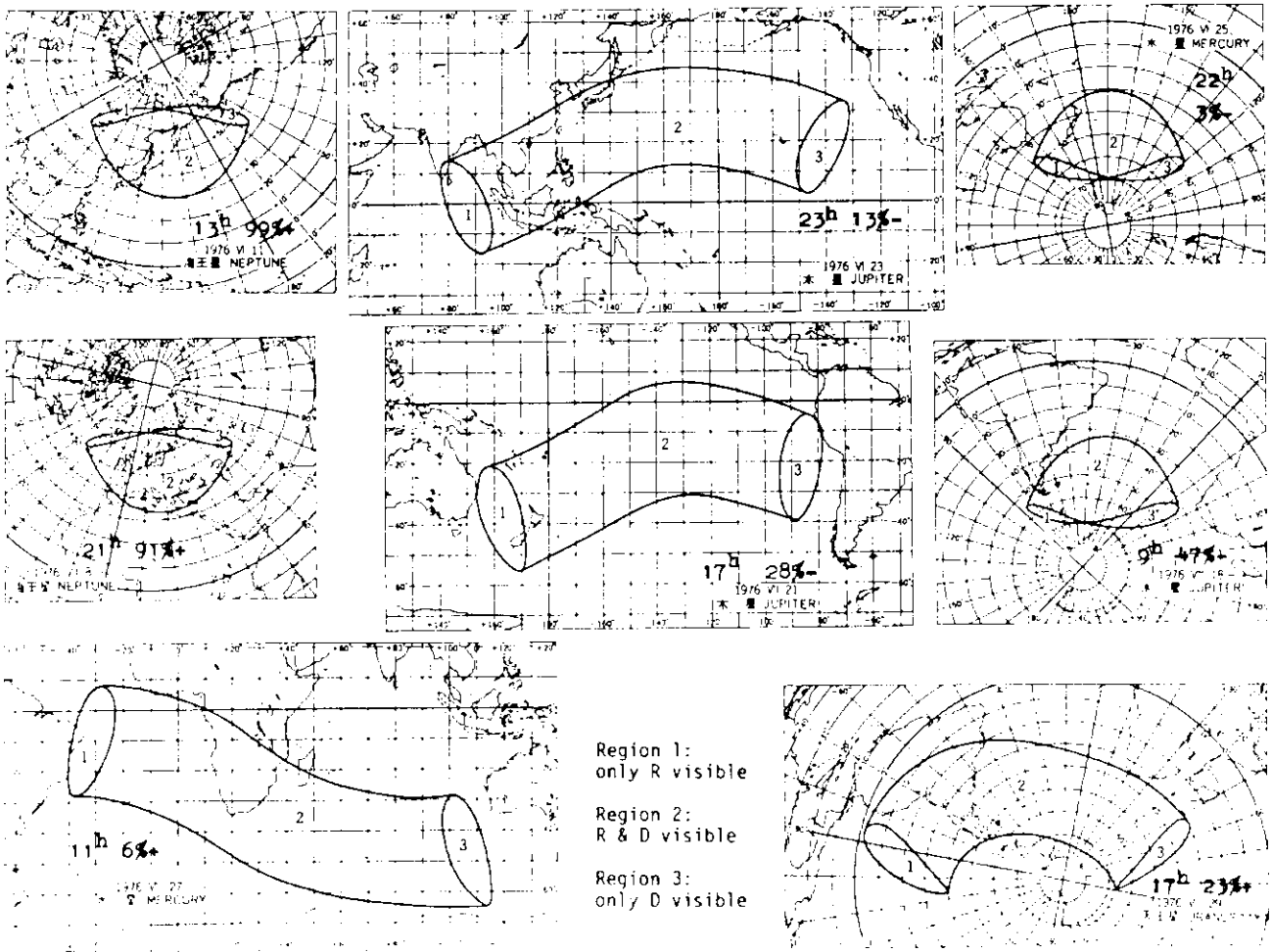
* The magnitude shown is about one magnitude fainter than the visual magnitude.

During occultations of Jupiter, occultations of the Galilean satellites also will be visible at locations where the events occur in a dark sky. Predictions for the occultations of the Galilean satellites have been computed by Frank Fekel, at the University of Texas, using data supplied by K. Aksnes of the Smithsonian Astrophysical Observatory and David Dunham; the detailed predictions are available from David Dunham.

The occultation of June 23rd will be visible before sunrise for most of Indonesia and southeast Asia. Io will be transiting the face of Jupiter at the time of the event.

The occultation of July 21st will be favorably visible from New Zealand, where the reappearances of the satellites, relative to the time of reappearance of Jupiter, are as follows: Callisto, -8^m; Europa, -4^m; Ganymede, $+1^m$; Io, $+4^m$. For estimating the reappearance point, the p.a. of the lunar equator will be 255°; that of the center of the dark limb will be 256°.

The maps showing the regions of visibility of lunar occultations of planets are reprinted by permission from the Japanese Ephemeris for 1976, published by the Maritime Safety Agency of Japan.



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 before.

The last few remaining occultations of β Scorpii are especially important, since as far as I know, none of the earlier occultations in the series has been observed photoelectrically. This important multiple system is discussed in the article by T. C. Van Flandern and P. Espenschied abstracted on pages 54 and 59 of previous issues. Most important will be the 1976 July 8 occultation visible from North America. The observations made in Rhodesia on 1975 October 8 (p. 60 of the last issue) indicate that the B component of β Scorpii (Z.C. 2302 and 2303) is rather faint, perhaps only 8th magnitude. Widespread cloudiness hampered attempts to observe the reappearance of β Scorpii on 1976 February 22, but Harold Povenmire (Florida) and I observed the event through lucky breaks in the clouds. Conditions were not good enough to see the B component.

Frank Fekel, Dept. of Astronomy, Univ. of Texas, Austin, TX 78712, is interested in receiving high-speed photoelectric records of occultations of the triple star β Capricorni (Z.C. 2969). He hopes that observations can be made from two or more observatories during at least one of several favorable occultations of the star which will occur during the next two years. Robert Sandy, Kansas City, MO, notes that the wrong Z.C. number is given in the text (but not in the table) on p. 60 of the last issue. Consulting the original reference (H. L. Alden, Astron. J., 89, p. 333, 1939) shows that the visual orbit was determined from a combination of spectroscopic and photographic data. Alden conceded that the determinations of the orbital parameters based on the photographic data were smaller than their uncertainties and noted that the masses of the stars, their separation, and parallax were not consistent. The observations made at McDonald Observatory last December indicate that 180° should be added to the orbital element ω and that the semi-major axis needs to be tripled to ".019. This is in accord with the masses of the stars and the parallax. The primary and secondary (itself a close spectroscopic binary) are now near their widest separation.

Frank Fekel used two photoelectric observations of occultations of Z.C. 913 observed at McDonald Observatory on 1976 January 15 and March 10 to make a graphical solution for the true position angle and separation, which are given in the table. During the graze of Z.C. 913 (64 Orionis, SAO 95166) on March 10, Harold Povenmire saw the disappearance in distinct steps, but the reappearance was sharp. This is in accord with Fekel's data, which indicates that Povenmire's reappearances for the two components would have been nearly simultaneous. Anomalies were also noticed by members of the Mt. Diablo Astronomical Society who observed the same graze in California. Z.C. 913 is noted as having a composite spectrum in Wilson's 1953 catalog of stellar radial velocities, so the duplicity of the star was known before the occultation. I need a volunteer to go through the notes of Wilson's catalog so that all such spectrum doubles can be identified in the Zodiacal special double star list.

Robert Sandy, Kansas City, MO, observed a quick stepwise fade during a total occultation of Z.C. 915 (SAO 77911 or χ^2 Orionis) on 1975 April 17. This was a few months before M. Reynolds and H. Povenmire noticed the duplicity during a graze (p. 45 of issue #5).

Photoelectric occultation observations by C. de Vegt at Hamburg Observatory in Germany show that the magnitudes of the components of several doubles need to be revised. In the special list, the components of SAO 76131 (Z.C. 537) are mag. 3.9 and 7.0, with separation 0".005 and code changed from J to U; SAO 76140 (Z.C. 539), change code from V to X; SAO 79804, mags. 7.9, 8.8, observed 1970 April 13; SAO 93062 (Z.C. 399), mags. 6.3, 6.8, and 8.3; and SAO 118355, both mags. 4.6, 1969 Dec. 29 (Z.C. 1547). In the Stockbauer visual double list, SAO 76682, Z.C. 701, mags. 7.1, 7.5, 1970 March 13; and SAO 118126, mags. 9.4, 9.8, 1972 April 22, change code from A to M.

Frank Fekel reports that a more careful analysis of the data for two previously-reported doubles discovered at McDonald Observatory shows that the duplicity is so doubtful that the stars should be removed from our list. The stars are SAO 118150 and SAO 164019 observed on 1975 March 25 and October 14, respectively. SAO 138911, in the list below, was also observed during a previous occultation at McDonald which showed no duplicity.

There are several stars in the Stockbauer list whose separations will become negative by 1990, or which have other problems. This is because the separation and position angle were only given for two dates in the Lick Observatory I.D.S. from which the Stockbauer list was compiled. More data for these stars have been provided by Charles Worley at the U. S. Naval Observatory, and Gary Ringler (Cleveland, OH) is going over the information to improve the data in the Stockbauer list so that more reliable position angles and separations at the current epoch can be computed for the stars. Otherwise, little progress has been made with the preparation of a comprehensive file of Zodiacal double star data. Some knowledgeable volunteers are solicited to help complete this task.

NEW ZODIACAL SPECIAL DOUBLE STARS, 1976 MAY 23

SAO/BD	ZC	M	N	MG1	MAG2	SEP	PA	MAG3	SEP3	PA3	DATE, DISCOVERER, NOTES
78417	0994	P	X	6.8	7.7	".003	269°				1970 Sept. 22, C. de Vegt, Hamburg, Germany
78778		P	V	7.7	8.4	0.25	69				1971 Apr. 4, C. de Vegt, Hamburg, Germany
92496		T	V	8.8	9.4	0.06	17				1976 Jan. 10, R. Nolthenius, Hacienda Heights, CA
92748		T	K	9.5	9.5	0.06	56				1976 Feb. 7, H. DaBoll, St. Charles, IL
93778		P	Y	8.0	10.7	.010	31	11.2	5".7	278°	1976 Jan. 13, D. Evans, McDonald Observatory, TX (2nd*; ADS 3010)
94934		G	K	8.7	8.7	0.02	9				1976 Mar. 9, J. Bourgeois, Cendron, Belgium
95166	0913	P	V	5.5	6.7	0.06	77				1976 Jan. 15, D. Evans, McDonald Observatory, TX
109262	0068	P	L	6.2	6.9	.031	233	8.8	.196	233	1975 Nov. 15, J. Africano, McDonald Observatory, TX (ADS 449)
117979	1454	P	K	7.9	7.9	.002	116				1973 Apr. 12, C. de Vegt, Hamburg, Germany
138911		P	K	8.1	10.3	.025	278				1975 July 15,J. Africano, McDonald Observatory, TX
138925		P	K	9.2	11.0	.055	108				1975 July 15, J. Africano, McDonald Observatory, TX
164213		P	K	9.0	9.5	.033	302				1975 Sept. 17, G. Ferland, McDonald Observatory, TX
164231		P	K	9.2	10.4	.016	228				1975 Dec. 8, D. Evans, McDonald Observatory, TX
164935	3262	P	K	7.6	8.2	.004	75				1970 Nov. 7, C. de Vegt, Hamburg, Germany
+19°554A		G	X	8.6	9.2	0.02	347				1975 Nov. 18, L. Pazzi, Nigel, South Africa (A.C. 19332 11)

FROM THE EDITOR AND COMPOSITOR

A compositor, in the narrow sense, is a typesetter; in the broad sense, especially in the context of today's photo-lithographic printing, he is the one who arranges and prepares the final copy for the printer. For *O.N.*, the work includes typing, cutting, pasting, and photography. Unfortunately, it sometimes also must include mechanical drawing.

We realize that we can not set our standards, for literary contributions, as high as those established for professional journals. However, we request that drawings be executed in black ink on white paper, in as professional a style as the contributor can manage. We can reduce drawings photographically, to fit available space, but please be forewarned that especially fine lines are likely to disappear completely, in the printing process, as happened on page 53 (#6).

David Dunham happened to have access to an IBM typewriter, with "Letter Gothic" and "Symbol" type elements, which he used to prepare most of the material he submitted for this issue. As he put it in our standard format,

we were able to use most of it without re-typing, which saved us quite a bit of work. This is neither a plea nor a precept, but if a contributor has access to an IBM typewriter, with a "Letter Gothic" type element, and submits his contribution in our standard format, we are less likely to cut, or otherwise alter, the article. The standard format is a 38-character column, at "elite" (12 characters/inch) spacing, before photographic reduction. In special cases, usually involving articles with large tables, the format may be expanded to a double column (80 characters), or even a triple column (122 characters), but we feel that, at the reduced type size, single columns are more readable, as well as easier to fit into a limited number of pages.

As we often have more than enough material to fill the available space, we tend to shorten an article, when typing it for the first time, to try to avoid a large amount of re-typing when it finally becomes apparent that the material will not fit. Consequently, regardless of the typewriter used, if a contributor were to put his submission into 38-character columns, so that we could have a fore-knowledge of the final number of lines, we would be somewhat less likely to cut his piece.

GRAZES REPORTED TO IOTA

David W. Dunham

I only have three grazing occultation station report forms left. Rather than make more copies of the current form, I plan to design new more compact forms which will minimize duplication and postage costs. They will also be in a format designed for direct keypunching.

A new timing method code, 18 (WATCH/VOICE/RECORDER), is needed for the situation where an observer records his event calls with a tape recorder while an assistant calls off elapsed stopwatch or watch time periodically for a time base. This might be necessary when an observer does not have a short-wave radio at his station. As usual when using a watch, the watch should be calibrated to short-wave or accurate telephone time signals before and after the graze. When possible, it would be preferable to record a preselected AM standard-broadcast station for the time base, with someone else recording both it and short-wave time signals to provide a master tape.

Yale Catalog star position shift calculations for grazes where the position source is Z.C. or G.C. were discussed on p. 68 of the last issue. Robert Bailey, 2320 Bartlett, Houston, TX 77098, can now also do these calculations for observers in the south-central and southwestern United States (E- and 8-Regions), but like Phelps and Campbell, he needs a large lead time for requests, which should be sent soon after receipt of predictions. A self-addressed envelope or postcard should be provided. Thomas Campbell in Temple Terrace, FL, will now do shift calculations for observers in the eastern 1/3 of the United States

Mo	Dy	Star Number	Mag	Snl	CA	Location	# Sta	# Tm	C	Ap cm	Organizer	St	WA	b
1974														
10	21	2759	3.6	36+	9S	Croydon, U. K.	1	6			Norman Wright		169	27
1975														
2	19	0633	5.4	55+	8N	Lübeck, D. B. R.	4	17	9	11	Ingo Reimann			
4	21	Z10338	7.2	79+		Rhadereistedt,DBR	1	0		25	Georg Holsten			
5	19	1605	6.2	66+	8N	Neckarrems,D.B.R.	3	10		15	Klaus Klebert			
6	14	Z09963	7.9	31+	N	Weilerbach,D.B.R.	1	2		15	Jutta Braun			
6	14	Z09963	7.9	31+	N	Stuttgart, D.B.R.	5	13	7	18	Marx			
8	30	Z03649	7.5	48-		Heidelberg,R.S.A.	1	1	7	15	M. Overbeek			
9	9	2079	7.8	21+	10S	Villiers, R.S.A.	3	7	7	8	Jan Hers		170	14
9	30	1197	6.0	32-		Frutigen, Switz.	1	2		7	Robert Germann			
10	1	Z08986	7.8	23-		Köln, D. B. R.	3	4	8	7	Wehmeyer			
11	1	1726	6.9	10-		Ohmi, Japan	7	30		11	Yasuo Yabu			
11	9	2975	7.0	40+		[illegible], Rhod.	8	45	9	6	Arthur Morrisby			
11	9	Z21744	8.0	41+		[illegible] Rhodesia	7	34	9	6	Arthur Morrisby			
11	18	E04010	8.2	18E	58U	Johannesburg, RSA	8	18	7	15	Jan Hers			
11	18	E04011	8.1	18E	58U	Johannesburg, RSA	1	4	7	25	J. Van Zyl			
11	18	E04011	8.1	18E	58U	Nigel, R.S.Africa	1	4		10	Luciano Pazzi			
11	28	Z11945	7.8	24-		Goulburn, Austrl.	3	11	9	32	David Herald			
11	29	1925	1.2	15-		Goulburn,Austrl.	21	121	9	10	David Herald			
12	8	Z22777	8.7	26+	7S	Klondyke, AZ	1	10	4	15	R. Nolthenius	C22	N167	-65
12	27	1925	1.2	34-	2S	Rayton,R.S.Africa	2	2	1	5	Jan Hers			
1976														
1	6	3290	7.3	19+	2S	Ira, TX	1	0			Mickey Schmidt			
1	22	1809	6.9	67-	4S	Nortonville, KS	2	2	3	6	Rick Binzel			
1	22	1809	6.9	67-	4S	Kansas City, MO	2	5	3	15	Robert Sandy	2N	185	46
1	23	1900	7.2	60-	7S	Randburg, R.S.A.	4	12	7	8	Jan Hers			
1	23	1925	1.2	58-	0N	Deerfield Bch.,FL	2	2		15	Joe Huertas			
1	24	2118	2.9	41-	-	Canberra, Austrl.	3	17	8	15	David Herald			
1	25	Z14789	8.8	32-	-3N	Tucson, AZ	1	3	4	15	Richard Nolthenius			
1	27	2509	6.0	15-	1S	Monee, IL	1	2	7	20	John Phelps	C	182	-29
1	28	2666	5.0	8-	S	League City, TX	12	51	8	6	Paul Maley	C		
2	3	3370	6.2	7+	-2S	Crockett, CA	1	0		20	Ray Bryant	N		
2	5	0145	6.7	27+		Waterloo, Belgium	4	12			Roger Laureys			
2	8	Z02368	8.3	47+	9N	Hartland, IL	4	21	4	25	Homer DaBoll	0	11	1
2	9	0628	4.8	63+	12N	Hammanskraal, RSA	5	19	9	8	Jan Hers			
2	10	0691	6.6	67+	12N	Sykesville, MD	3	5	8	20	Walter Nissen, Jr.	8N	13	29
2	20	2031	8.7	72-		Barrington, IL	1	1	1	25	Berton Stevens, Jr.			
2	21	2233	5.5	56-	2S	Lucena C.,Philip.	1	1		8	Cesario Taganas			
2	25	2773	6.1	19-		Clinton, MS	4	5	5	11	Ben Hudgens			
3	5	0299	6.3	17+		Kohriyama C.,Japan	3	14	7	5	Yasuo Moriya		10	-10
3	6	Z02564	8.2	27+		Gerpinnes,Belgium	3	12		25	Jean Bourgeois			
3	7	0482	7.8	29+	4N	Hinckley, MN	1	6	5	15	L. Nelson	1N	6	12
3	7	0495	8.3	30+	10N	Rock Creek, KS	1	2	8	15	Rick Binzel	10N	13	14
3	7	0495	8.3	30+	10N	Kansas City, MO	4	10	8	15	Robert Sandy	10N	13	14
3	7	0495	8.3	30+	11N	Belle, MO	1	2	9	20	Joseph Senne	10N	13	14
3	9	0769	6.6	49+	11N	Beachwood, MO	1	4	4	15	Gary Ringler		13	41
3	9	0769	6.6	49+	12N	Earleville, MD	3	2	2	8	James Kauer		14	41
3	9	Z05014	7.1	57+	N	Cendron, Belgium	2	6		14	Jean Bourgeois			
3	10	0913	5.2	59+	6N	Walnut Creek, CA	3	15		15	Ray Bryant		6	51
3	10	0913	5.2	59+	14N	Miami, FL	2	6		15	Harold Pvenmire		14	51
3	12	1332	5.7	88+	15N	Campbellsburg, KY	1	1	3	25	David Dunham		9	73
3	21	2425	5.9	64-	0N	Scott, AR	1	1	7	20	Homer DaBoll	1S	358	-26
3	22	2556	7.1	56-	4S	Salem, IL	1	2	6	25	Berton Stevens, Jr.	0	182	-39
3	23	2724	6.6	43-		Raymond, MS	2	3	4	11	Ben Hudgens	0		
3	25	2969	3.2	26-		Las Cabezas,Spain	4	18		7	Luis Quijano			
4	5	0736	6.2	24+	9N	Dallas, WI	3	17	9	10	James Fox	3N	12	41
4	5	0736	6.2	24+	9N	Plymouth, WI	4	7	7	20	Homer DaBoll	3N	12	41
4	6	Z04746	8.9	32+	10N	La Fox, IL	1	2	7	20	Homer DaBoll	1S	12	50
4	9	1359	5.1	71+	N	L.Chollets,France	10	20			Willy Verhaegen			
4	10	1397	5.5	75+	8N	Leisure City, FL	3	18		15	Harold Povenmire			
4	22	3093	4.5	38-	5N	Rolla, MO	5	38	9	10	Joseph Senne	3N	357	-61
4	22	3093	4.5	38-	5N	New Athens, IL	3	15	8	20	Homer DaBoll	2N	356	-61
5	3	0830	8.1	12+	6N	Bucyrus, KS	4	17	7	25	Robert Sandy	4N		49
5	3	Z05622	7.5	18+	N	El Coronil, Spain	3	8		10	Luis Quijano			
5	4	Z06255	8.3	21+	N	Canberra, Austrl.	4	7	3	6	David Herald			
5	5	Z07282	8.3	29+	5N	Atchison, KS	2	3	5	15	Rick Binzel			
5	10	1703	7.7	81+	9N	Oxford, KY	3	2	6	20	David Dunham	1S	5	55

(A- and D-Regions). I will continue to provide AGK3 shift information. Observers should use these shifts with care, especially when the shadow shifts north for a northern-limit graze or south for a southern-limit. We have found that the Z.C. sometimes (especially for stars brighter than mag. 7.0) has the true position, after all, and the truth often lies halfway between Yale and the Z.C. The G.C. positions are virtually always worse than Yale.

We are rather confident in the Z.C. position for 4.0-mag. ρ Sagittarii (Z.C. 2826), a spectacular graze of which will be visible from the central United States in late November. Gordon Taylor analyzed the data for many previous occultations of the star at HMNAO and found that the star was within 0".2 of its Z.C. place.

EQ4010 and EQ4011 refer to two non-SAO stars whose grazes were observed during the Lunar eclipse of 1975 November 18. They are the two components of BD +19° 554, with Astrographic Catalog designations (as used on p. 50 of issue #6) of 19332 10E and 19332 11D, respectively. L. Pazzi's observations indicate that 19332 11D may itself be a close double.

On 1976 January 28, Paul Maley led a large expedition from Houston, TX, to observe their second graze of ZC 2666 (21 Sagittarii). This was in the southern Cassini region, and data has been sent to the computors so that the results will be included in future predicted ACLPPP profiles. It is remarkable that so many observers turned out for the event on a weekday morning when most observers had to drive directly to work from the graze site, which fortunately was near most of their homes.

The expedition for the graze of Spica (Z.C. 1925) in Australia last November was the 3rd most successful of 1975 and now ranks 12th overall. A graze of another star was observed from some of the same stations the previous night. One observer followed the graze of Spica without optical aid. Grazes of the star were also observed the next two months, in South Africa in December (where clouds interfered considerably) and in Florida in January, where good timings of the reappearance were made in spite of a star altitude of only 1°.5.

Half the observers saw a miss during the graze of Z.C. 1703 on May 10, indicating that the empirical corrections applied by ACLPPP for northern-limit grazes were in error. The Z.C. position of the star now agrees with the Yale Catalog position to within 0".2. Previous observations were scanty in that area of the Moon, but some of them also indicated problems. Examination of Watts' charts apparently resolved the problem. These showed an anomalously low area between W.A. 354° and 2° for latitude librations (b) greater than +2°.5, in the northern Cassini region. Some observations there showed that the true Lunar limb was near, or even slightly above, the mean limb rather than far below it, so we had shifted all profiles 1".0 north for b greater than 4°.99 and W.A. 353° to 7°. I did not realize until May 10 that the area which needed to be corrected was not symmetric about W.A. 0°, so profiles for grazes with W.A. between 2° and 7° were being shifted too far north. A notice (Grazing Occultation Computor Bulletin #21) correcting this was sent to the computors within a week, and hopefully will be applied in time for most of the profiles for the 2nd half of 1976. Computors should note an error in GOCB #21; the corrected statements are in subroutine LOADLC, not MATCH. The shift listed for the Z.C. 1703 graze is based on the new corrections; the shift based on the old profile which we used was 0".7 south.

Sometimes, graze failures are as important as successes, in order to establish limits as to what can be observed. On 1976 February 14, I tried to observe a graze of 8.0-mag. Z08433 at a cusp angle of 21°N with the Moon 97% sunlit waxing. Skies were clear and the seeing rather good, but I never saw the star with my 25-cm reflector. Glare would probably be reduced so that such a graze might be seen by an experienced observer in a dry desert area. Half an hour after the graze, it clouded up, indicating the presence of glare-producing moisture in the air.

The observations of the graze of Z.C. 633 (53 Tauri) on 1975 February 19 were published in the German periodical Sterne und Weltraum. A month later, another graze of the same star was the 2nd most successfully observed of 1975. The graze of Z.C. 1809 on 1976 January 22 is the fifth graze which Robert Sandy has observed from his back yard during the past decade.

SOME COMMENTS ON READING-OUT GRAZE TAPES

Robert R. Bailey

For graze observations in the Houston area, each station is equipped with a WWV receiver, a cassette tape recorder, and a Halloween "cricket". WWV is recorded continuously during the observing session. When an event is observed, the observer quickly presses and releases the cricket, making a distinct "click-it" sound on the tape. He then verbally describes the event, "in", "out", "blink", "flash", etc. The double click is useful in discriminating against the random sharp noises which are always present. After the graze is over, the tapes are turned-in to the leaders, who read-out the tapes.

Here is my favorite method for reading-out graze tapes. I play the cassette, and rerecord it on an open reel tape recorder running at 7½ ips (note that there need be no exact relationship between the speeds of the two recorders). I locate the events to the second by counting the seconds ticks, while listening to the tape. In order to locate the cricket signals to about 0°.1, I set the open reel recorder in "Pause" near the event. I can manually rotate the reels to slide the tape back and forth over the playback head. In this way, I can find the linear location of the event marker, and of the WWV tick on each side of it. Near the beginning of a tape running at 7½ ips, one second corresponds to about one revolution of the takeup reel.

I have found that sharp ticks can be located, relative to each other, to an accuracy of a very few millimeters. For 7½ ips this corresponds to roughly 0°.005/millimeter. By marking the tape with a very soft pencil, at an arbitrary reference point, such as a guide post, and measuring the separations between pencil marks with a ruler, event marker times may be determined to a few hundredths of a second. Of course, this is much more precise than uncertainties in the reaction time at the original recording.

Occasionally, an observer is unable to receive WWV because of propagation effects or RFI. One really ought to be equipped to receive WWV at both 5 and 10 MHz (and preferably 2.5 MHz too) as oftentimes one frequency will not provide good reception at the place and time of the graze. But all is not necessarily lost if one cannot pick up WWV. The unfortunate observer can still get good timings by going to a neighboring station to borrow some signals, several minutes before the graze. He records enough WWV to catch at least three time announcements, leaves his recorder running, returns to his station, and records the graze as usual, except for the WWV. Immediately after the graze, with the recorder still running, he returns to the neighboring station to record at least a few minutes more of WWV. When the tape is read-out later, the leader measures the time announcements before and after the graze in a single run. He then computes a least squares best linear fit of the time announcements. Residuals will give an indication of the uniformity of the recording; this is why several minutes of WWV should be recorded. With reasonably good cassette recorders, the residuals will be remarkably small (about 0°.1 or 0°.2) for so many minutes of total recording time. Then the times of the graze events may be measured with a stopwatch from the beginning of the tape, and the results used in the least squares equation derived from the time announcements to determine the actual times of the graze events. For this process, I find my HP55 calculator ideal, both for measuring the times on playback, and in computing the least squares fit. The general formula is

$$y = ax + b$$

where x is the measured time at playback, y is the true time (the time of WWV announcements when calculating a and b, and the true time of occurrence of the events when calculating the event times after finding a and b), a is the ratio of the rate of playback to the rate of record speeds, and b is a constant which is nearly zero if times are measured from the first WWV announcement on the tape.

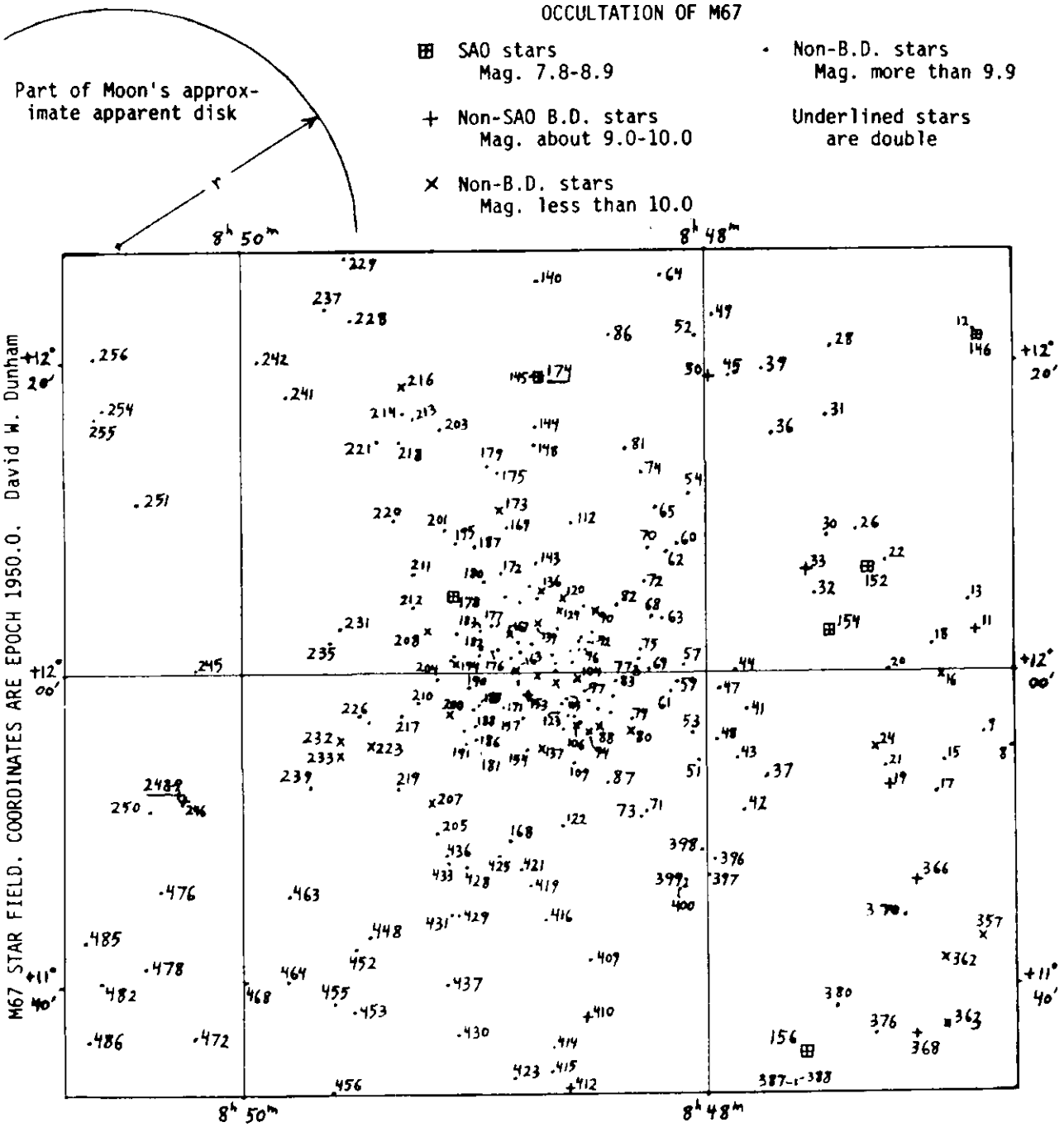
OCCULTATIONS OF GALACTIC-NEBULAR OBJECTS

David W. Dunham

A list of deep-sky Zodiacal objects compiled by Richard Nolthenius was described on p. 70 of the last issue. These "Galactic-Nebular" (GN) objects have been assigned USNO reference numbers prefixed with G and will be included, along with planets, in the USNO total occultation predictions for 1977. For the rest of 1976, Thomas Van Flandern has supplied me with predictions for selected stations, from which the table below was prepared. The article in the last issue includes a list of occultations of M67 through June. In July and August, it will be too close to the Sun. Occultations of these objects can also not be observed when the Moon is highly gibbous. The series of occultations of M67 will last through the end of 1977. The cluster is so far south of the ecliptic that occultations of it are visible only from the Northern Hemisphere; during much of 1977, the occultations will be visible only from the Arctic.

M24 is an even richer cluster which is now being occulted. It is a very compact cluster composed of about 50 9th-magnitude stars. SAO 161294, an 8.0-mag. star at 1950 R.A. 18^h15^m5, Decl. $-18^\circ27'$, is on the southern edge of M24 2 1/2' south of its center; it can be used as a guide in your current USNO predictions. The occultations of M24 began this year and will last into 1980. Besides the clusters listed in the table below, the following other GN objects are now being occulted, but none of them favorably occulted as seen from areas with many observers: M23 (open cluster, mag. 6.9, diameter 25'); M72 (globular cluster, 9.8, 2'); M73 (open cluster, 9.0, 5'); and NGC 7009 (planetary nebula, Saturn Nebula, 8.4, 0!7).

If the occultations of many stars in an open cluster are accurately timed by several observers, the data can be used for studies of Watts' limb correction data, as occultations of the



Pleiades and total Lunar eclipses are used. Historically, occultation observations have been concentrated at Pleiades passages, which biases analyses for Lunar orbital parameters and provides limb correction information for only a limited range of librations. For this reason, numerous observations during passages across other open clusters in different parts of the Zodiac would be valuable and would sample different parts of the range of librations. Therefore, I have distributed detailed predictions of occultations of numerous faint non-SAO stars to IOTA members well-situated to observe the M67 passage of June 3. Measurements of the positions of the stars were taken from the Bordeaux Astrographic Catalog and keypunched by Robert Walker (Sayre, OK). I converted the measurements to R.A. and Decl. using Paul Herget's plate constants in Cincinnati Observatory Publication 24. The predictions were computed by Frank Fekel using my total occultation prediction program at the University of Texas. The stars are identified with SAO, BD, and A.C. numbers, in that order of preference. An A.C. number such as 12848 464 means that the star is no. 464 on the Bordeaux A.C. plate whose approximate center (Epoch 1900) is R.A. 8^h 48^m, Decl. $+12^o$. The magnitudes are photographic, as measured from the A.C. plate, and therefore accentuate the blue stars. Consequently, some observers may be able to see some occultations of red stars which are not predicted. A fictitious 30th-mag. "star" called M67 CENTER has been included in the predictions, located at 1950 R.A. 8^h 48^m3, Decl. $+12^o$ 0', but the densest part of the cluster seems to be occulted about 12 minutes later. Letters (A, B, or C) indicating the components of double stars are inserted between the A.C. plate identification and number, between the B.D. zone and number, or after the SAO number. An M indicates that the mean position for a very close pair has been used. The June 3 occultation of M67 will be visible from the Caribbean, eastern Mexico, and the southeastern United States. Observers in the Midwest and Mid-Atlantic states will be able to observe occultations of the southern members of the cluster and have therefore also been sent predictions. The support of the NSF photoelectric occultation grant at the University of Texas for the considerable amount of computer time used is gratefully acknowledged

Please send me reports of any observations of the occultations of M67, in order to assess their value, and the usefulness of the predictions. For this type of observation, the largest aperture telescope available should be used. If this is larger than the largest one listed on the information form which you returned to me or to IOTA, let me know, since it will probably be necessary to limit predictions for future passages to those with access to larger telescopes who can see the most events. An effort like the one for the June 3 passage will not be possible again at the University of Texas, so another possible source for such predictions is being sought. It would also be useful to be able to predict occultations of the individual members of M24, and a volunteer is sought to set this up, as I have done for M67. I will show anyone interested what has to be done.

The letters A and B between the A.C. plate identification (12848) and number (non-BD stars only) do not indicate duplicity, but instead indicate elongated and poorly-defined images on the plate, respectively. SAO 98174C is not in the SAO catalog, but is a relatively distant companion of SAO 98174M, itself a close double. The letter Q indicates possible duplicity. The chart of M67 is based on computer plots produced at the University of Texas by Frank Fekel using data supplied by me. A.C. plate 12848 numbers are given for non-SAO stars. For each SAO star, the SAO number -98000 is given. Some faint stars in crowded areas are not plotted, and the numbers are not given for some. Use your predictions, comparing times and P.A.'s for nearby events, to identify unnumbered stars on the chart. If you time an occultation of an unnumbered star on the chart which is not in your predictions, tell me the star's location with respect to nearby identified stars on the chart, and I will send you its number.

OCCULTATIONS OF OPEN CLUSTERS

M67 (mag. 6.1, diameter 15')

1976 Date	Approx. U.T.	% Snl	Nighttime area of visibility
Sep 20	9^h	15-	e. 1/3 USA &Canada
Oct 17	8	36-	n.e. Asia, Japan
Nov 14	1-3	59-	U.K., Europe

M24 (mag. 4.6, diameter 4')

Sep 2	22-24	70+	S.America,sw Africa
Sep 30	6	48+	s.e. Pacific Ocean
Oct 27	14	26+	west Australia
Nov 24	1	8+	west South America

M25 (mag. 6.5, diameter 40')

Sep 30	10-11	50+	east Asia, Japan
Oct 27	17-18	27+	UK, west Europe

DOUBLE STARS

Star	Double Designation	Mags Pri.	Sec.	Sep.	PA
12848A &M	BRT 1257	11.5	11.5	3.6	39°
SAO 98174M	ADS 7049	7.9	10.2	2.0	88
SAO 98174C	-AC		11.8	14.1	98
BD+12°1932	ADS 7063	9.8	10.5	6.6	324
BD+12C1932	-BC		10.7	22.5	215
BD+11°1930	ADS 7052	10.4	11.9	3.6	348

Non-SAO B.D. Cross Reference List

A.C.# 12848	B.D. No.	A.C.# 12848	B.D. No.
4	+12° 1912	343	+11° 1918
11	+12 1913	364	+11 1919
14	+12 1915	366	+12 1916
19	+12 1917	368	+11 1920
27	+13 1997	369	+11 1921
33	+12 1920	390	+11 1925
34	+12 Q1921	410	+11 1926
50	+12 1922	412	+11 1927
56	+12 B1923	426	+11 1928
58	+12 A1923	432	+11 1929
78	+13 2001	443	+11 B1930
114	+12 1924	444	+11 A1930
145	SAO 98174C	454	+11 1933
153	+12 1926	469	+11 1935
215	+12 1928		
222	+12 A1929		
224	+12 B1929		
227	+13 2005		
232	+12 A1930		
233	+12 B1930		
246	+12 C1932		
247	+12 1931		
248	+12 B1932		
249	+12 A1932		
258	+12 1933		
264	+12 1934		

The stars in the left column are on the northern half of the A.C. plate. The stars in the right column are on the southern half of the plate.

MORE PUBLISHED PAPERS ABOUT OCCULTATIONS

David W. Dunham

T. G. Barnes and D. S. Evans, "Stellar Angular Diameters and Visual Surface Brightness--I. Late Spectral Types", *Mon. Not. R. Astr. Soc., 174*, 489-502 (March 1976). This important paper, making extensive use of stellar angular diameters determined from high-speed photoelectric lunar occultation records, gives details for the *Bull. Am. Astron. Soc.* abstract by the same authors described on p. 59 of the last issue. The graphs make it clear that the V-R relationship is best. The star with the largest angular diameter is R Leonis, 0".076 if limb darkening is taken into account. The V-R relationship is successfully applied to the Mira variable R Trianguli.

R. L. Duncombe and P. C. Van Flandern, "Secular Variation of the Obliquity of the Ecliptic", *Astron. J. 81*, 281-284 (April 1976) Observational determinations of the secular variation of the obliquity of the ecliptic are summarized. Solar and planetary results show a discordance between observation and theory amounting to -0".3/century, but the lunar occultation results agree with the theoretical variation. It is shown that incomplete reduction of Sun, Mercury, and Venus meridian circle observations to the fundamental stellar reference system may be the cause of the apparent observed correction to the secular variation from those data. Use of lunar occultation data has the advantage that it completely eliminates the need for systematic catalog corrections. Since only the times of events are recorded, the observations can all be rereduced with modern star positions, improved lunar ephemerides, and limb corrections; the results are unaffected by whatever reference system was in use at the time of the event.

D. W. Dunham, D. S. Evans, E. C. Sil-

verberg, and J. R. Wiant, "The Angular Diameter of TX Piscium", *Mon. Not. R. Astr. Soc. 173*, 61P-62P (1975). This occultation was successfully observed with the 107-inch telescope at McDonald Observatory with the sun altitude +1°. The angular diameter was found to be 10.2 ± 2.5 arc ms; combining with other observations gives 9.8 ± 0.5.

J. L. Elliot, J. Veverka, and J. Goguen, "Lunar Occultation of Saturn. I. The Diameters of Tethys, Dione, Rhea, Titan, and Iapetus", *Icarus 26*,387-407 (1975). This paper gives the same results, but with more details, as the *Sky and Telescope* article "Measuring the Sizes of Saturn's Satellites" mentioned on p. 59 of the last issue.

J. Engelbrecht, "1000 Volt Supply for Portable Photoelectric Photometer, Parts I and II", *Sidereal Times* (1975 Sept. and Oct.). This is the publication of the Austin (Texas) Astronomical Society. Part I gives a description and specifications for the equipment, with detailed circuit diagrams. Part II gives a description of operation and a detailed parts list.

S. L. Howe, Editor, "Outages and Phase Perturbations over 5 Minutes", *NBS Time and Frequency Services Bull. No. 221*, 5 (1976 April). According to this monthly publication of the National Bureau of Standards, WWV was not broadcasting for over two hours on all frequencies starting on 1976 March 7 at 16:28 U.T. At 2.5, 20, and 25 MHz, the outage lasted for nearly a day. Future major outages of time signals will be noted in *O.N.*, and may explain why you couldn't receive time signals for a particular event.

F. Link, "Spikes of Light During the Stellar Occultation by Planets", *Astron. & Astrophys. 48*, 263-268 (April 1976). In French. A photometrical theory of spikes is presented. The results, based on purely mathematical models, present some difficulties in application to the Jovian atmosphere, since they require relatively strong perturbation of the planetary atmosphere.

T. C. Van Flandern, "Is Gravity Getting Weaker?", *Scientific American 234*, 44-52 (1976 Feb.). This is a valuable discussion of the physical consequences of a decreasing gravitational constant, an interesting account of perhaps the most significant result from analyses of occultation observations. There are two minor errors. In the diagram on p. 48 showing a high-speed photoelectric occultation record, the first fringe rises to 1.37 times the unocculted brightness, not 1.5, and the toe of the curve does not end abruptly, but is proportional to $1/t^2$, where t is time measured from the point of geometric occultation. In the next diagram, showing a graze profile, the statement, "If observers are stationed 100 feet apart on earth, their observations can establish position of moon to an accuracy of .02 second of arc", is misleading. In general, observers should be spaced farther apart, preferably over a range of a mile or more. Then this accuracy can be achieved by fitting the observed contacts to Watts' predicted profile.

L. H. Wasserman, J. L. Elliot, and J. Veverka, "Galilean Satellites: Observations of Mutual Occultations and Eclipses in 1973", *Icarus 27*, 91-107 (1976). Photoelectric observations of seven mutual events recorded at three wavelengths with a 0.1 sec. time resolution are discussed. Model light curves and analyses show that, before color information about albedo distributions and limb darkening on the satellites can be obtained, values of the satellite radii and impact parameters must be accutately determined using all mutual-event data obtained in 1973-4.

THE LACOMBE GRAZE

[Ed: Extracted from reports in the RASC Calgary Centre's *The Star Seeker*, reporter, F. John Howell, and the RASC Edmonton Centre's *Stardust*, reporter, Franklin Loehde]

THE GRAZE FOR THE BRAVE, F. J. H.

..invite[d] the Edmonton Centre grazers to join the Calgary enthusiasts for fairly easy challenge of observing 5.5 mag. ZC2217 graze the south cusp of a 32% illuminated waning moon on January 25th...5:30 on a Sunday morn, or if you prefer, a very late Saturday night!

A computer generated profile...showed a very high peak and a smaller one... the mountain was a fair sized imitation of our local variety west o'Calgary.

The Edmonton lads and two lasses arrived in one vehicle - yup - all eight of 'em! It was Franklin Loehde's rambling home - a Cabana motor home. Paul Dean emerged carrying a...baby video camera! Our northern friends were going to record the graze on video tape for an instant replay!...exciting day in Canadian astronomy.

...Tuning in CKRD from nearby Red Deer, we were cheerfully informed that "under clear skies, with an eight mile an hour breeze from the west, it is minus 23° Celsius".

...A trip down the road to see how the Edmonton observers were progressing with their TV project revealed the worst...Murphy had struck! The video camera needed 110 volt power, which was why Franklin supplied his motor home. It has a gasoline powered generator, but the starter cord had broken with the first pull...so - no power - no video taping. The cold...signs of frostbite...shortwave radios useless - no WWV or CHU. Getting out of the car at 5:30 after the last warm up - or rather, "defrosting" and having tried all wave bands from 2.5 MHz up for the time signal, the radio antenna caught the top of the car door frame and a fair-sized jolt of static electricity arced and the radio gave an anguished squawk and went dumb.

...perfect disappearance... Using my wrist watch I time it very roughly... It must be reappearing soon - yes - there it is - digital watch shows 5:41 - press the button - 23 seconds - occultation lasted almost two minutes... Jump into the car to warm up and go see Franklin, Paul and company. They had observed multiple events - but no time signal, probably due to the aurora...trying the radio again, and suddenly WWV comes in. Get the tape recorder, he shouts. I checked my watch - it is 12 seconds fast, so I have a rough time for the reappearance.

...time signal problem is the biggest unsolved factor. One solution seems feasible...using the new electronic watch as a timekeeper, if it is as accurate as advertised would give a time source independent of the radio signal.

...Did the static electricity discharge at the receiver antenna "blow" the shortwave transistors?...verdict was definitely a blown transistor ($2.75) and the static was 90% probably the cause - 10% chance the transistor "gave up" naturally.

THE GREAT GRAZE OF JANUARY 25, F. L.

...brave contingent of amateur stargazers ventured forth from Edmonton that wintry morning with the snow flying about....Somehow in the storm which prevailed in the city, we lost Neil Rowlands and his father -- they haven't been reported since! Loaded down with enthusiasm, cameras, tape recorders, telescopes, short-wave radio, the planetarium V.T.R. equipment, extension cords, hot chocolate...rendezvous with the group from Calgary at the thriving metropolis of Lacombe, Alberta, Canada. John Howell and his group immediately segregated themselves...a mile north of the Edmonton base camp.

Fortunate...in not being spotted by the R.C.M.P. or the Emergency Measures Organization because...electronic gadgetry...protected by the cannon-like devices would certainly have caused the immediate mobilization of N.O.R.A.D. defenses...

Poor seeing conditions made it impossible to time when the star disappeared...reappearance...11 H. Librae disappeared behind another invisible mountain peak and flashed into view about 1/5 second before disappearing.. .final reappearance...was...dramatic.

...The tape recorder slowly ground to a halt...and the electrical generator start-cord broke in two different places preventing the T.V. camera-telescope system from being used...

SAO ERRORS AND OCCULTATIONS OF NON-SAO STARS

David W. Dunham

On 1975 Dec. 25, Bill Fisher (Colfax, CA) observed SAO 138528 (ZI1557) to reappear six seconds earlier than pre-

dicted. No other accurate position is available for this southern-hemisphere star. On 1976 March 4, Willy Verhaegen (Wetteren, Belgium) observed the disappearance of a non-SAO star which he estimated to be mag. 7.5. From the information given, the star was found to be BD +10° 203, with m_{pg} 8.5 according to the AGK2. Predictions for this star, and similar ones, will be available after the zodiacal parts of the SAO and AGK3 are combined at U.S.N.O. The disappearance of SAO 93842 (Z03535) observed by James Van Nuland at San Jose, CA on 1976 March 8 was 24 seconds late, three times the estimated accuracy. According to the AGK2, the right ascension is 5" greater than that given by the SAO. The observation indicates that the AGK2 is right. During 1976 March 10, Robert Walker Sayre, OK) observed 4 occultations of faint unpredicted stars, 3 of which are not even in the B.D.; he used a 14-inch Celestron. He has keypunched some data for this part of the sky from the Astrographic Catalog, and calculations are now in progress to identify the stars.

Bryan Siebuhr (Titusville, FL) has keypunched the list of non-SAO stars found by John Phelps, Jr., described on p. 58. Six of the brightest stars happened to be in the Z.C.

THE DANISH TIME-CUBE

N. P. Wieth-Knudsen

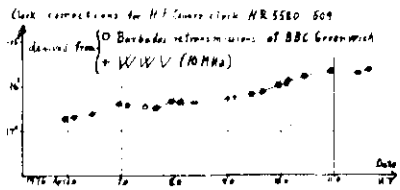
I am accustomed to work in my observatory by the eye-and-ear method with the beats of my pendulum observational clock, which are picked up by a microphone placed near the escapement, amplified, and made audible by a loud speaker mounted at the inner wall of the observatory. Thus equipped, it is not necessary to receive radio time signals continuously, but those received occasionally are referred to the same beats.

For my Barbados expedition for the occultation of ε Geminorum by Mars, I was worried about receiving time signals, so decided to augment my portable equipment with a Philips H. F. Quartz-electronic clock, type HR 5580, which was available here, in Denmark, for only 250 Danish Kr. (about forty U.S. dollars). Its second hand is actuated by a stepping motor, giving a faint beat when advancing the hand each second. In Copenhagen, I had an electronic shop make make me a small amplifier, with a microphone fastened to the almost cubic box of the clock, giving the amplified signal to a pair of headphones, which I can use at distances as great as 20 meters from the clock, with a suitable extension cord. The headphones exclude foreign sounds, e.g., the waves of the Caribbean! For such remote use, I synchronise a stopwatch with the clock, so I can defer counting the numbers of the seconds until just before the event. Even so, I prefer to count off the seconds loudly, while my wife watches the clock, as a further check.

The cost of the amplifying system, with microphone and headphones, was about 550 Danish Kr., equivalent to some 90 U.S. dollars. The entire system, costing about $130, has worked very well, and indeed, I was very happy to have it, as I didn't catch the WWV (10 MHz) signals until an hour after the Martian event, until then being compelled to be content with the Barbados retransmissions of the "six pips" of the Greenwich BBC time signal. In fact, these were quite satisfactory, as can be seen from the interpolation curve of the Quartz-clock during my stay at Barbados. Calibration of the clock to the radio time signals was accomplished with the headphones displaced a little, and the amplification adjusted to a convenient level.

The clock rate varies with temperature. In Copenhagen, the rate of its correction was about -0$4/day, but the tropical temperatures at Barbados make the rate slightly positive.

I am indebted to Dr. P Darnell, the leader of the section for occultations of our Danish "Astronomisk Selskab" (Astronomical Society) for having brought to my attention the possibility of acquiring such Quartz-crystal clocks at reasonable costs.



PLANETARY OCCULTATIONS, David W. Dunham

In the list below, the occultations by minor planet (1580) Betulia were predicted by Derek Wallentine, Albuquerque, NM, and the occultations by other Solar System objects were predicted by Gordon Taylor, HMNAO:

Date	U.T.	Object	SAO No.	Mag.	Epoch 1950.0 R.A.	Dec.	Possible nighttime area of visibility
May 23	04^h07^m	Betulia	159446	9.0	$15^h39^m.3$	$-10^\circ59'$	s.e. Brazil, Argentina
May 23	04 05	Betulia	159447	9.2	15 39.3	-10 59	n.w. of above path
May 24	17 24	Betulia	183363	9.2	15 15.9	-20 21	New Zealand,s.e.Australia
Jun 16	21 33	Iapetus	80046	8.0			east Brazil, Argentina
Jul 17	08 53	Vesta	94517	8.4	5 21.0	+19 57	Caribbean
Jul 25	21 32	Vesta	77347	9.1	5 35.7	+20 14	west Australia
Jul 29	17 06	Pallas	132592	8.5	5 49.0	-2 56	Aleutian Islands
Aug 9	23 18	Pallas	132996	9.0	6 11.5	-3 57	Arabia, India
Oct 10	13 00	Pallas	153844	8.9	8 4.2	-13 31	west North America
Nov 3	16 05	Ceres	99608	9.0	11 24.1	+12 59	Alaska
Nov 15	15 31	Neptune	184653	8.7	16 45.2	-20 52	east Indian Ocean
Nov 25	13 05	Venus	187562	6.4			Antarctic

Possible occultations of SAO stars by Betulia during its current flyby are discussed in Sky and Telescope, April, 1976, p. 290. Mr. Wallentine used ephemeris data supplied by Dr. Brian Marsden to compute predictions for 11 possible events. Only the last three are listed, but unfortunately you are probably reading this after even they have occurred. Since the actual occultation paths are only 3 or 4 km wide, the chances that a given observer would see an occultation are very small. Even if an occultation occurred, chances are good that an observer would mistake it for a seeing variation, since the duration would be only about 0$1. An occultation of SAO 66473 was predicted to occur in the United States on May 10 at 10^h22^m. Early data indicated the path would cross Pennsylvania and Arkansas, but a calculation by Gordon Taylor had it crossing Georgia and passing south of New Orleans.

Although it occurs in twilight, the occultation by Saturn's satellite Iapetus should be a more observable event, lasting up to 2 minutes. At the time, both Titan and Iapetus will be in p.a. 258°, separated by 2!8 and 5!1 from the center of Saturn, respectively. The major axis of the outer edge of Saturn's ring will be 0!63. If the diameter can be well-determined from accurate timings by at least two observers, the observations of the Lunar occultation of this strange satellite recorded by Cornell scientists at Mauna Kea in March, 1974, can be used to determine the limb darkening. I have heard that an occultation of SAO 79100 by Rhea was observed visually in Spain on 1974 August 29. Unfortunately, there was only one observation so that the diameter could not be determined.

The occultation by Vesta on July 25 will occur in western Australia at about 21^h30^m UT, while the one by Pallas on October 10 may occur in western North America at about 12^h58^m UT. Gordon Taylor will issue more detailed predictions later, after the relative positions of the stars and minor planets have been improved with recent photographic observations. In late January, Gordon Taylor distributed predictions for an occultation of SAO 81985 by (13) Egeria in Europe on Feb. 17; only a few reports mentioning overcast skies were received. He has started work on predictions of occultations of SAO stars by 30 minor planets (in addition to Ceres, Pallas, Juno, and Vesta) for 1977. In the above list, positions are not given for bright planets or their satellites, which are easy to find.

Gordon Taylor reports that preliminary analysis of the observations of the occultation of Mebsuta by Mars show that the planet was within 0!1 of the J.P.L. ephemeris which was used for the predictions. Richard Gomer, Pomona College, Claremont, CA, designed and built an apparatus for less than $200 to digitally record photoelectric occultation data at 5 msec intervals. He successfully used it with a 16-inch telescope at Berea College, KY, for the occultation by Mars.

OCCULTATION OF EPSILON GEMINORUM BY MARS

David W. Dunham

Generally clear skies prevailed over the eastern third of North America during the evening of April 7-8th, so Sky and Telescope and Gordon Taylor have been deluged with reports of observations of this event. The June issue of S&T will undoubtedly publish a summary of this data with several photographs. Although some observers, visual and photoelectric, saw some dimmings or brightenings, most observers reported gradual disappearances and reappearances, the beginnings and ends of which were difficult to time and depended on seeing, irradiation, and the brightness of the sky. As a result, the lengths of immersions and emersions reported varied enormously. The half-intensity points on photoelectric records will probably have to be used to obtain an accurate position of Mars with respect to the star. Dr. N. P. Wieth-Knudsen traveled from Denmark to Barbados to observe the event. The seeing was good enough there that he could discern a small amount of separation between the star and Mars at the disappearance, but most observers were not so lucky. The occultation was recorded photoelectrically with three telescopes at McDonald Observatory, Texas. An area scanner was used with the 107-inch reflector. The same structure was present in the records obtained at all three telescopes.

Astronomers from Cornell University made photoelectric observations from NASA's jet, which is normally used for infrared observations. They flew over the predicted central line east of the Atlantic Coast. They must have been close to the actual central line, since amazingly they recorded a brightening during the center of the occultation, when the star was behind the center of Mars. Light passing through the atmosphere all around Mars focused at the center to cause this. Did any other observers notice this? I did not think about it beforehand, and could have tried to observe it, since the central line passed over Indiana, southern Ohio, and Virginia. The central brightening recorded by the Cornell observers is curiously asymmetric, indicating that they probably were not exactly at the center. The variety of observations indicates that the Martian atmosphere is heterogeneous around the planet. The star's light faded to invisibility for all observers before it was cut off by the solid surface of the planet.

The weather pattern was not as fortunate for the occultation by Phobos which I had predicted. It was cloudy in all the prime areas where observations were organized, including south Texas, southern Florida, and the Dominican Republic. Only a few negative observations were reported from the northern part of the possible area, McDonald Observatory being closest to the predicted line (130 miles north).

The Cornell observations of the central brightening indicate that Gordon Taylor's prediction for Mars was probably accurate to within 60 miles, so the actual path for Phobos probably did not deviate by much more than this from the predicted line.

There were some errors in my special bulletin about the occultation by Phobos. Most important was the predicted line for the occultation of AGK3 $+25^{\circ}$ 750, which had been calculated from the AGK2 differences between its position and that of Epsilon Geminorum. We had some trouble reading the AGK3 data for the stars from a magnetic tape, and didn't succede until the day after the event. Proper motion was significant; the AGK3 predicted line for the occultation of AGK3 $+25^{\circ}$ 750 by Phobos passed near Edmonton, Alta.; north of Winnipeg, Manitoba; north of Sault Ste. Marie; south of Ottawa, Ont.; and near Boston, MA. My special bulletin was sent to few observers in that area, since my early prediction had the line crossing the southern United States. The occultation of the faint star by Phobos probably would have been impossible to observe due to glare from Mars, whose surface would have been only about one arc second away when it occurred. Another error which I discovered soon after the notice was sent out was that Epsilon Geminorum was identified as Mekbuda; it is actually Mebsuta. This was also pointed out by Derald Nye and Francis Hart.

OCCULTATIONS DURING LUNAR ECLIPSES

David W. Dunham

Reports of occultations during the eclipse of 1975 November 18-19 made by 62 observers on five continents have been received. Most of these were copies kindly sent by HMNAO. Since the moon traversed a relatively bright part of the umbra, fewer timings per observer were made than during the darker eclipse of 1975 May 25, but the total number of timings was greater in November due to the much larger number of observers. Fortunately, skies were mostly clear over heavily populated parts of the northeastern United States and western Europe. A complete list of observers and the number of timings they made will be published in the next issue. Time and space preclude their publication here.

Frank Fekel at the University of Texas tried to compute predictions of occultations during the small partial eclipse of 1976 May 13 using my computer program there and data supplied by me. Some test runs produced no predictions because, most likely, no events occurred in the umbra for the stations used. Consequently, we could not check the accuracy of the data, and the project was abandoned in order to concentrate attention on predictions for other more important occultations. In any case, most observers already had USNO predictions for the SAO stars (although most of the predicted events would occur outside the umbra), and occultations of fainter stars could not be observed during such a small eclipse. The most favorable events would be grazes at the south limb, predictions for which should have been included in the grazing occultation predictions, if any were close enough. The eclipse was visible mainly from the Eastern Hemisphere. If you were able to time any occultations during the May 13 eclipse, please send me a report, and I will mention them in the next issue, with the observations during last November's eclipse.

TIMING THE GRAZE AT HARTLAND

Ray Magdziarz

[Ed: The graze expedition for ZC2368, on 1976 February 8, near Hartland, IL, was a battle against strong gusty wind, drifting snow, and occasional clouds. Lightly mounted 20-cm reflectors were inadequate. Two observers with sturdily mounted 25-cm reflectors were well placed, but see text for another problem.]

I was at my station near Hartland, IL, with the telescope set up in plenty of time, but I could not receive WWV on either of the frequencies available to me (5 and 10 MHz), even though I had a 10-foot whip antenna and over 100 feet of wire deployed. I went ahead with the graze, using Chicago broadcast station WBBM (780 KHz) for my reference. Unknown to me at the time, Berton Stevens was duplicating my scheme.

During my recording of WBBM's program, the announcer indicated a time of 10:09 CST (before the graze) and also 10:13 (after the graze). I later noted that the 10:09 announcement was 20 seconds late, and 10:13 was nowhere near that time.

After the graze, I sent a letter, on Chicago Astronomical Society stationery, to the general manager of WBBM, explaining that grazing occultation timings are useful information to the U.S. Naval Observatory and Her Majesty's Nautical Almanac Office in England, and that they aid N.A.S.A.

I requested a copy of their air check tape (which has the broadcast program, with Chicago telephone time signals superimposed) for the time period of interest. I suggested that it be done at their convenience, and indicated my willingness to come to their studio to make the copy myself. They responded within a week, stating that they would make a recording for me. Two weeks later I called them back, and found out the job had been forgotten by the person delegated to do it, but two days later, the tape was ready, and I picked it up at the studio.

I feel that my success in obtaining the tape was due to: 1) directing the request to a high level, such as the general manager; 2) making a polite request, suggesting a minimum of inconvenience to the radio station; 3) the use of Club stationery; and 4) signing the request as President of the Chicago Astronomical Society.

[Ed: Chicago telephone time signals (312/228-8000) are given at 10-second intervals, and are synchronised with WWV signals to an accuracy of 1 msec.]