Occultation Newsletter

Volume I, Number 7 — January, 1976

Edited and Published for IOTA by H. F. DaBoll, 6 N 106 White Oak Lane, St. Charles, Il 60174, U. S. A.

MORE ON THE APRIL 7-8TH OCCULTATION OF EPSILON GEMINORUM BY MARS

David W. Dunham

Jean Meeus' diagram on p. 47 of the last issue can be used to compute the approximate position angle (not too crucial, since Mars' apparent diameter will be only 6".3) and U.T. at your location, to within a few tenths of a minute. It is not possible in any case to compute predictions more accurately due to small uncertainties in our current knowledge of the relative position of the planet and the star. Gordon Taylor stresses that timings of the occultation will be valuable for refining the relative positions and establishing Mars' orbit in the FK4 system; the diameter of the planet is accurately known from Mariner 9 results. ϵ Geminorum (Z.C. 1030, or Mebsuta) will disappear on the dark limb of Mars. However, since the maximum separation of the terminator from the dark limb (the "defect of illumination") will be only 0".63 in p.a. 93°.9, seeing and irradiation will probably make the dark limb unnoticeable to most observers. A piece of Mars ¼-second-of-arc on a side will be only mag. 6.7, so the occultation should be readily observable if the seeing is reasonably good. Mebsuta's spectral type is G5.

James Elliot points out that photoelectric records of Mebsuta's passage through Mars' atmosphere, which may be evident for several seconds around the time of the two contacts, will have special value for the study of planetary atmospheres. The star is so bright that more details about the atmosphere can be obtained than were obtained by radio occultations of Mariner 9. Will there be sharp spikes in the light curve due to narrow "warm" layers in the atmosphere, as observed during the occultation of β Scorpii by Jupiter in 1971? If so, an accurate diameter of Mebsuta, and limb darkening, might be determined from high-speed photometry of the spikes. Best results for these studies would be obtained with integration times of a few milliseconds to .01, but photoelectric records with integration times of even a few tenths of a second would be more valuable than visual observations. In order to best compare photoelectric results made at various locations, standard filters should be used. James Elliot, Center for Radiophysics and Space Research, Space Sciences Bldg., Cornell University, Ithaca, NY 14853, suggests observing at 4500 Å with a 100 Å bandpass; details of such a filter are available from him.

Visual observers should accurately time any spikes (sudden brightenings of Mebsuta) which may occur as the star dims into the Martian atmosphere, and make an estimate of the relative brightness of the observed spikes. This should help in establishing the spatial extent of "warm" layers, if timings are made by many observers over a wide area. Another important question: Will Mebsuta fade completely from visibility due to refractive dispersion in Mars' atmosphere before it is occulted by the solid surface of the planet? This may depend on the height of the Martian topography which occults the star. There is great variation in Martian topography, and consequently also in atmospheric density at the surface. Approximate "limb corrections" could perhaps be computed knowing the geocentric orientation of Mars at the time of the occultation and using topography determined from radar ranging and Mariner 9 data. At Mars' distance, the spacing between fringes in the Fresnel diffraction pattern would be about 300 meters, which would be covered in about [illegible] for a central event, a time scale comparable to lunar occultations. The Fresnel diffraction pattern will probably not be observable due to the Martian atmosphere, unless one were lucky enough to see an occultation by Phobos or Deimos, which could last several tenths of a second. The predicted paths of the occultations by the Martian satellites should be computed, so that nearby observers could watch for the events (the path uncertainty would be many times the diameter of the satellite). Due to the rarity and value of this spectacular occultation of Mebsuta by Mars, some observers may want to travel into the nighttime area of visibility, and those already there may want to make plans to travel in case local weather prospects are not good.

AGK3 +25° 750, a tenth-mag. spectral type K2 distant companion of Mebsuta (probably not physically related), will be occulted by Mars about ¼ hours after the primary is occulted. Gordon Taylor provides the following predictions for this much more difficult event:

Place	Disappearance U.T.	Disappearance p.a.	Reappearance U.T.	Reappearance p.a.	Alt. of star	Alt. of sun
Montreal, Quebec	2h 28m	26°	2h 29m	346°	39°	28°
Edmonton, Alberta	2 25	36	2 28	335	58	-2
Palomar Mountain, Calif.	2 24	82	2 29	290	74	-4
Bronson, Florida	2 27	71	2 [illegible]	301	45	13

IOTA NEWS

David W. Dunham

My address is still 2976 Linwood Ave., Apt. 2; Cincinnati, Ohio 45208; U.S.A. I am president of I.O.T.A., and requests for graze predictions or about IOTA membership should be addressed to the Secretary, Berton Stevens, Jr., who lives at 4032 N. Ashland Ave., Chicago, Illinois 60613. Rather than use precious space to try to explain this, my name was used with the Chicago address at the end of my article on p. 67 of the current issue of *Sky and Telescope*. Essentially the same thing was done on the last page of the *1976 Occultation Supplement* for the United States and Canada.

Unfortunately, we have not been able, for the most part, to distribute graze predictions far in advance, as had been hoped earlier. This has been due to some errors found in the programs, and various other problems which some of the computors have had. As a result, predictions for a few regions for the last quarter of 1975 were not computed, and the data for some of the other regions were distributed after the quarter had begun. These problems are being overcome, so that by now, all IOTA members should at least have predictions for the first quarter of 1976. Also, most computors now have the ACLPPP working, so that most observers have (or soon will have) received the computer produced profiles described on p. 46 of the 1975 August issue. As soon as the double star data are all keypunched, put in the same format, and a file of them prepared at U.S.N.O. (good progress has been made on this project, which hopefully will be completed soon), the largest current manual job in the graze prediction process can be eliminated, which should speed up the job.

A second meeting of all IOTA officers was held in Highland Park, Illinois, during 1975 December 28. Besides the problems mentioned above, future IOTA publications were discussed. It was agreed that a short publication, a few pages long, on the basic use of the graze predictions and profiles, essentially an updated rewriting of *What to Do with the Predictions and Profiles* and *New Format for Grazing Occultation Predictions*, was urgently needed; we are now out of the old papers and don't want to reissue them. Joan Dunham has written a preliminary draft; we hope to have the final version ready within 2 or 3 weeks. It will form the nucleus for a more comprehensive IOTA manual on graze observing techniques and information, which we will probably issue in parts during the next several months. Paralleling this will be a paper about total occultations, mainly an update and rewriting of Thomas Van Flandern's *Precision Timing of Occultations* and Gordon Taylor's *The Visual Observation of Occultations*, being prepared jointly at U.S.N.O. and H.M.N.A.O. Berton Stevens will prepare a roster of IOTA members, which will be distributed with the basic use of graze predictions paper. Robert Walker, Sayre, Oklahoma, has keypunched the remaining data needed for the photoelectric occultation index, which should be published by IOTA within two months.

LUNAR OCCULTATION TIMING COUNTS

David W. Dunham

A coupon is enclosed to report the number of total occultation timings made during 1975. A list of 1975 totals, based upon returned coupons, and any copies of occultation timing reports received, will be published in a later issue, probably October, 1976, or perhaps as late as January, 1977. This should allow enough time for many overseas observers to publish their 1975 results, which we can then use in our 1975 tally to make it more comprehensive. As for the previous counts, grazing occultation timings are not to be included, but you should include the timings of any total occultations made from sites where grazes were observed or attempted. For occultations of planets, only 2nd and 3rd contact timings should be included; don't count 1st or 4th contacts. If you get timings on both components of a double star, that's two timings for your count.

Reports of timings of occultations during last November's lunar eclipse have been received from observers on five continents. Fortunately, clear skies prevailed over populous areas of the northeastern United States and western Europe. Apparently, the eclipsed moon was somewhat brighter in November than during corresponding phases of last May's eclipse (when the moon passed more centrally through the umbra), so that relatively few timings of non-SAO stars could be made. A ridiculously long postal strike again prevented observers in Canada from receiving any predictions. If this trend continues, Canadians won't have to worry about another postal strike until their next total lunar eclipse on 1979 Sept. 6. A discussion and tally of last November's eclipse occultation observations will be published in the next issue, to give a little more time for overseas observers to send me their results.

OCCULTATIONS OF BRIGHT NON-SAO STARS

David W. Dunham

During 1975 October 12 U.T., Richard Nolthenius, in Tucson, Arizona, timed an easy unpredicted occultation of B.D. -18° 5299. Half an hour later, at $2^h\ 05^m\ 14^s.05$ U.T., the same occultation was recorded photoelectrically at McDonald Observatory, Texas. Two fringes were clearly evident in the diffraction pattern, allowing a determination of the local lunar slope. Timings were also made visually by Robert Sandy, Kansas City, Missouri; Berton Stevens, Chicago, Illinois; perhaps Robert Walker, Sayre, Oklahoma; and possibly others. The star was estimated to be magnitude 7.7, favorably visible near the first quarter moon. Observers' attention was drawn to the star by the predicted disappearance of 7.4-mag. SAO 162442 about 15 minutes before. Three hours later, Nolthenius timed the unpredicted occultation of another star of about magnitude 8.4.

During the afternoon of 1975 November 7, skies cleared unexpectedly at Cincinnati, so I made a last-minute decision to try to observe a graze of 9.1-mag. Z 19408 by the 23%-sunlit moon near Manilla, Indiana. The star was actually even fainter and very difficult to see against the earthshine-lit dark southern limb of the moon. Ten minutes after the graze, a nearby star, about mag. 7.7 and very easy to follow, missed the south limb by only about 30". The 7.7-mag. star is not in the SAO Catalog, but was found in the Yale Catalog (B.D. -19° 5222) and would have produced a favorable graze near Indianapolis, about 50 miles northwest of my observation site.

Although B.D. -18° 5299 and B.D. -19° 5222 are both in the Yale Catalogs, no proper motions are listed for them due apparently to insufficient early observations. Due to the lack of proper motions, they were excluded from the SAO Catalog, and therefore from even the U.S.N.O. total and grazing occultation predictions, which use the SAO and Z.C. Catalogs. Both stars are listed at mag. 8.0 by Yale, but visual comparison with other nearby stars shows that they are both a few tenths of a magnitude brighter, a not uncommon occurrence. Both have spectral type K, and the Yale Catalogs are largely compiled from photographic data.

I sent input data to Frank Fekel, who computed future events involving the two stars with the University of Texas total occultation prediction computer program. The series of occultations of both stars soon ends, with only one more occultation of each possibly being observable, both occurring during January 29 U.T. The occultation of B.D. -19° 5222 will occur at about 2^h U.T., with the moon 5% sunlit waning, visible from part of Russia around longitude 40° or 50° East, and possibly from parts of eastern Turkey, western Iran, and Iraq. The moon will be only 3% sunlit for the occultation of B.D. -18° 5299, visible from part of the eastern United States. Predictions for the reappearance for some locations are given in the table below. A graze might be observed along the southern limit, which crosses the Florida Peninsula about 30 miles south of Tampa. Detailed predictions of the graze have been sent to IOTA members in Florida within range of the southern limit.

REAPPEARANCE OF BD -18° 5299, 1976 JANUARY 29

Place	U.T.	Cusp Angle	P.A.	Star Alt.	Star Azimuth	Sun Alt.
St. Louis, MO	$12^h\ 05^m.0$	41° S	223°	3°	117°	-12°
Jackson, MS	11 44.0	13 S	195	2	113	-15
Chicago, IL	12 15.1	53 S	235	5	120	-9
Chattanooga, TN	12 01.3	35 S	217	7	119	-8
Berea, KY	12 08.9	44 S	226	8	121	-6
Cincinnati, OH	12 14.1	49 S	231	8	122	-6
Bronson, FL	11 43.1	9 S	191	8	117	-8

Add 7° to the P.A. to obtain Watts angle. SAO 162442 will reappear under similar circumstances several (11 at Cincinnati) degrees farther north along the moon's limb and a few (5 at Cincinnati) minutes earlier than B.D. -18° 5299. Please send me any observations obtained.

John Phelps has found a few dozen more non-SAO stars brighter than mag. 8.6 by scanning some of the southern zones of the Yale Catalogs. The data are being keypunched and will be used to see which stars are now undergoing occultations. Although proper motions are not available, the Yale positions at epoch are accurate, so that good total occultation and passable graze predictions can be computed for the stars. The brightest star Phelps found had 7.3 listed by Yale as the visual magnitude. He plans to scan the rest of the Yale volumes south of -1° declination within 6° 40' of the ecliptic to try to find more non-SAO stars. North of -2° declination, any such stars (such as B.D. +19° 554, the 7th-magnitude double star occulted during the November eclipse discussed on p. 49 of the last issue) should be included in the new AGK3 Catalog. The zodiacal parts of the AGK3 and of the SAO Catalog (U.S.N.O. "SZ" catalog) have been combined at U.S.N.O. to form a more comprehensive catalog (with about half again as many stars as the SZ) which will soon be used for predictions.

MORE PUBLISHED PAPERS ABOUT OCCULTATIONS

David W. Dunham
and
Wayne H. Warren, Jr.

T. G. Barnes III, D. S. Evans, and S. B. Parsons, "Stellar Angular Diameters and Visual Surface Brightness. A New Calibration with Color Index and an application to Variable Star Distances", *Bull. Am. Astron. Soc.* 7, 504. Numerous stellar angular diameters found by lunar occultation permit the relationship between visusl surface brightness and color index to be defined for stars as late as spectral type M8. By combining these angular diameters with others from the literature, the relationship is found to be well defined for the spectral type range O5-M8, without dependence on luminosity class, provided the calibration uses (V-R) rather than (B-V). A new and fully independent method for determining the distance scales of variable stars is demonstrated to follow from this relationship, although at present the precision of some of the data needed for the method is questionable. (DWD)

W. Fresschle et C. Meyer, "Remarques sur l'utilisation des Profils Lunaires pour la Reduction des Observations d'Occultations", *The Moon 12*, 475. Occultation calculations are usually done by projecting the moon and the observer onto the fundamental plane, which passes through the center of the earth and is perpendicular to the direction to the occulted star. The projection onto the fundamental plane causes a small distortion of position angles. The author gives a formula for the correction to the position angle needed to remove the effect of this distortion, which can amount to 0°14. Although this has not been published in the open literature, the formula has been known and applied at H.M.N.A.O. and at U.S.N.O. for many years, and is given on p. 32 of T. C. Van Flandern's doctoral dissertation, "A Discussion of 1950-1968 Occultations of Stars by the Moon" (1969). (DWD)

Y. Fukada, I. Kasahara, S. Hayakawa, F. Makino, Y. Tanaka, H. Akiyama, J. Nishimara, M. Matsuoka, M. Oda, N. Nakagawa, H. Sakurai, V. S. Iyengar, R. K. Manchanda, B. K. Kunte, and B. V. Sreekantan, "Lunar Occultation of the Hard X-ray Source in the Crab Nebula", *Nature 255*, 465. Hard X-rays from the Crab Nebula were observed during a lunar occultation on 1975 January 24 with two sets of scintillation counters aboard two balloons launched from Hyderabad. Referring to a standard 10-kHz time signal, the authors found the apparent period of the Crab pulsar to be 33.17582 ms, consistent with the barycentric period of 33.1736 ms obtained from a radio observation at Arecibo. The observed data were fitted to both a Gaussian model for the diffuse source and a model assuming two line sources with the pulsar in between. The structure of the source as determined from these assumptions is discussed in some detail. (WHW)

A. J. Jeffries, "A Theory for Fading at Occultations", *J. Brit. Astr. Ass. 85*, 420. The author has rediscovered Fresnel diffraction, which has been well known to affect occultation light curves for many decades. The detailed diffraction curve is (must be) routinely computed for the precise analysis of high-speed photoelectric occultation records. Unless the star is very bright, an observer would not notice it at 1/40th its brightness (4 magnitudes); the steepest part of the diffraction curve, which can be noticed visually sometimes under very good conditions during grazing occultations, occurs over a distance of only about 10 meters. The fading observation by Patrick Moore referred to by Jeffries involved the star SAO 76152, an 8th-mag. star known to be double both from earlier occultation observations and visual observations by P. Coteau at Nice. I discussed this in a letter to *J. Brit. Astr. Ass. 83*, 144, abstracted on p. 9 of *o.o.n.-VIII*. (DWD)

H. L. Kestenbaum, W. Ku, R. Novick, and R. S. Wolff, "3 November 1974 Lunar Occultations of the Crab Nebula", *Am. Phys. Soc. Bull. 20*, 604. See p. 55 of the last issue, R. S. Wolff *et al.*, for remarks about this work. (DWD)

S. T. Ridgway, D. C. Wells, and R. R. Joyce, "Stellar Diameter Measurements by Infrared Observation of Lunar Occultations", *Bull. Am. Astron. Soc. 7*, 510. This is a continuation of the work of the first two authors described on p. 41 of issue #5. Angular diameters for five more stars of spectral type later than M3 are given and discussed. The color temperature - effective temperature relation of Dyck *et al.* (*Ap. J. 189*, 89) is verified to M6 (3160° K). The Mira variable U Orionis is found to have a wavelength-dependent diameter, with a relatively hot star (T_{eff} > 3000° K, diameter 0"009) surrounded by a shell or extended atmosphere (T about 2000° K, diameter about 0"02) which is optically thick at visual wavelengths. The radial brightness distribution is being investigated by deconvolving the observed occultation light curve. The carbon star spectral type temperature index is not simply correlated with T_{eff}; an opacity effect related to carbon abundance may be responsible. (DWD)

T. C. Van Flandern and P. Espenschied, "Lunar Occultations of Beta Scorpii in 1975 and 1976". This paper was discussed on p. 54 of the last issue; a continuation of the table of Beta Scorpii occultations is given below:

1976 Date	UT	% Snl	Night Land Area
Mar 20	15^h	73-	Hawaii, s. Alaska
Apr 17	1	91-	Europe, n. Africa, Mid-East
May 14	12	99-	Hawaii, s. Alaska
Jun 10	22	98+	Europe, n. Africa, Mid-East
Jul 8	6	86+	USA, Canada, n. Mex.
Aug 4	12	68+	Manchuria, e. Siberia, n. Hokkaido

(last in the series) (DWD)

J. Veverka, J. Elliot, and J. Goguen, "Measuring the Sizes of Saturn's Satellites", *Sky and Telescope 50*, 356. The diameters of Saturn's five brightest satellites were determined from analysis of photoelectric observations made by the authors at Mauna Kea Observatory. The larger-than-expected diameter for Titan indicates a density of 1.4 grams/cc, implying an icy composition. Most *O.N.* subscribers also get *S & T* and have already seen this interesting and well illustrated article first hand. (DWD)

FROM THE PUBLISHER

We apologize for the fact that most of this issue will not even reach the printer, let alone reach you, during the month of January. That month appears on the cover page because that sheet was pushed ahead of the rest of the issue in order to get the article "Occultations of Bright Non-SAO Stars" into the hands of observers in the predicted region of visibility of the January 29th reappearance of BD -18° 5299, before the event.

The size of an issue of *Occultation Newsletter* is generally held to no more than 10 pages (5 sheets) per copy, not only to try to hold down printing cost, but because even an extra 1/3 of a sheet (such as the coupon enclosed) brings the weight of the mailing to more than one ounce (>28.34 grams), and raises the cost of domestic mailing from 13¢ to 24¢ per copy. When it became obvious that eight pages would be inadequate to carry the priority items on hand for this issue, we decided it would be the one in which to publish items which space limitations had kept out of previous issues.

The basic price of *Occultation Newsletter* remains at 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. 8, the basic price would be figured as 2 @ $0.50 + 2 @ $1.00 = $3.00.

The basic price includes first class surface mail delivery, with air mail available at the difference in cost to us (except that the difference will be figured at the old postage rates, for subscriptions received prior to publication of this issue): 16¢/year in Canada and Mexico; $1.28/year in Central America, Colombia, Venezuela, the Caribbean islands, Bahamas, Bermuda, St. Pierre and Miquelon; $1.76/year in all other countries.

Please note that the foregoing applies only to separate, individual subscriptions to the newsletter. IOTA memberships, including a subscription to the newsletter, remain priced at $7.00 for residents of the U. S. A., Canada, and Mexico, and $9.00 for others.

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.

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 most important recent discovery is a probable third component of Spica (α Virginis, Z.C. 1925, SAO 157923), and a possible fourth component. On 1975 November 29, a spectacular graze of Spica by a 14% sunlit waning moon was observed from 20 stations in Australia. David Herald reports that many observers saw distinct fadings, from which he deduced the separation and position angle given in the table. He estimates that the separation could not be less than 0.″02.

Spica is a well known spectroscopic binary with a period of 4.01455 days. The system was well observed with the intensity interferometer at Narrabri, Australia. From this data and the spectroscopic data, R. H. Brown *et al.* (*Mon. Not. R.A.S. 151*, p.161, 1971) determined all orbital elements of the pair, and the distance, 84 ± 4 parsecs. The semimajor axis is 0.″00154 ± 0.″00005 and the eccentricity is 0.146. As a consequence, the separation is so small that the diffraction pattern of an occultation light curve would barely be distorted at all from a point-source form. It would be difficult to detect the changes with a good quality high-speed photoelectric record; visual observers would not have a chance.

So the fadings seen by the Australian graze observers are most likely due to a third star. Such a companion (C) could not be brighter than about 4th magnitude (5% of the total luminosity of the system) or it would be detected in spectra or by the intensity interferometer. The true separation may be 0.″1 or more, or its orbit may be close to the plane of the sky. Otherwise, variations in the orbit or mean radial velocity of the close pair (AB) could be detected. If the magnitude of C is 4.5, then A and B would be 1.4 and 3.4, respectively.

Several of the graze observers recorded some events when Spica was well behind the moon, indicating the possibility of a more distant faint component D. Data for the C and D components with respect to AB are given in the list.

Future observations of occultations of Spica, especially made photoelectrically, will be valuable for learning more about this important system. Observers near Johannesburg, South Africa, were planning to record another spectacular southern-limit graze of Spica by a 33% sunlit moon on 1975 December 27, but I have not heard if they were successful. Three grazes of Spica were observed during the 1968 series, but the circumstances were not as favorable as they were in Australia last November. I don't know about any past photoelectric observations. During 1976, the occultations of Spica move into the northern hemisphere, but North Americans won't get any favorable events (see p. 66 and 67 of *Sky and Telescope*, January 1976). The star is not even occulted in the daytime for all the major observatories in the southwestern United States.

Another star to watch is β Capricorni (Z.C. 2629, SAO 163481). The McDonald Observatory photoelectric observation indicates a considerably larger separation than that inferred from the spectroscopic data (0.″006). Either the star's parallax or orbit needs revision, or a new component has been found. β Scorpii is another very important multiple system now being occulted (see Van Flandern and Espenschied, p. 59). The B component was seen by observers during an occultation in Rhodesia on 1975 October 8, according to Arthur Morrisby.

Stars whose SAO numbers are followed by asterisks are known (usually visual) doubles for which some of the data, usually the magnitudes, have been revised based on recent occultation observations, which are referenced in the DATE, DISCOVERER, NOTES column. SAO 128380 and 146307 (Z.C. 3340) were discovered to be double recently during occultations; see p. 45 (Aug. issue) and p. 36 (May), respectively. The discovery graze observation and recent photoelectric data for Z.C. 3340 are in good agreement, so the two have been combined for the separation and p.a. in the list.

As pointed out on p. 281 of the 1974 November issue of *Sky and Telescope*, SAO 163645 (Z.C. 2995, 17 G. Capricorni) was first discovered to be double by W. S. Finsen with an eyepiece interferometer at Union Observatory, S. Africa, in 1954, rather than during the 1974 graze of the star mentioned on p. 21 of the 1975 January issue of *O.N.* With the help of Stockbauer's comprehensive list of visual zodiacal doubles available since last June and described on p. 45 (August issue), mistakes like this should not occur in the future (Z.C. 2995 is in Stockbauer's list).

The looking up and insertion of double star information into the input graze data is now the main manual task involved in preparing graze predictions. Progress is being made on the job of converting all available double star data into a standard machine-readable format so that manual graze work can be reduced and the predictions speeded up. Mike Reynolds and Wayne Green, Jacksonville, Florida, have copies of all my double star data and are working on the project. Walter Nissen has also done some work with the binary data at USNO, which also wants it for reductions of occultation observations.

NEW ZODIACAL SPECIAL DOUBLE STARS, 1976 JANUARY 15

SAO/BD	ZC	M	N	MG1	MAG2	SEP	PA	MAG3	SEP3	PA3	DATE, DISCOVERER, NOTES
95576	0971	T	K	7.5	9.5	0.″05	320°				1975 Sept. 28, R. Nolthenius, Tucson, AZ
96407	1072	G	X	7.0	7.0	0.02	197				1975 Oct. 26, B. Stevens, Princeville, IL
109262	0068	P	T	5.8	8.8	.196	233	9.7	27.″5	83°	1975 Nov. 15, J. Africano, McDonald Observatory, TX (2nd*; ADS 449[illegible]
109596*		P	T	8.9	9.0	1.7	305				1975 Dec. 13, J. Africano, McDonald Observatory, TX (ADS 635AB,
117777	1412	T	K	8.9	8.9	0.5	91				1975 May 18, R. Sandy, Kansas City, MO
118452		G	K	8.5	9.1	0.1	190				1975 Oct. 30, R. Nolthenius, Marana, AZ
128380*		P	V	8.9	10.8	.086	56				1975 Nov. 14, J. Africano, McDonald Observatory, TX
145973*		P	A	8.5	9.6	0.7	281				1975 Nov. 12, D. Evans, McDonald Observatory, TX (ADS 15777)
146307*	3340	P	X	7.7	9.5	0.05	149				1975 Dec. 10, J. Africano, McDonald Observatory, TX
157923	1925	G	L	1.3	4.5	0.05	225	7.5	0.5	180	1975 Nov. 29, D. Herald, Canberra, Australia
162133	2774	T	X	7.1	7.1	0.1	90				1975 Oct. 11, G. Kirby, Weymouth and Baguley, Reading, U.K.
16337[illegible]		T	V	9.5	10.0	0.36	252				1975 Oct. 10, R. Nolthenius, Tucson, AZ
163471*	2968	T	B	6.2	8.3	0.8	84				1975 Dec. 7, H. Povenmire, Cocoa, FL (ADS 13717)
163481*	2969	P	I	3.5	4.7	.022	60	6.7	.0001		1975 Dec. 7, J. Africano, McDonald Observatory, TX (2nd*)
163795	3021	T	K	8.0	9.0	0.25	235				1975 Nov. 10, W. Clark, St. Louis, MO
164019		P	K	9.7	10.3	.017	34				1975 Oct. 14, J. Africano, McDonald Observatory, TX
185447		T	X	9.0	9.8	0.07	257				1975 Oct. 13, R. Nolthenius, Tucson, AZ
-20°5127		P	K	9.2	10.0	.042	44				1975 Oct. 11, J. Africano, McDonald Observatory, TX

DIGITAL ELECTRONIC TIMER

Thomas H. Campbell Jr.

[Ed.: This is the device mentioned in Mr. Campbell's article "Florida Graze Observers Meet", *Occultation Newsletter, I.* (#3) 25.]

This article contains a detailed description of an electronic digital stopclock primarily designed for occultation work. It is made up of integrated circuits, with a minimum of discrete components. The circuit does not have the problems of a mechanical stopwatch, because it has no moving parts. The rate error is solely dependent on the basic timing oscillator used. Tuning fork and crystal oscillators have very small rate errors.

The first application of this circuit was to the measurement of personal equation. A light emitting diode was used as an artificial star. Each of several observers was tested, under identical conditions. Favorable and marginal conditions were simulated. The observer reacted by pressing a button to stop the clock. Voice reaction times were also measured, using a voice-operated switch also described here.

How it works. Refer to Fig. 1 and the logic truth tables. The integrated circuits used are TTL (transistor to transistor logic) positive logic type. 0 volts is a logic "0", and +5 volts is a logic "1". Fig. 1 shows the circuit with the personal equation test feature. The main circuitry and numeric display are set up on a table, near the examiner. The observer being tested sits at the opposite end of the table. In front of him are only the components shown within the dotted line of Fig. 1. Any TTL input pin which is not connected behaves as if there were a logic "1" present.

R1 controls the intensity of LED1; maximum resistance is for sub-marginal, and minimum for spectacular events. S1 is a normally open silent pushbutton switch, to avoid giving away an event by an audible click. IC1 generates a positive-going trigger pulse about 250 nanoseconds wide. A trigger is generated when S1 is pressed or released. LED1 is dark when S1 is pressed, and lit when S1 is released. IC2-A is used as an inverter. IC2-B and IC2-C are two cross-coupled nand gates that form a flip-flop. A logic "0" at pin 1 will flip it to the start mode. A logic "0" at pin 5 will flip it to stop mode. A start condition places a logic "1" on pin 12 of IC2-D, allowing the 100 Hz pulses present at pin 13 to go thru and to the counter circuits. A stop condition places a logic "0" on pin 12 of IC2-D, thus inhibiting the 100 Hz basic timing pulses. IC2-D is used as a nand gate, and its output is controlled by pin 12. 100 Hz pulses are always present at pin 13; they are generated by A1, which is tuning fork oscillator-divider module assembly. A stop condition is generated by pressing S2 or by shouting a voice command into the microphone. IC10 is a medium gain differential amplifier with a built-in TTL nand gate, wired as an inverter. R4 adjusts the bias voltage to the inverting input of the amplifier. The microphone is a dynamic type. The very first positive-going audio amplitude voltage from the mike that exceeds the bias input voltage causes the amplifier output to swing immediately from a logic "0" to a logic "1". The TTL gate inverts this to a logic "0", and this signal goes thru CR1 to the stop input of the flip-flop. CR1 prevents the destruction of IC10 when S2 is pressed. IC3 thru IC8 form the counting chain. Their outputs are in binary-coded decimal form. IC3 counts the hundredths of seconds, IC4 the tenths. IC5 and 6 make up the seconds counter; they count from 0 to 59 seconds. IC7 and 8 make up the minutes counter; they count from 0 to 59 minutes. IC3, 4, 5, and 7 are divide-by-10 counters. IC6 and 8 are divide-by-6 counters. S5 is a normally closed pushbutton switch. When pressed, the switch opens, removing the ground on the reset inputs of IC3 thru 8, and a logic "1" is applied thru pullup resistor R5. This resets all counter IC's to zeros. DS1 thru DS6 are dot matrix LED numeric displays. They display numerals 0 thru 9, according to the binary-coded decimal information at their inputs, as long as the enable line is a logic "0". A logic "1" on the enable line disables the readouts, i.e., the displays will "freeze" a time display while the counting circuits keep on counting. The displays used here have a built-in decoder and latching memory. They can remember the last instant of time before they are disabled. When they are continuously enabled, the time display changes continuously according to the B.C.D. information fed from the counters. When in the strobe mode, it is possible to sample time and freeze the reading while the counter keeps running, keeping the current time. IC9 is a one-shot circuit. Its output is normally high, or "1". It generates a one microsecond negative-going pulse each time the switch S3 is pressed. That puts a one microsecond "0" on the enable line, allowing the displays to take a time sample at that instant.

Parts List

Quantity	Part No.	Description	Item
6	5082-7302	Numeric L.E.D. readout, Hewlett Packard	DS1-6
1	7486	Quad exclusive or gate integrated circuit	IC1
1	7400	Quad nand gate " "	IC2
4	7490	Divide-by-10 counter " "	IC3,4,5,7
2	7492	Divide-by-6 " " "	IC6,8
1	9601	One-shot " "	IC9
1	NE526A	Diff. Amp. I.C. Signetics, Inc.	IC10
1	LQ-CCR 7	Osc. module, 100 Hz Fork Standards, Inc.	A1
1	R1-50	Light emitting diode Monsanto	LED 1
1	1n914	Diode	CR1
3		Switch, pushbutton, normally open	S1-3
1		Switch, " " closed	S5
1		Switch, SPDT	S4
1		Switch, DPDT	S6
1		Resistor, carbon, 5% tol., ¼ watt, 360 ohm	R2
1		Resistor, " " " " " , 50 ohms	R3
1		Resistor, " " " " " , 2K ohms	R5
1		Resistor, " , 2 watt, 1 ohm	R6
2		Potentiometer, ¼ watt or less, 10K ohms	R1,R4
1		Diode, Zener 5.1 volts, 10 watts	VR1
1		Capacitor, silver mica, 50PF	C1
1		Capacitor, ceramic, 50 volts, 1uf	C2,3
1		Capacitor, tantalum, 15 volts, 60uf	C4
2		Capacitor, " " " 10uf	C5,7
1		Capacitor, silver mica, 100PF	C6
1		Battery, 6 volts, heavy duty lantern type	B1
1		Battery, " " light duty	B2
2	A23-2023	Socket (for mounting DS1-6) Jermyn, Inc.	
ARS		Aluminum, 1/8" X 3/8" X 6" minimum length	
1		Diode, Zener 5.1 volts, ¼ watt	VR2
1		Resistor, carbon, 5% tol., ¼ watt, 47 ohms	R7
1		Resistor, " " " ¼ watt, 27K ohms	R8

Truth Tables

7490

Count	OUTPUT 12	9	8	11
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

7492

Count	OUTPUT 12	11	9
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1

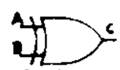
7400

INPUT A	B	OUTPUT C
0	0	1
1	0	1
0	1	1
1	1	0

7486

INPUT A	B	OUTPUT C
0	0	0
1	0	1
0	1	1
1	1	0

Nand gate



Exclusive or gate

Construction. Packaging the electronic components into a small cabinet with printed circuit cards will not be a problem if good construction techniques are used. As of 1974 December, the circuit was constructed on breadboard type plug in cards. For simplicity, Fig. 1 does not show the circuit broken up on separate plug in cards. When making printed circuit cards, each card should have its own filter capacitor for the +5 volt supply line, and its own 5 volt supply and ground lines tied directly to VR1. The cabl net must be ventilated so the IC circuits can be cooled by convection. The display readouts must use a heat sink. The aluminum bar described in the parts list fits nicely into a groove in the mounting sockets. Use thermal compound between the displays and the aluminum bar heat sink. The aluminum bar can be used to mount the displays on a window in the cabinet. An aluminum cabinet does a good job of sinking heat from the aluminum bar, thereby lowering the temperature of the displays even more. Cost can vary from about $150 to less than $50. These items have been on the industrial market since about 1969. Many government surplus stores have them.

Checkout. With the power off, perform a continuity check, with an ohmmeter, to make sure all connections have been properly made. Turn the power on, press the stop switch, and then the reset switch. The displays should read all zeros. If they do not, the trouble is probably a bad IC. Substitute suspected IC's until the problem is corrected. If this doesn't correct the trouble, then use Fig. 1 and the truth tables as a troubleshooting aid. IC's generally either work or they don't. Some fail at higher operating temperatures. Good IC's last almost indefinitely as long as the supply voltage never exceeds 5.5 volts and they are operated within their temperature range. Press start switch and make sure the displays are counting 0 thru 9, or 0 thru 5, as appropriate. Since the tenths and hundredths digits are impossible to read while the numbers are changing, they can be checked by interchanging them with the seconds display. Adjust bias pot R4 for highest sensitivity of voice switch consistent with not causing a stop condition from noise, such as circuit transients and AC hum. Shielded leads must be used at both inputs of the amplifier IC10. Test voice switch by shouting into the microphone. The running counter should stop. Switch to strobe mode and start the counter. Displays should be frozen until a new time sample is taken by pressing S3. Counter should continue to run. This can be verified by switching back to enable mode, to see if the displays are continuously changing. Check rate of error by starting counter to known WWV time. Allow to run for, say, ten minutes, and check against WWV. Repeat the check at high (140° F) and low temperatures, using your oven and deep freeze, to simulate extreme outdoor conditions. If the circuit continues to operate after the 140° test, you can be sure it is reliable.

Possible applications.

A. Stop clock. When operated in strobe mode, it can be used like a running stopwatch, to time several total occultations that are very close together. For grazing occultations, the display can be [read-out by an assistant or] photographed by a camera that has a shutter triggered by the strobe pulse which also can trigger a film advance mechanism.

B. Chronometer. With the addition of two displays for hours, and a crystal oven type oscillator and a method to set the clock, it would be possible to carry the correct universal time with you. Audio tone burst generators can be built-in to beep for every second and minute. A WWV sync circuit can be used to cause the clock to lock on

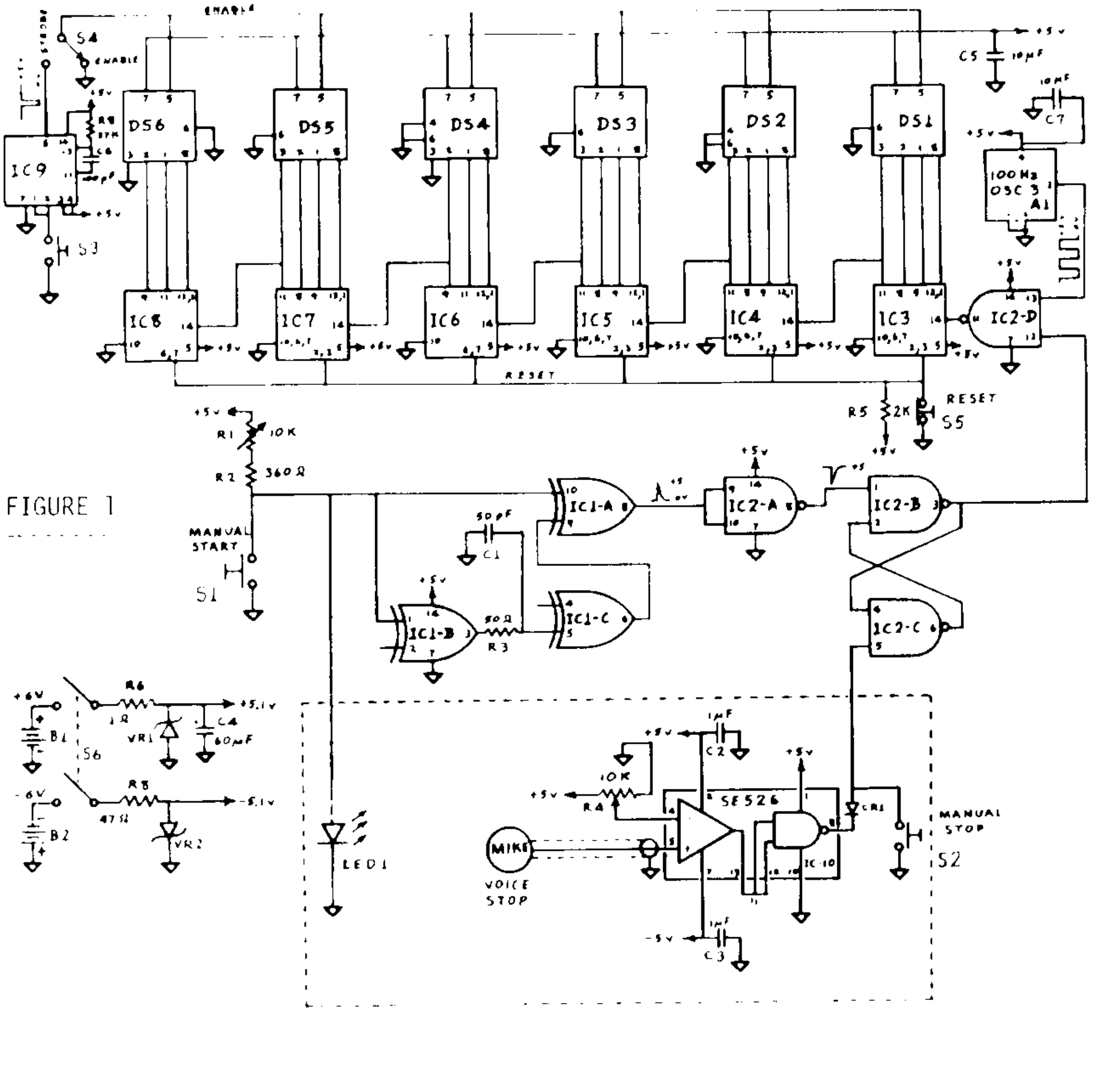


FIGURE 1

with WWV to an accuracy of ± 1 milli second. When the radio signal fades, the clock maintains the U.T.

C. Event time recorder. By modifying the chronometer, adding shift registers and solid state memories, it is possible to record multiple events. Since the outputs of the counters are binary coded decimal, an event time can be loaded into shift registers (parallel in serial out) and those bits can be shifted into memory. Type of event and station # can be binary coded and stored with the event time. The same displays can be used to read back the recorded times and station #. Solid state memories are small, and can store up to 2048 bits per IC package.

D. Photoelectric. Measure time interval of close binary star occultation.

Personal Equation Test Results. Eight observers were checked-out for personal equation on 1974 December 8. All were checked for four types of event (D,R,B, and F); six were checked by both pushbutton and voice signalling; and four were checked for both spectacular and marginal simulated events. No systematic difference was found between disappearances and reappearances. Each observer's personal equation was a little longer using voice than using the pushbutton, about $0\overset{s}{.}09$ longer, on the average. Of the four checked for both spectacular and marginal events, all showed longer personal equations for marginal events, about $0\overset{s}{.}11$ longer, on the average. There were significant differences between observers, amply sustaining the notion that each and every observer ought to have an individual determination of his personal equation.

Epilog. I invite correspondence with others who share an interest in astronomy and a knowledge of electronics, to exchange ideas about circuits that can be applied to occultations.

5405 98th Avenue
Temple Terrace, FL 33617

NOTICE
TO TOTAL OCCULTATION OBSERVERS ON NAVAL OBSERVATORY MAILING LIST

Peter Espenschied

The U. S. Naval Observatory provides annual predictions of total occultations, without charge, to active observers (amateur and professional) around the world. Each year many of these observers change their mailing addresses or their observing locations, necessitating a change in the computer-readable records that are used in generating the predictions.

The production of the annual predictions for all observers requires about three hundred hours of computer time, as well as a large amount of manual work (primarily to incorporate revisions into the information used by the computer). Since this work must be interleaved with many other projects (for both the computer and the people), the predictions for each year are generally produced between February and July of the preceding year. It is therefore desirable that information affecting the next year's predictions be received as early in the year as possible. When such information is received after August, we often cannot implement it before the mailing of the predictions.

ASTRONOMICAL CALENDAR 1976

Written and published by Guy Ottewell, Department of Physics, Furman University, Greenville, SC. 1975. 56 pages, softbound. $4.95. Sponsored by the Department of Physics, Furman University, in cooperation with the Astronomical League.

As the title suggests, this publication is designed to call attention to astronomical events which will occur during the year. This inevitably invites comparison with *the Observer's Handbook 1976*, which probably is familiar to most U.S. and Canadian observers. The two publications do fill similar, but non-coincident, niches.

A.C. has a large (11X15-inch) format, making it a tight squeeze for a small attaché case, and a bit awkward to handle at the telescope. However, its saddle-stiched binding allows it to lie open on the desk top, for easy reference. Paper and printing are of excellent quality, and the book is well designed. Typographical and editorial errors occur, but they are rare. Incidentally, the type face for the main body of text appears to be IBM "Letter Gothic", the same type face, and at almost the same degree of reduction in size, as currently used in *O.H.*

Each month of the year is given a two-page spread, as in *the O.H.*, but the larger format allows additional material to be included, while leaving out *the O.H.'s* columns for Minima of Algol, Configuration of Jupiter's Satellites, and the Sun's Selenographic Co longitude. For each month, there is a separate mid-evening sky map, comparable with the one in *Sky and Telescope*, except that positions are shown for superior planets and the brightest asteroids, at the beginning and end of the month, and for the moon at the times of quarter and full phases. Major meteor shower radiants are also shown, in appropriate months. These pages are well supplied with diagrams.

Another novel feature, which some observers may find useful, is the set of cloud cover maps for the 48 contiguous states of the U. S. A. These show mean percentages of sky covered by cloud in daylight hours, for each month, for each of 242 reporting stations.

Fourteen relatively large sky charts, showing apparent paths of the sun, all major planets, four minor planets, and twenty-two comets, will be among the most valuable features for observers.

Most of the remainder of the material presented is elementary solar system astronomy and constellation study. Stellar astronomy is neglected. The volume offers little or nothing to the specialist in any branch of observing. *A.C.* does not provide anything akin to the many tables of useful information found in *the O.H.*

While designed to be useful to the beginner, *A.C.* is attractive enough, useful enough, and convenient enough to appeal to the advanced observer.

H. F. D.

GRAZE OBSERVER'S HANDBOOK

Harold R. Povenmire. Vantage Press, 516 West 34th Street, New York, 1975. 134 pages. $4.95.

Many may be surprised to learn that this is not the first book on the subject. *Das Ocultaçoes Rasantes de Estrelas pela Lua* (Grazing Occultations of Stars by the Moon) was published by Luiz Eduardo da Silva Machado of the Observatório do Valongo, Universidade Federal do Rio de Janeiro, Brazil, in 1973. For those who understand a little Portuguese, it is a rather comprehensive, well organized work illustrated profusely with diagrams, formulae, examples, and references, up to date as of 1970. But several important developments have occurred in this fast paced field since then.

Povenmire's book is the first about grazing occultations in English. It gives the basic information needed for setting up a graze expedition, including many observing hints and useful anecdotes. The author's long series of graze observations shows that his methods are successful and that his experience is of some value to beginning observers.

The book begins with an interesting account of the most successful graze expedition, which was led by the author in 1970, and some useful general and historical information in Chapter 2. Unfortunately, after that, the book is not organized very well and contains many errors. One would think that the publishers would take some steps to edit out several spelling and grammatical mistakes. They don't seem to have much regard for how well the book sells, an important point for the author, who would like to recover a major portion of the considerable sum he has paid for publication.

A few more diagrams would have helped considerably in some places. Povenmire omits references in order "not to endorse any persons or products" (Foreward) and the Bibliography on pp. 127-128 is rather scanty and inadequate for those who want to read more about occultation work. Although it is wise to delete brand names and references to situations which are embarassing to certain individuals, there are many other places where references would be valuable for those interested in more details. It would take too much space to correct all the scientific errors. Some of the most important ones which we feel must be mentioned are listed below.

On p. 110, the statement is made that "two major institutions endorse the program - University of Texas and USNO". Royal Greenwich Observatory should replace the University of Texas. Although the Astronomy Department of the University of Texas did give some unofficial support to the preparation and mailing of occultation predictions while David was there, grazing occultations have never been an official program of the University of Texas.

WWV and WWVH no longer have silent periods as described on p. 65. The 29th second beat, not the 30th one, is skipped.

Mr. Povenmire's advocacy of railroad tracks should be discouraged except when there is absolutely no alternative, and then the permission of the railroad must be sought. At least the observers can learn what trains will be coming. And if one does come, it doesn't matter if the train comes between the observer and the moon or not. Trains vibrate the ground nearby so much that no observations can be made in any direction.

The Watts charts of the marginal zone of the moon are not topographic maps, as identified on p. 79. They are charts which can be used to predict the outline of the moon as presented to an observer at a particular time and place on the earth.

Anyone following Mr. Povenmire's instructions on photographing grazes (Chapter 16) will have a very hard time.

He defines the ecliptic plane as "the plane extending from the sun's center out through its equator and into space." (p. 117) The ecliptic plane is the orbital plane of the earth around the sun, to which the sun's equator is inclined 7°.

From p. 34, "Stars of very large proper motion are not very useful because their position is too uncertain." This is not true. If the proper motion is known accurately it doesn't matter what the size, the star's position can still be judged accurately.

The "Ultimate Grazing Occultation" described on p. 45, that of multiple total solar eclipses for an observer properly situated on the eclipse limit is highly unlikely. The sun is not a point source, nor does the photosphere have the sharply defined edge needed for such an event.

Not everyone would agree that "Most of the refractors of the 2.4-inch size category are not of very high quality" (p. 47). Many refractors of this size are quite satisfactory for most grazes. Nor would everyone agree that newer coatings for mirrors "put the reflector of equal aperture at an advantage over the refractor" (p. 47). While a 6-inch reflector would probably perform better than a 2.4-inch refractor on a graze by a crescent moon, it will never do as well as even a mediocre 5-inch refractor.

It is difficult to publish up to date specific information about obtaining occultation information due to the fast changing situation in recent years. Unfortunately, major changes in the prediction procedures (especially computer-produced profiles and formation of the International Occultation Timing Association) occurred just after Povenmire's book went to press. In addition, total and graze observations should no longer be sent to the USNO or to the University of Texas as stated on pp. 19 and 22.

Joan Bixby Dunham
David W. Dunham

TIMINGS REVEAL CATALOG ERRORS

Richard Schmidt, USNO

When an accurately timed occultation event disagrees significantly with its prediction, the possibility of a star catalog error exists (see *O.N. 1*, [#4] 28). Such was the case in several recent reports investigated at USNO. Robert Hays, Jr. of Chicago, IL is credited with uncovering the worst star position error to date. He recorded a disappearance of Z07912 on 1975 April 19, 175 seconds later than the predicted time! Blame in this case goes to the *Yale Trans. 18*, 61, the source for the SAO catalog position, where the declination as printed is exactly one arc minute north of the correct position.

Reports of timing discrepancies by Tom Campbell of Temple Terrace, FL (Z02875, 1975 July 5), and John Korintus of Palm Bay, FL (Z16381, 1975 August 16) were attributed to small errors in declination and proper motion. The position error of Z16831 combined with the effect of a steep lunar mountain and near-grazing conditions to produce a disappearance nearly two minutes early!

A report of a 12-second discrepancy by N. P. Wieth-Knudsen of Tisvildeleje, Denmark (Z00610, 1975 July 2) appears not to be a star catalog error. It is still being checked against timings of the same star by other observers.

TARDY STAR - RESULTS

Several days after publication of *O.N. 1*, #6 we received a personal communication from David Dunham, explaining the discrepancy between predicted and observed times as noted by Robert Hays (see p. 53). According to Dunham, the SAO position was taken from the Yale catalog, where the position shown was one minute north of the AGK2 position. This analysis is, of course, confirmed by the article above, subsequently received from Richard Schmidt.

Timings of the reappearance of Z07912 (SAO 97334) on 1975 October 27 have been received from five observers, unfortunately all within an 18° range in position angle. In the table, predicted times and position angles are from the USNO predictions for the stations of the several observers, except for Stevens, who was far from home, at the intersection of the limits of two submarginal grazes; we calculated his predicted time and position angle using our USNO predictions for St. Charles. Binzel had difficulty hearing the WWV verbal announcement of the minute, and was not sure whether his reappearance was at the time shown below (obviously it was) or one minute earlier.

Because the discrepancy already was resolved, and because of the narrow range of position angles, we decided not to attempt to use the data to derive a new position for the star, but only to see if the corrected position was consistent with the observed times. Using the USNO predictions for St. Charles and the mean apparent semi-diameter of the moon (932".58), the apparent direction and rate of the moon's motion were determined, from the predicted times, position angles, and coordinates of stars Z07884 (SAO 97315 and Z07908 (SAO 97332). With this information, we found that a star at the corrected position would reappear later than the original predictions, for the position angles shown, by the amounts in column 6, neglecting the Watts limb corrections. Residuals are shown in column 7, and certainly are within the range of uncertainties imposed by the approximations in the analytical method and the rounded-off values in the predictions.

Observer	Location	Predicted U.T.	Observed U.T.	P.A.	Δt	Col 6	Col 7
Walter V. Morgan	Las Vegas, NV	$09^h03^m42^s$	$09^h04^m04^s.4$	282°	$+22^s.4$	$+26^s.0$	$-03^s.6$
Robert L. Sandy	Kansas City, MO	09 32 00	09 32 42.2	288	+42.2	+40.9	+01.3
Rick Binzel	Atchison, KS	09 31 03	09 31 45.1	290	+42.1	+45.8	-03.7
Berton Stevens, Jr.	Banner, IL	09 39 27	09 40 30.1	298	+63.1	+66.1	-03.0
Robert Hays, Jr.	Chicago, IL	09 42 55	09 44 06.9	300	+71.9	+71.3	+00.6

PLANETARY OCCULTATIONS, David W. Dunham

The following possible occultations of stars by planets during the first half of 1976 have been computed by Gordon Taylor, Royal Greenwich Observatory:

Date	U.T. of conjunction	Planet	SAO No.	Mag.	Possible nighttime area of visibility
Jan. 21	$22^h\ 39^m$	Venus	185584	6.7	Antarctica
Feb. 4	14 01	Venus	187342	6.2	Antarctica
Feb. 27	01 47	Juno	118514	9.2	S. Atlantic, n. S. America
March 10	22 04	Mars	77550	8.5	Antarctica
March 10	20 24	Vesta	110087	8.8	Antarctica
March 11	00 18	Juno	118410	7.6	Arctic Ocean?
March 25	23 50	Jupiter	92688	7.0	western South America

The occultation of ι Geminorum by Mars on April 8 U.T. is discussed on page 57.

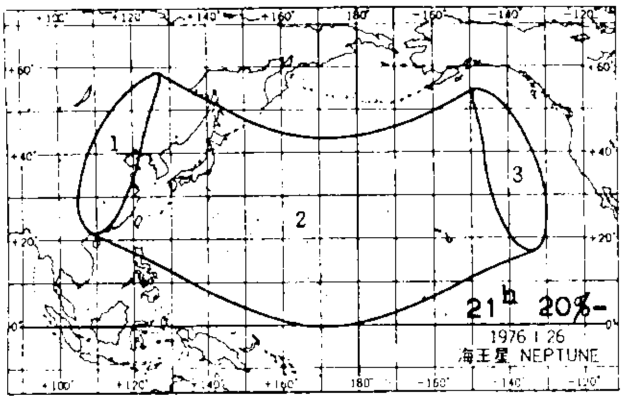
LUNAR OCCULTATIONS OF PLANETS

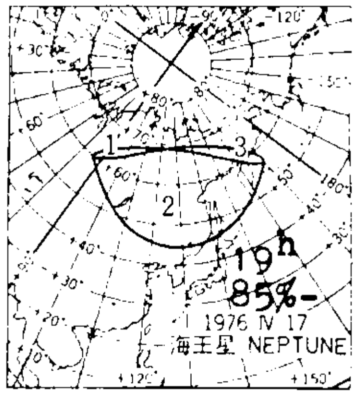
David W. Dunham

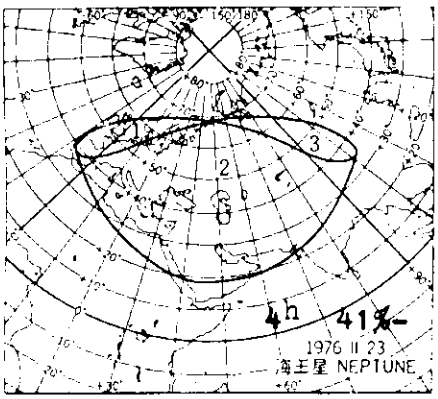
Occultations of planets by the moon have been called "planetary occultations" in previous issues of *Occultation Newsletter*. Gordon Taylor has made a strenuous objection to this terminology, and I have to agree with him. When we speak of a lunar occultation, we mean that the moon is occulting something (usually a star or planet), so that a planetary occultation would logically refer to a planet occulting something (usually a star). We will use this logic in this, and future, issues of this journal.

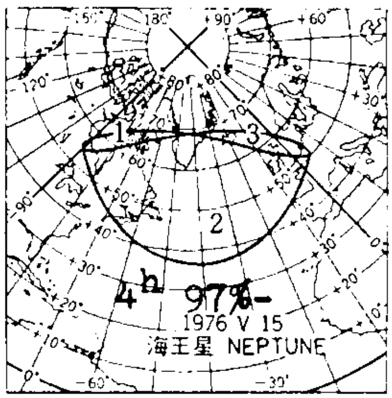
The maps showing the regions of visibility of lunar occultations of planets are reprinted by permission from the Japanese Ephemeris for 1976, published by the Maritime Safety Agency of Japan. Two useful quantities have been added to the maps: the Universal Time hour of geocentric conjunction; and the percent of the moon's apparent disk which is sunlit, with a "+" signifying that the moon's phase is waxing and a "-" showing that it is waning. Nearly always (only exceptions are in polar areas), the event will occur during the night in the western part of the region of visibility if the moon's phase is waning, and in the eastern part if the phase is waxing. The occultation will occur about 2^h before the time of geocentric conjunction at the western end of the area of visibility, and about 2^h after conjunction at the eastern end.

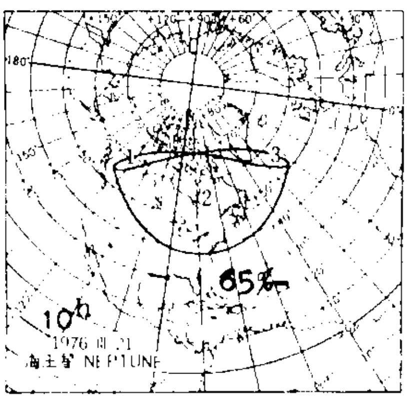
Occultations of Uranus will occur on Feb. 20, March 18, April 15, and May 12, all visible only from Antarctica and adjacent seas. Photoelectric observations of occultations of Neptune would be valuable for measuring the limb darkening of the planet, since its diameter is accurately known from observations of a Neptunian occultation of a star. Photoelectric observations of the reappearances of the Galilean satellites, visible from central Europe, on May 27 could be used to determine diameters and limb darkening. Fairly accurate diameters of Io and Ganymede have been determined from photoelectric observations of occultations of stars by those satellites, and Europa's diameter was measured from observations of the mutual satellite phenomena which occurred during 1973.

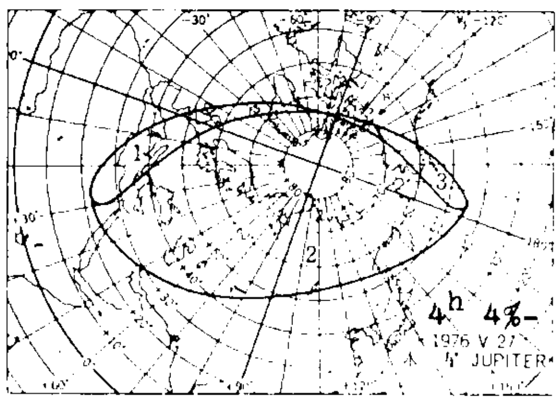












TIMEKUBE REVISITED

Thomas H. Campbell Jr.

As the one who first mentioned the Timekube in *Occultation Newsletter* (see #2, p. 15), perhaps I am the one who should mention some second thoughts.

Lately, the reception of WWV on 5 MHz and 10 MHz, in Florida, has been very poor, partly because of ionospheric conditions influenced by sunspot minimum, and partly because of interference by a Cuban broadcast station. As it is generally hopeless to try to get WWV on 15 MHz at night (and not very likely during the day, at sunspot minimum), the Timekube has not been very useful for occultation work recently. The capability of tuning to 2.5, 3.33, and 7.335 MHz is sorely missed.

Also, about the time the warranty runs out, the frequency selector switches start to misbehave; it becomes necessary to operate the switches a number of times in order to make good contact at the desired frequency. This fault can be corrected, at least temporarily, by cleaning the switch contacts. Remove the four screws which hold the board to the case, and remove the antenna jack. Use a spray-on-type contact cleaner (freon degreaser) on the switches, just as you would clean the contacts of a television tuner.

[Ed: Timekube is a Radio Shack item, priced at about $50. It is being discontinued, but there are still a few for sale. Incidentally, although you may have noticed that *the Observer's Handbook* has not listed 15.0 MHz for the last several years, WWV still broadcasts on that frequency.]

USNO OCCULTATION PROGRAM VERSIONS

Thomas C. Van Flandern

Users of graze and total occultation predictions based on calculations done at USNO may have noticed the cryptic notation "Version - 75A -", or something quite similar. This identifies the version of the USNO program named "OCC" which was used in the computations. The first two digits correspond approximately to the year of first use of the version; changes of year designation reflect major changes in the program, including empirical corrections (based on observations) which will change the predicted circumstances of events. The letter in the designation is sequential through the alphabet; and changes of letter reflect only very minor changes in the program, such as updating the double star codes.

Some recent OCC versions and features are the following. Most 1975 graze and total predictions were computed using version -72C-. Version -73A-, effective 1975 March 14, was based on all new empirical corrections, including a preliminary correction from the FK4 to the (proposed) FK5 celestial coordinate system. A bug affecting the probable error of the star's position was corrected. In addition, the program was modified to produce punched cards for use in automatic profile plotting.

Version -73B-, effective 1975 June 13, included all double star code updates through *O.N. 1*, #4, and was the version used in the initial computations for most 1976 predictions.

Version -74A- was an intermediate version used in the construction of -75A-.

Version -75A-, effective 1975 August 8, contained new empirical corrections based on recent comparisons with observations, and is overall slightly more accurate than -72C-. The format of automatic profile plotting cards was slightly revised, and double star codes listed in *O.N. 1*, #5 were included.

Version -75B-, effective 1975 September 17, contained some of the double star codes listed in *O.N. 1*, #6.

Version -75C-, effective 1975 October 16, is the current version, and will be used for at least some 1977 predictions. In addition to the rest of the double star code updates in *O.N. 1*, #6, it contains new coding which will permit occultations of planets to be included along with the regular total occultation predictions, beginning in 1977.

THE SCIENTIFIC VALUE OF GRAZING OCCULTATIONS

David W. Dunham
and
Thomas C. Van Flandern

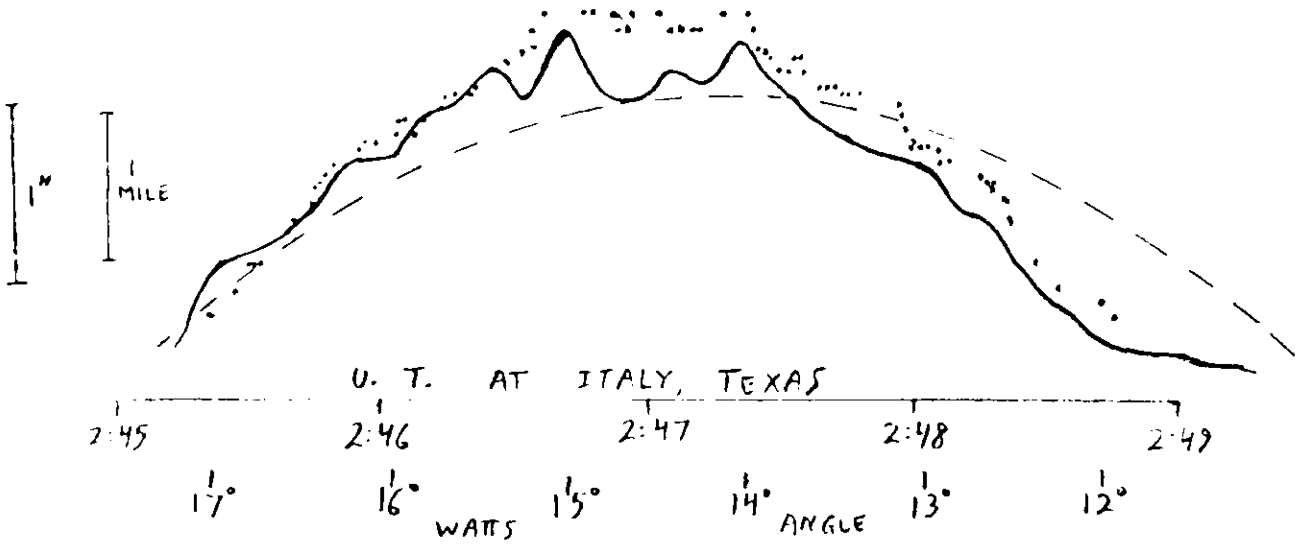
The most obvious use of grazing occultation observations is to study the moon's motion in ecliptic latitude. The lunar laser ranging experiment gives unprecedented accuracy in measuring the moon's distance, while observations of total occultations give precise information about the moon's ecliptic longitude with respect to the stars. Grazing occultation observations measure the moon's cross-track motion, which is determined mainly by the inclination and longitude of the node of the moon's orbit, elements to which the other observation types are relatively insensitive. Problems with obtaining agreement between the predicted and observed motions of the obliquity of the ecliptic (which in turn affects the system of stellar proper motions, and the inferred mass and rotation rate of the Galaxy), and of the longitude of the node of the moon's orbit, can be resolved or brought into sharper focus with grazing occultation data. It is presently planned to use all three types of data in combined solutions to improve all lunar orbit parameters. In particular, the orientation of the inertial system implicit in the laser ranging observations with respect to the fundamental reference system FK4, and the offsets in three dimensions of the center of the Watts limb correction datum from the lunar center of mass, can only be determined unambiguously in such a combined solution.

The graze observations provide very accurate data about lunar limb profiles. Heights of the order of 15 meters can be resolved. (Unfortunately, lunar orbiter photographs have neither the selenodetic control, nor the earth-based perspective, needed for lunar profiles; the spacecraft positions and orientations were too poorly known.) An error of 0°2 in position angle for Watts' reference datum was discovered from early graze observations. Studies to determine other small systematic errors in the Watts datum, such as ellipticity and variations in size or shape with librations, are in progress, but observations over a complete 19-year nodal cycle will be needed for a comprehensive analysis. Graze data greatly improve the separability of parameters when combined with total occultation data, which in turn enable the solutions to give more accurate estimates of interesting values such as the rate of change of the gravitational constant.

Since the moon occults stars over a large region of the sky, and since its motion can be described to high accuracy mathematically, it can in principle be used to determine a very accurate dynamical system of stellar right ascensions and declinations. The relative accuracies attained with graze observations are on the order of a few hundredths of a second of arc. Problems with variations in the dimensions of the reference sphere for limb corrections with librations, plus errors in individual star positions, will need to be studied and eliminated before an accurate reference system in the zodiacal regions can be determined dynamically from occultation data.

Due to the grazing geometry, observers often see the components of a close double star disappear or reappear in two steps. Stars with separations as small as 0.01 arc second can be resolved, about an order of magnitude improvement over standard visual methods, and nearly as small as binaries which can be resolved by photoelectric observations of total occultations. Grazing and photoelectric total occultation observations can detect and measure double stars too close for the usual visual and photographic methods, yet too far apart for their radial velocity difference to be distinguished by the Doppler effect in spectra.

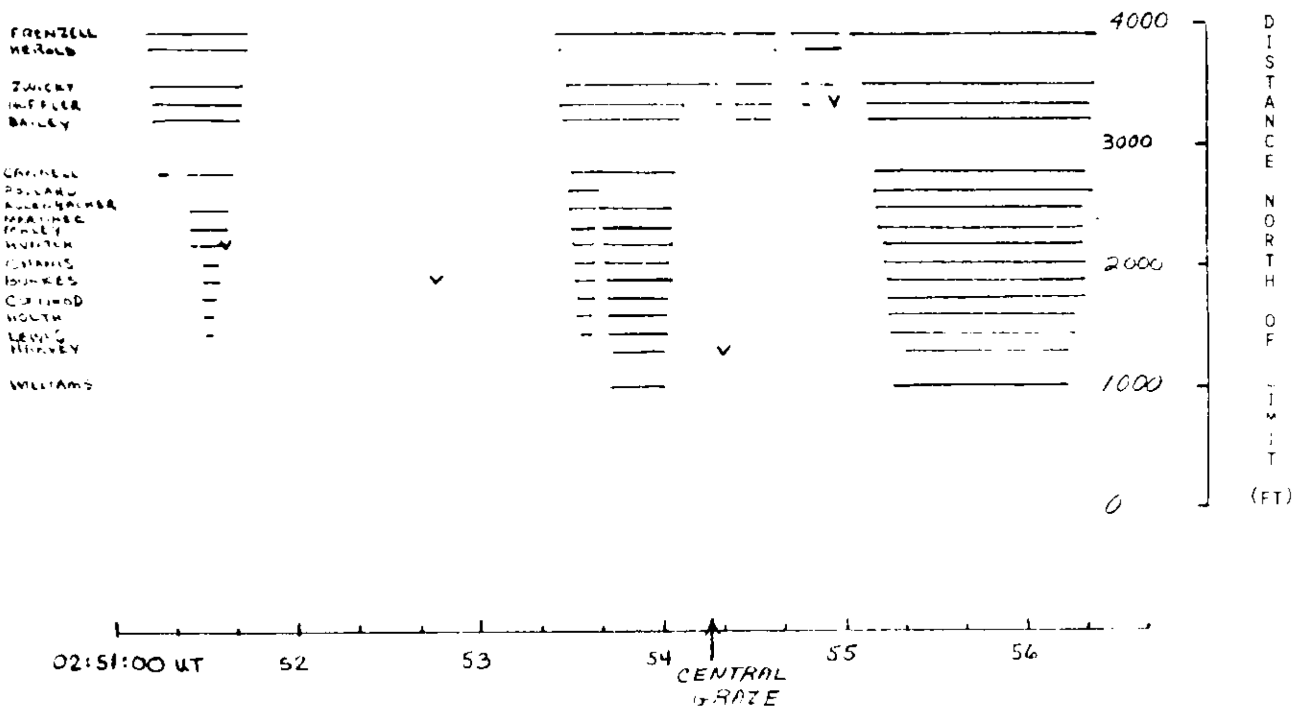
The voluntary efforts of amateur astronomers around the world to collect observations is, of course, essential to the survival of the program. Some groups have built rather expensive special equipment with which to make the observations. Many thousands of man hours of work for the program have been contributed by the most enthusiastic individuals. This is one of the few astronomical endeavors where large numbers of amateur observers obtain data of scientific value which could not, for the most part, be obtained at professional observatories.



PROFILE FOR GRAZE OF 53 TAURI AT ITALY, TEXAS, MARCH 19, 1975

Dots are observed contacts, the wavy line is the profile predicted from Watts' charts, and the dashed curve is the moon's mean limb. The observations were plotted by Danny Morrison on Watts' predicted profile, which was drawn by Brian Cuthbertson from data supplied by the U. S. Naval Observatory.

GRAZE OF 21 SAGITTARI, 1975 OCTOBER 11, KATY, TEXAS



GRAZES REPORTED TO IOTA

David W. Dunham

Read "The Scientific Value of Grazing Occultations" on p. 66. A slightly different earlier version was used on my unsuccessful federal grant applications over a year ago. Thomas Van Flandern and I decided to publish the article here in order to help you obtain the support of local observers, those running predictions to get computer time, etc.

Predictions of north and south shifts based on Yale Catalog positions are now being computed by John D. Phelps, Jr.; 8621 W. 167th Place; Orland Park, IL 60462, for observers in the C-Region (mainly the midwestern U.S. and central Canada; those observers who receive their predictions from Joseph Senne, Rolla, MO), and by Thomas H. Campbell, Jr.; 5405 98th Avenue; Temple Terrace, FL 33617, for observers in the southeastern and south central U.S. (D- and E-Regions). Requests for shift calculations should be sent soon (preferably within a week) after receipt of predictions, since Phelps has to make special arrangements to visit a distant library to look up the data, and can only do this about every three months. Campbell has easier access, but has to schedule his time carefully due to evening college work and other outside projects. A self-addressed postcard should be sent, along with the Z.C. and/or SAO number, date, position angle, and expected number of observing stations for each graze for which a shift is desired. For observers not in areas covered by Phelps or Campbell, Yale shift requests should be sent to me if 5 or more stations are planned. AGK3 (only covers the sky north of dec. -2°) shifts for all observers are available from me if 3 or more stations are planned. These shifts are useful for improving the positions only of stars whose position source, listed in the heading of the predictions, is Z.C. or G.C. The other catalogs used are more accurate than Yale or AGK3. Also, it might be useful to check graze observation lists in previous issues of *o.n.*, to see if a graze of the star has been observed previously. If so, and if an observed shift was reported, that would be better to apply than any Yale or AGK3 shift we could compute. The shifts reported in the lists are now with respect to the computer-produced profiles, which include many empirical corrections. Readers are reminded that a description of the computer-produced (ACLPPP) profiles now being distributed to most observers is on p. 46 of last August's issue. The position angle of graze given on the ACLPPP profile is for a point in the limit close (usually very close) to the point in the line which is closest to the observer, while the U.T. and coordinates given on the lower left side are usually for another point, often much farther away (usually west). Watts angle and cusp angle have also been adjusted to the close point to give a more useful presentation of the profile for the observer.

The Mira variable star U Orionis (Z05115) is now undergoing a series of occultations. It will be at minimum light during the early spring and will not be observable for the next several months during occultations. Its next maximum will be late in the summer.

The results of Robert Sandy's expedition for the graze of the FK4 star λ Piscium (Z.C. 3494) on November 13th have helped to define the lunar profile in a previously poorly observed part of the southern Cassini region. The computors have been sent correction data for the ACLPPP to include these results, along with some others for the northern Cassini region, supplied by Richard Nolthenius, based on an expedition he led on 1974 Sept. 12.

Paul Maley's expedition for the graze of 21 Sagittarii (Z.C. 2666) on October 11 was the most successful effort of 1975. Perhaps most remarkable was the fact that he got the final report to me within two weeks of the event, amazing for such a big expedition with so many timings. Another expedition for the graze, near Dalton, Georgia, jointly led by Emil Volcheck (Chattanooga, TN), Mike Reynolds (Jacksonville, FL), and me, obtained about 25 timings; the exact number is not available yet since the timings made by the Jacksonville observers (who manned half of the stations) have not yet been received. When the timings for all expeditions are added up, the graze will occupy the #3 position in the top dozen list (see p. 16 of the 1974 October issue). The Houston, Texas observers led by Maley have an opportunity to observe another graze of the star this month.

Steven Bourgeois' expedition from Albuquerque, NM, for the graze of 53 Tauri (Z.C. 633) during 1975 March 19 netted six relative timings; shortwave time signals failed to be recorded. However, from their known position and the numerous accurate timings made by expeditions east and west of New Mexico, it will be possible to establish absolute times with careful reduction calculations, as soon as the Albuquerque report is received. This means that the total number of timings made during the graze was 158, qualifying it for the #5 position (#4 before October 11).

David Herald's 20-station expedition (the largest number of stations of any during 1975) for the graze of Spica in Australia on November 29 (see the New Double Stars section) netted "at least 103 primary events." It will certainly qualify for the top dozen, especially when the timings for the other components are added. It is at least the second most successful expedition in the Southern Hemisphere (unless South Africans did better during a graze of Spica the next month) and, considering the thin crescent moon, 1st-magnitude star, and the nighttime circumstances, must be one of the most spectacular grazes ever observed.

Of well over a hundred grazes which he has observed, Richard Nolthenius considers the graze of κ Virginis (Z.C. 1815) which he observed on November 1 to be the most spectacular. Due to the negative cusp angle, the graze was not in our usual graze prediction coverage, being just outside of a limit in USNO's graze selection program. At 5% sunlit, the cusp was so thin that it was substantially dimmer than the star. Nolthenius found out about the graze from a "GRAZE NEARBY" message in his USNO total occultation predictions (with "extended graze radius option"). The sun's altitude was -4°9 at Nolthenius' location.

A couple of volunteers have begun the slow job of keypunching the large backlog of graze observations not now in machine-readable form. A few more workers would be welcome. New report forms will be designed to make the keypunching easier for future events, and will be distributed to observers when the supply of the current forms is exhausted (which will be soon).

Observers should watch for graze predictions which have only the heading, or only one line of data. If there is one line of data, it will not refer to the graze in the heading, but instead to the previously listed graze. We have known about this problem for some time. It only occurs when the moon is low in the east, always so low in the past that the graze could not be observed, so we did not take the time to track the problem down. However, Homer DaBoll, John Phelps, and Berton Stevens found two grazes in their early 1976 C-Region predictions like this, but which are favorable enough that they might be observed. Joseph Senne did some investigating and made some changes to the program which circumvented the error by specifying a special input quantity. Following Dr. Senne's lead, I figured out why the error occurred (it was rather obscure, in a part of the program written mainly by John Cotton, Dallas, TX, several years ago). Program changes to correct the error are being sent to all the computors, so if you have one of these bad cases in your early 1976 predictions, write to your computor to get revised data.

When James Fox plotted the results of his expedition for the graze of ZC 2816 on October 12 onto an ACLPPP profile, he found a 0°4 offset in position angle. Paul Maley also noticed that his results for the 21 Sagittarii graze the night before did not line up with the ACLPPP profile. The problem turned out to be in the graze program, and was one which was not noticed, or was easily circumvented, when profiles were manually drawn. No error could be found in the program, and I expect that it is a mathematical limitation of the method. By making changes in both ACLPPP and the graze program, we were able to bypass the error with the help of accurate data on the limb cor rection cards from USNO. These program changes were sent to the computors in December.

An examination of many grazes computed on both versions 72C and 75A showed that the difference rarely exceeded 0"25, and did so in no obvious pattern. Due to the small size of these shifts, it was decided that no program changes were needed for the "75" versions.

Although the two expeditions I led on November 11 were on the same U.T. date, they were during separate local nights, 19 hours apart. Nevertheless, the shifts for the two grazes were similar, so the data for the first event were successfully used to get into an advantageous position on the profile for the second graze. Keith Horne had to really hustle for the two grazes he observed during 1975 September 29, since they were separated by 12 miles and 27 minutes. Fortunately, the moon was rather low in the east, so that he left his telescope set up in his van and observed by opening the side door. On 1973 March 8, a five-station expedition from Austin, TX, managed to observe a similar pair of grazes 8 miles and 27 minutes apart.

During the August 30th graze expedition, Harold Povenmire independently discovered Nova Cygni. The October 26th graze near Princeville, IL, was rather easy in spite of the -2°1 sun altitude. The moon was 60° high.

Starting with this issue, I've decided to include all reports received , in the list, whether they were made before or after 1974 January 1. This may stimulate some tardy "graze turkeys" to get in their reports (including a few of my own).

The expedition for the graze of Z.C. 3320 (Situla or κ Aquarii) on 1973 December 2 had a north shift of 1"2 on the then-current version, but zero on 75 versions with ACLPPP corrections applied (this is the shift listed; the observations of this FK4 star, along with others observed that month, were important for determining the empirical corrections we are now using). Situla is still being occulted, and at least three other successful expeditions have observed grazes of the star. One was in the U.S.S.R. in 1973, according to Dr. A. Osipov, Kiev, Ukraine. Observations of future grazes of Situla will have special value for studies of the moon's orbit and profile.

The grazes of the two 5.2-magnitude stars 64 and 71 Orionis (Z.C. 913 and 947) on 1976 March 10 U.T., both visible from northern California and southern Nevada will be especially valuable for studying the moon's northern limb over a large range of position angles (or Watts angles) and will be a valuable check of the northern limit empirical corrections used in ALCPPP. The graze of 64 Orionis also passes near Albuquerque, NM; Dallas, TX; New Orleans, LA; and Miami, FL, where there will probably be expeditions (see p. 12 of the *1976 Occultation Supplement*).

Mo	Dy	Star Number	Mag	% Snl	CA	Location	# Sta	# Tm	C C	Ap cm	Organizer	St WA b
1973												
12	2	3320	5.3	50+	14S	Freehold, NJ	11	27	9	6	Trudy Bell	0167 -5
12	2	3320	5.3	50+	14S	Huntington, NY	5	9	9	8	Trudy Bell	0167 -5
1974												
6	20	Sun	-27	0		Cave Pt., W.Austrl.	1	2	9		Harold Povenmire	
1975												
1	24	0847	3.0	88+	-	Longwy, France	2	8		13	Jean Bourgeois	
5	19	Z10338	7.2	58+	6N	Palm Bay, FL	7	14		41	Harold Povenmire	
6	1	3272	5.8	56-	8N	Stuart, FL	5	24		25	Harold Povenmire	
7	14	1743	6.8	35+	0	Fukuchiyama, Japan	1	2		8	Uehara	
7	14	1743	6.8	35+	0	Hamamatsu, Japan	1	2		6	Motonobu Tonomura	
7	18	2119	6.7	78+	S	Canberra, Austrl.	3	13	6	8	David Herald	
8	3	Z04190	7.8	20-	-1S	Corn Creek, NV	1	2	8	15	Walter Morgan	178 26
8	16	Z16381	7.2	71+	11S	Palm Bay, FL	2	10		25	Harold Povenmire	S
8	30	o700	5.7	46-	4N	Homestead, FL	3	3		25	Harold Povenmire	
8	31	Z04887	7.2	34-		Wynola, CA	1	1	6	25	John Hildebrand	
9	1	Z06196	8.0	25-	0N	Buckley, IL	1	1	5	20	John Phelps	C3N355 43
9	7	1759	6.5	4+		Cooma, Australia	3	18	5	8	David Herald	
9	13	2547	4.9	55+	10S	Tarpon Springs, FL	1	1	6	20	Thomas Campbell	0
9	28	0971	7.3	50-	1N	Randsburg, CA	1	1	6	25	Keith Horne	
9	28	0971	7.3	50-	0N	Boulder City, NV	2	4	9	15	Walter Morgan	
9	29	Z07085	8.8	40-	2N	Lucerne Valley, CA	1	1	3	25	Keith Horne	358
9	29	Z07116	8.9	40-	2N	Stoddard Ridge, CA	1	1	5	25	Keith Horne	358
9	30	Z08240	7.6	30-	S	Brighton, WI	1	2	7	15	Berton Stevens	
10	2	Z10117	8.1	10-	7S	Perris, CA	1	10	9	25	Keith Horne	180
10	10	Z16854	8.5	29+	9S	Withamsville, OH	1	1	3	25	David Dunham	167-25
10	11	2666	5.0	40+	14S	Katy, TX	18	147	9	8	Paul Maley	0165-41
10	11	2666	5.0	40+	14S	Edwards, MS	1	4	8	20	Robert Schiffer	0165-41
10	11	2666	5.0	40+	14S	Clinton, MS	3	11	5	6	Ben Hudgens	0165-41
10	12	2816	6.8	50+	12S	Rochester, MN	5	25	8	15	James Fox	3S168-49
10	12	Z20167	8.6	51+	13S	Lockhart, CA	1	1	8	25	Keith Horne	166
10	13	Z22368	8.7	69+	8S	Vermilion, OH	1	4	3	15	Gary Ringler	173-59
10	15	3184	7.1	78+	S	Toltec, AZ	1	0	7	15	Richard Nolthenius	>6N174-61
10	16	Z24120	8.5	86+	16S	Vail, AZ	1	2	4	15	Richard Nolthenius	170-60
10	25	0894	4.6	77-	6N	Spring Lake, FL	1	0	3	20	Thomas Campbell	CN358 44
10	25	0894	4.6	77-	6N	Edgewater, FL	2	4		25	Harold Povenmire	CN358 44
10	25	Z05221	8.7	76-	6N	Amado, AZ	1	3	4	15	Richard Nolthenius	CN358 45
10	25	0915	4.7	75-	2N	Searchlight, NV	2	2	9	15	Walter Morgan	
10	26	1072	6.2	65-	9S	Victor, IA	1	1		20	Frank Olsen	
10	26	1072	6.2	65-	9S	Princeville, IL	7	40	8	15	Bart Benjamin	4S192 58
10	27	1190	7.1	55-	2N	Tucson, AZ	1	1	8	15	R. Nolthenius	C6N358 64
10	28	Z08960	8.9	44-	1S	Continental, AZ	1	4	7	15	R. Nolthenius	0181 69
10	28	Z08960	8.9	44-	9S	Satellite Bch., FL	1	0		41	Harold Povenmire	
10	29	Z09719	7.8	34-	0N	La Fox, IL	5	6	4	20	Homer DaBoll	C3N354 72
10	29	Z09748	8.5	33-	3S	Cincinnati, OH	1	5	6	25	David Dunham	0181 71
10	30	Z10448	7.5	23-	2S	Buckley, IL	2	12	7	20	John Phelps	9S178 68
10	30	Z10542	8.6	22-	6S	Green Valley, AZ	1	2	5	20	Robert Lasch	13N180 66
10	30	Z10547	8.1	22-	5S	Warner Springs, CA	2	6	8	25	Keith Horne	185
10	30	Z10547	8.1	22-	6S	Marana, AZ	1	8	7	15	Richard Nolthenius	0186 66
11	1	1815	4.8	5-	-9N	Needles, CA	3	21	7	10	Walter Morgan	
11	1	1815	4.8	5-	-10N	Bumble Bee, AZ	1	10	9	15	Richard Nolthenius	C 2 47
11	8	Z19408	9.1	23+	10S	Manilla, IN	1	1	2	25	David Dunham	167-46
11	8	Z19561	9.0	24+	11S	Rillito, AZ	1	7	7	15	Richard Nolthenius	18S166-49
11	11	3154	7.4	53+	9S	Terrill, KY	4	14	7	20	David Dunham	6S172-64
11	11	Z23131	9.2	53+	12S	Red Rock, AZ	1	6	4	15	Richard Nolthenius	10N169-65
11	11	Z23137	8.1	54+	11S	Mercury, NV	3	6	8	15	Walter Morgan	
11	11	3259	7.4	62+	10S	Batesville, IN	2	16	8	20	David Dunham	6S171-60
11	11	3259	7.4	62+	10S	Bay Village, OH	1	5	6	15	Gary Ringler	171-60
11	13	3494	4.6	79+	7S	Odessa, MO	2	6	8	15	Robert Sandy	C177-50
11	22	1040	6.2	87-	6S	North Lake, WI	4	11	4	20	Paul Murn	
11	26	Z10338	7.4	47-	8S	El Descanso, Mex.	2	2	6	8	Keith Horne	10N187 7
11	27	1623	5.4	38-	N	Pocahontas, MS	2	2	5	8	Ben Hudgens	N
11	30	2017	6.4	8-	6S	Stuart, FL	3	12		25	Harold Povenmire	
12	7	Z21581	8.4	17+	7S	Rockledge, FL	2	13		25	Harold Povenmire	
12	8	Z22735	8.5	26+	10S	Radec, CA	2	4	8	25	Keith Horne	15N167-63
12	8	Z22735	8.5	26+	6S	Hastings, MN	1	4	4	25	James Fox	1 N172-63
12	8	Z22777	8.7	26+	7S	Klondyke, AZ	1	10	4	15	Richard Nolthenius	10N167-65
1976												
1	6	3290	7.3	19+	2S	Heekin, KY	6	14	8	20	David Dunham	C4N176-61
1	8	Z25246	8.2	35+	6S	Samsula, FL	1	4		25	Harold Povenmire	
1	10	Z01351	8.8	56+	5N	Gilman, IL	1	1	4	20	John Phelps	6S 7 25

OCCULTATIONS OF MESSIER OBJECTS

David W. Dunham

Richard Nolthenius noticed that during the morning of 1975 October 28, about half of the open cluster M67 in Cancer would be occulted by the 44% sunlit waning moon as seen from his area. He observed a graze of an 8.9-mag. SAO star, an outer member of M67, just before the cluster was occulted. The observable occultations "were all reappearances and I didn't get any timings, but all those dozens of 10th mag. stars against the earthshine looked really beautiful," according to Nolthenius.

A long series of occultations of M67 is now in progress. The cluster's total magnitude is 6.1, but it is composed of about 65 tenth-magnitude stars spread over an area about 15' in diameter, half the moon's diameter. Due to the faintness of the stars and the fact that the moon will be nearly full, the January and February occultations will not be observable. The table below lists occultations of the cluster for the rest of the first half of this year, based on University of Texas predictions computed by Frank Fekel using input data supplied by me. The moon's phase will be waxing (so disappearances will be at the dark limb) for all events in the list. The moon will probably still be too bright to see most of the members of M67 during the occultation in March.

1976 Date	Approx. U. T.	% Snl	Nighttime Area of Visibility
Mar 13	2^h - 3^h	87+	North America
Apr 9	12 - 14	69+	Asia, northwest Pacific Ocean
May 6	20 - 21	46+	Europe, n. Africa
June 3	2 - 3	24+	U.S.A., Mexico, Caribbean east of longitude 100° west
Jun 30	7 - 8	8+	North-central Pacific Ocean

The May 6 and June 3 events should be the best, and visible from heavily populated areas. They should present good photographic opportunities. Use the largest available telescope and a tape recorder to accurately time many events in quick succession, as during a Pleiades passage. Draw a diagram of the cluster as you see it before the occultation and number the stars, to make identification of non-SAO stars as easy as possible. 8.0-mag. SAO 98178 is 12' east and 5' north of the center of the cluster.

Nolthenius has compiled a list of two dozen other zodiacal deep sky objects, brighter than mag. 10.0. They are mostly open and globular clusters, but two are diffuse nebulae (M8 and M20), one is a planetary nebula (Saturn Nebula), and one is a supernova remnant (Crab Nebula). A series of occultations of the Crab ended recently and was of great interest to X-ray astronomers. Calculations are in progress to determine which of these objects are now being occulted. The occultations of individual members of only the brighter open clusters are likely to be observable, and then only at favorable lunar phases. Most of the bright open clusters have been well studied, and lists of the positions of their member stars are available. These could be used to compute detailed occultation predictions, as has been done with the Pleiades, and hopefully will be done for other clusters in the future. Some astronomers at the University of Texas have been interested in observing occultations of small planetary nebulae photoelectrically to measure accurate diameters, and have computed some predictions for McDonald Observatory, but I have heard of no successful observations.

The May 6 and June 3 events should be the best, and visible from heavily populated areas. They should present good photographic opportunities. Use the largest available telescope and a tape recorder to accurately time many events in quick succession, as during a Pleiades passage. Draw a diagram of the cluster as you see it before the occultation, and number the stars, to make identification of non-SAO stars as easy as possible. 8.0-mag. SAO 98178 is 12' east and 5' north of the center of the cluster.

Nolthenius has compiled a list of two dozen other zodiacal deep sky objects, all but three of them Messier objects, brighter than mag. 10.0. They are mostly open and globular clusters, but two are diffuse nebulae (M8 and M20), one is a planetary nebula (Saturn Nebula), and one is a supernova remnant (Crab Nebula). A series of occultations of the Crab ended recently and was of great interest to X-ray astronomers. Calculations are in progress to determine which of these objects are now being occulted. The occultations of individual members of only the brighter open clusters are likely to be observable, and then only at favorable lunar phases. Most of the bright open clusters have been well studied, and lists of the positions of their member stars are available. These could be used to compute detailed occultation predictions, as has been done with the Pleiades, and hopefully will be done for other clusters in the future. Some astronomers at the University of Texas have been interested in observing occultations of small planetary nebulae photoelectrically to measure accurate diameters, and have computed some predictions for McDonald Observatory, but I have heard of no successful observations.

ANOTHER ELECTRONIC STOPWATCH

Walter V. Morgan

The HP-55 pocket calculator has a built-in electronic timer, as has been mentioned in *Occultation Newsletter*. I have just learned that the HP-45 also has this, but unfortunately without a precise time base. However, it does appear to be quite stable, so IOTA members who have access to an HP-45 may find it useful in some cases, applying a calibration multiplier after the timing. For whatever value it may have, here is how to use an HP-45 as a timer.

Switch ON. Press RCL. Press simultaneously 7,8,CHS. Four pairs of zeros should appear. (If they do not, repeat RCL, and 7,8,CHS. The problem is most likely in the simultaneity of the pressing. I recommend the three middle fingers of one hand, with the calculator on a hard surface.) Press CHS to alternately start and stop the time, displayed as HH.MM SS SS. EEX will alternately suppress and display the hundredths of a second. Pressing any digit 1 through 9 will store time in that register, which may be recalled later after the timer is stopped. The time of stoppping is recalled by pressing zero. Return to normal operation with ENTER, or decimal. If it is desired to start with some non-zero time, simply enter that time as HH.MMSSSS (or just part of those) prior to pressing RCL.

My HP-45 runs about 10% slow, requiring a correcting multiplier of 1.105 when on AC, and 1.102 on battery. Quite probably there is some dependency on battery condition and temperature. In view of the accuracies needed by IOTA, this may turn out to be a toy timer; but a fun toy, at l ast

[Ed: We note that Edmund Scientific Co. lists an electronic digital stopwatch, at $120.00. Accuracy is stated to be ±0.0001%. See their catalog for other specifications. We have not seen one. We would be happy to publish a brief report by an actual user.]

ON WEATHER FORECASTS

N. P. Wieth-Knudsen

[Ed: The author ranked #1 in the 1973 Total Occultation Tally and #2 in 1974. See *Occultation Newsletter, 1*, 22 and 39. This note accompanied his coupon for 1974.]

Surely, I shall not hold the same top rank, as in 1973, due to the moistness, damp, and fog, accompanying our rather mild winter, now and a year ago, although the fact that my number of over-nightings at "Dorthens Huus" (my land-house observatory) was some 10% higher than formerly shows that I was no less persistent in trying to take advantage of clear nights.

I am much indebted to weather forecasts for the degree of success I have enjoyed. But even if I pay some attention to the immediate forecasts, I am much more interested in the general weather situation reported - with high pressure zones, depressions, etc. - and in following the movements of these features by a comparative study of the successive reports. This gives a sort of "second derivative of the weather", considering a forecast itself as a "first derivative" - to be applied for an interpretation of observation on actual weather features. It is my opinion that the most common reasons for failure of an actual weather forecast are the facts that weather development may run faster or slower, or depressions may move otherwise, than predicted. To some extent, these can be taken into consideration by such "comparative listening" to forecasts.