Occultation Newsletter

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IOTA NEWS

David W. Dunham

The last issue of *Occultation Newsletter* was duplicated by Roger Hoefer of the Miami Valley Astronomical Society (MVAS), using the facilities of the Dayton (OH) Museum of Natural History. IOTA had to pay for the cost of materials only, a considerable saving over having the job done commercially. Douglas Sauer, another MVAS member, who was to have collated and mailed the issue, was stranded in Kentucky, due to a car breakdown, so Art Hudson took the un-collated material to the convention of the Great Lakes Region of the Astronomical League in Indianapolis, where Hudson, Gary and Kathy Ringler, Rick Binzel, Joan and I assembled the mailing Sunday, June 20th. Joan and I were also in a hurry to drive to Silver Spring that day to make arrangements for our move the next day, when the issue was finally mailed. This and future issues will be assembled and mailed by Douglas Sauer and other MVAS members, to be reimbursed for materials and postage costs by IOTA. This should make it unnecessary to raise IOTA dues for some time, and possibly we could even lower them, if we are too rich when we assess IOTA's financial position early in 1977.

The Spanish edition of *Occultation Newsletter* (issue #8 only) is now available free from Guillermo Mallén, Goya 64-11, Col. Mixcoac, Mexico 19, D.F., Mexico. Mucho gracias to Eduardo Przybyl, Rafaela, Argentina, for doing the translation, and to the Instituto de Astronomia of the Universidad Nacional Autonoma de Mexico for providing duplication and mail services. A small fee probably will have to be charged when the number of observers wanting the Spanish edition becomes too large.

During the last three months, we have received two requests for IOTA's mailing list. As a temporary policy, we have decided to sell our mailing list to such requesters for $25, if they are willing to buy it. This should filter out some requests, but even if we offered the list for free, it is doubtful that your mail box would be filled with junk mail as a result. In this way, someone selling equipment which may indeed be of interest to many of us can send us an advertisement without going to a somewhat greater expense of putting an ad in *Sky and Telescope*, for example. If you have any strong feelings about this, let us know; we could make provision to delete certain addresses when requests for IOTA's mailing list are filled. The first request was from Dr. Hynek's Center for UFO Studies, which wants to poll serious observing amateur astronomers. Although we won't bend over backwards for such requests, it might be of some value for them to know that most serious observers have negative views on the subject, if that is the case. Another possibility along these lines is to accept paid advertising in *Occultation Newsletter*, but we have received no requests for this, and have therefore formed no policy.

Definite sections have evolved in *Occultation Newsletter*, such as IOTA News, Lunar Occultations of Planets, New Double Stars, Grazes, Planetary Occultations, Galactic-Nebular Objects, observations of special events, and star position errors. If you send me a letter containing information relating to two or more different sections, it would be helpful to have them written on separate pieces of paper, each with date and your name. I know that in some such cases, I have left out some material which I wanted to include. Also, write the information in a form as ready as possible for publication here, sending it to Mr. DaBoll, the editor, rather than to me, for items several sentences, or more than one paragraph long. Preparation of material for *Occultation Newsletter* takes a lot of my time, which in part could be better spent working on such things as the *IOTA Graze Manual* or minor planets computer work (see Planetary Occultations, p. 85-86). Therefore I would like to decrease the percentage of *O.N.* written by me, and strongly encourage others who can write passable English and are reasonably capable of meeting deadlines, to volunteer to write some of the sections of *O.N.* If you volunteer to do a section, we would publish an announcement of this in the next issue, asking observers to send reports relating to your section directly to you. This would also help the separation problem mentioned above.

I am no longer in Cincinnati. My address is now: P.O. Box 488, Silver Spring, Maryland 20907. My telephone number is 301,585-0989. I work in the Orbit Determination Department of Computer Sciences Corporation's System Sciences Division, which does contract work for Goddard Space Flight Center. This does not include work on occultations, which, like most of you, I must do during evenings and on weekends. The U.S. Naval Observatory is nearby, so that I can work closely with Thomas Van Flandern and Peter Espenschied, thereby better coordinating IOTA activities with those of U.S.N.O. But the time I can work on occultations is limited, so help from others is needed in order to make better progress with the various IOTA projects, such as the manual and the Zodiacal double star project. I am grateful for the extra work currently done by others, such as the other IOTA officers, the computors for graze predictions, Michael Reynolds for writing the Lunar Occultations of Planets section, Robert Walker and Wayne Coskrey for keypunching data, and David Herald for determining faint star positions and preparing maps of the M24 and the 1978 March 24 lunar eclipse fields. I am especially indebted to Conrad Bardwell at Cincinnati Observatory. He gave much valuable assistance in my computer work in Cincinnati; the significant computational advances which were made during the past year would not have been possible without his help.

I am typing this less than a day before departing for France and the IAU General Assembly in Grenoble, where I plan to garner support for the minor planet occultation project (see p. 85-86), among other things. I will return September 7th.

STILL MORE TIMEKUBE

Our comment that the Timekube was being discontinued (*O.N. 1*, 66) is hereby retracted. Radio Shack's latest catalog not only lists it, at a reduced price of $31.95, but adds a CHV [sic] version, also at $31.95.

James H. Van Nuland writes: "I've been using my Timekube for 10 months and am pleased with it. Good reception of Colorado or Hawaii or both. I have found all three frequencies necessary at various times, but have always had a usable signal. No trouble with selector buttons yet.

"At a recent San Jose star party, I punched-up WWV for a coming occultation. A voice said, 'There goes that song again.' Another, "I don't know how that station can stay on the air, playing that one crummy tune all the time.' And a last, 'Well, I hear they get a lot of requests for it.'"

PASSAGE OF THE MOON THROUGH M24

David Herald

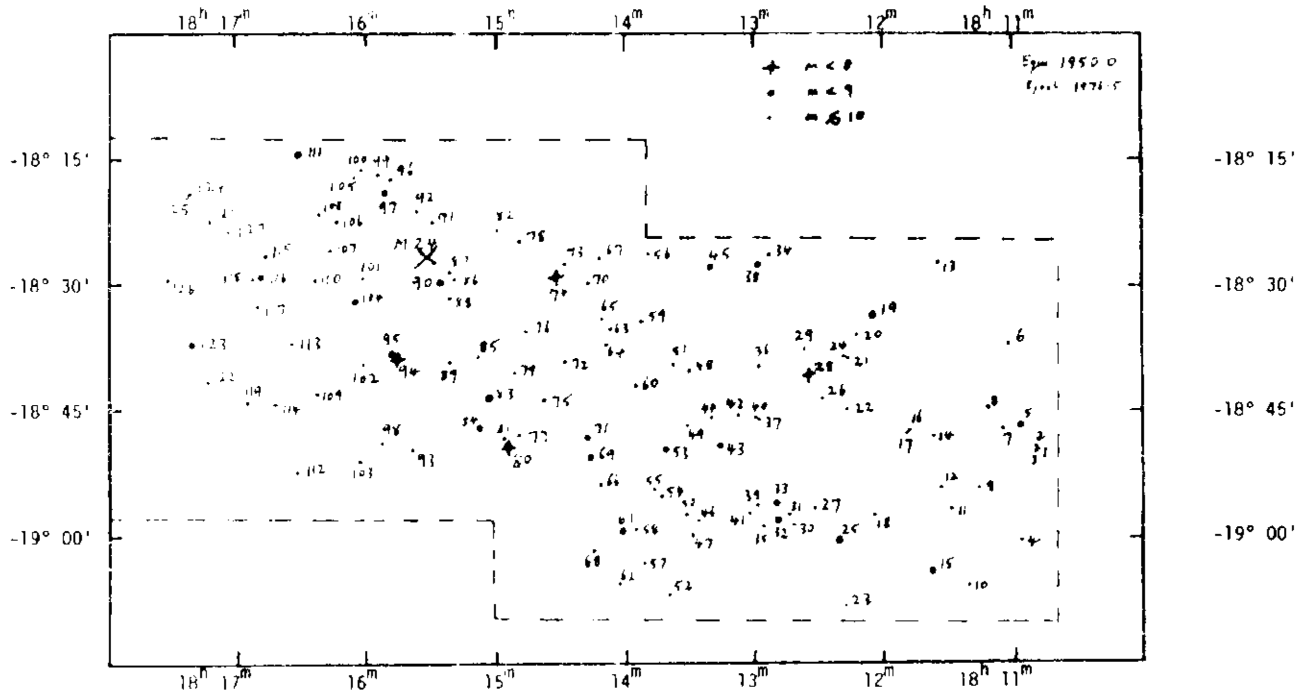
The Southern Hemisphere will see a series of M24 passages starting September ? (see the table on p. 77, col. 1). The best will be on November 14, observable from western Australia. M24 is actually composed of 15th magnitude stars, and is only about 5' in diameter. However, it is embedded in a rich field of 9th to 12th magnitude stars. I have taken and measured two photographs of this region. The photographs cover most of the star field, and I measured stars down to approximately mag. 10. The chart with this note is of the field near M24, made from the measurements, and can be used to determine approximate predictions. The stars are numbered in order of right ascension, and those which also have SAO numbers are cross-referenced in the table. There are six stars of 9th magnitude or brighter which are not included in the SAO, their numbers are: 19, 32, 38, 45, 69, and 104.

Note added by David Dunham:
Using Mr. Herald's measurements, accurate to 1" or 2", I will compute and distribute detailed occultation predictions of the stars near M24 to those in the region of visibility who request them, late in September or early October.

A table cross-referencing Mr. Herald's identification numbers with the Astrographic Catalog and the BD, as well as double star information, will be prepared for a later issue.

#	SAO	#	SAO	#	SAO
4	161200	59	161249	94	161304
15	161208	61	161255	95	161306
25	161217	62	161257	97	161308
28	161227	74	161267	111	161328
33	161229	80	161278	116	161335
43	161241	83	161284	123	161351
47	161245	84	161288		
53	161247	90	161294		

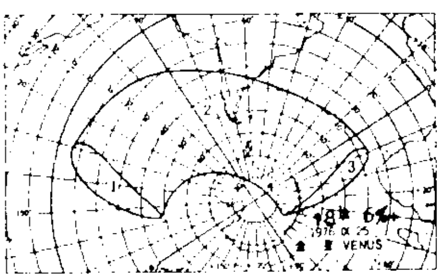
FIELD NEAR M24

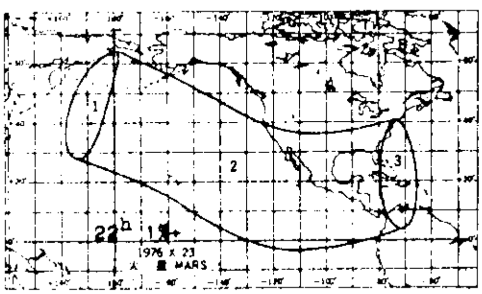


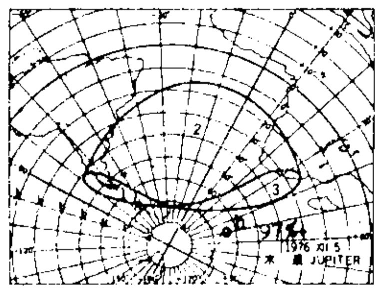
LUNAR OCCULTATIONS OF PLANETS

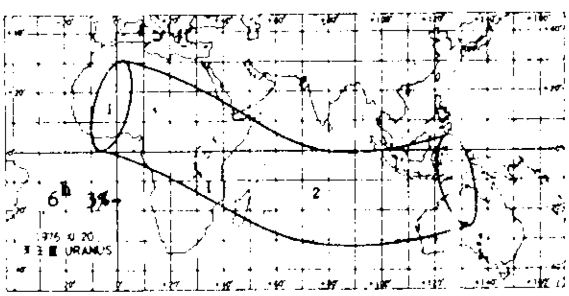
Mike Reynolds

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 Hydrographic Department of Japan.





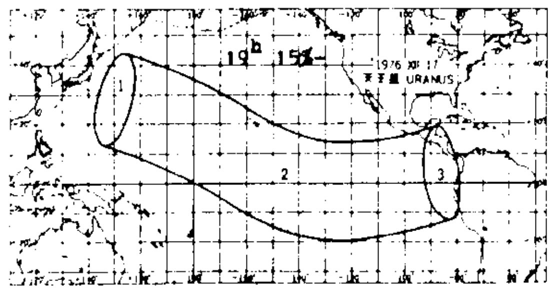




Region 1:
only R visible

Region 2:
R & D visible

Region 3:
only D visible



OBSERVATIONS AND ANALYSES
OF SOME TOTAL OCCULTATIONS,
INCLUDING β SCORPII

Richard Nolthenius

On UT date 1976 July 8, the 85% sunlit waxing moon occulted the multiple star system β Scorpii as seen from North America. In order to interpret the photometric data obtained during the occultation passage of this star system behind Jupiter's atmosphere in 1971 May, accurate information on magnitudes, position angles, and separations of all components is needed. This is especially important for the B component. The spacing of these components is too close to allow direct visual observation, and lunar occultation timings promise the best results.

In order to use occultation timings to determine position angles and separations for close multiple star systems, observations widely separated in occultation position angle must be made. This report presents the results made at observing sites in the San Jose Hills above the California Polytechnic University, Pomona, California.

For the best results, at each observation location, the slope of the lunar limb should be known over a distance corresponding to the separation of the stars. For the July 8 event as seen from southern California, resolving the components of the A and C systems of β Scorpii required finding the slope over a distance of about a mile along the lunar surface. This slope resolution was obtained by setting up a team of seven observers spaced over a mile and a half along a north-south direction. In this way, timings of a given star from each station corresponded to a height value at a different point on the lunar limb.

Given the geographic positions and times of occultation for two observers, the point of occultation on the lunar limb can be found for one observer with respect to the other by using quantities given in the U.S. Naval Observatory Total Occultation Predictions (with and without the photoelectric option) and by considering the geometry involved.

Table of Beta Scorpii Occultation Prediction Parameters

Comp.	PH	Azimuth	Alt.	Hour Angle	P. A.	W. A.	VA	Librations λ	Librations φ	a	b	c	CNTCT Angle	R "/sec	Distance	Declination
AB	D	190°8	35°4	9°352	123°5	111°1	114	1°6	-1°7	-2.1	-1.2	-0.5	-2[illegible]3	-0.3500	365155 km	-19° 44' 31"
C	D	190.8	35.4	9.352	122.6	110.2	113	1.8	-1.7	-2.1	-1.2	-0.5	-2[illegible].4	-0.3524	365155 km	-19 44 18
AB	R	211	30	27.842	249.3	237.0	223	1.5	-1.7	-1.8	-0.1	+1.0	-15[illegible].6	+0.3670	365703 km	-19 44 31

Altitude and azimuth can be found accurately from declination, hour angle, and the latitude of the observer using spherical trigonometry. Given a parallel to the mean limb and a central station star path, two quantities are needed to fix the position of the other timings; the distance σ between star paths on the lunar limb plot, and the height above the mean limb parallel. The station 3 timings were used to establish a central station reference elevation for the plots. σ can be found from S, the perpendicular distance between stations.

$$S = -(La_C - La)\sin B - (Lo_C - Lo)\, m \cos B$$

where m is the ratio of the length of a unit of longitude to a unit of latitude at the observer's latitude, and B is the bearing, or azimuth of travel of the moon's shadow. With the difference in elevation (E is elevation above sea level) considered, this becomes:

$$S = -(La_C - La)\sin B - (Lo_C - Lo)\, m \cos B - \frac{\sin D}{\tan(Alt)}(E_C - E), \text{ where } D = Az - B.$$

If S is converted to miles, then

$$\sigma = S \times VPS.$$

$$\sigma = \frac{0.864\, S}{\sqrt{\frac{\sin^2 D}{\sin^2 Alt} + \cos^2 D}} \text{ in arc seconds.}$$

B can be found from: $B = Az + \tan^{-1}[\tan(VA + CNTCT)\sin(Alt)]$ subtracting 180° if B > 180°.

The height value can be found from the a, b, c factors. Let T_p be the predicted time of occultation at the station, computed from the actual time of occultation at the central station T_c, and let T_a be the actual time of occultation. Then the height will be:

$$H = \frac{-(T_p - T_a)\, R}{\cos(CNTCT)} = [T_c - T_a - a(Lo_c - Lo) - b(La_c - La) - c(E_c - E)] \times \frac{-R}{\cos(CNTCT)}$$

For the β Scorpii occultation disappearance, these equations become:

VPS = .5011 arc sec/mile

$$\sigma = -.570\,(La_C - La) + .071\,(Lo_C - Lo) - .000133\,(E_C - E)$$

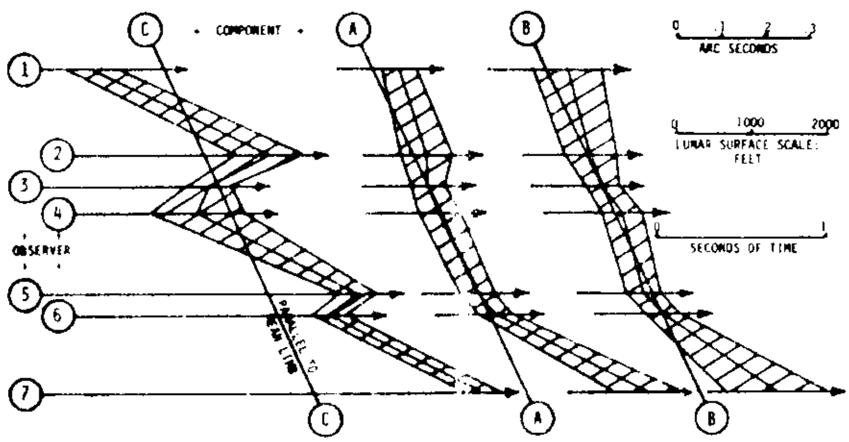
$$H = .388\,(T_C - T_a) + .467\,(La_C - La) + .816\,(Lo_C - Lo) + .00006\,(E_C - E)$$

for longitude and latitude in minutes, elevation in feet, and σ, H in arc seconds.

Respectively, the seven station numbers, observers, telescopes, and relative station heights (σ's) were: #1, Patti Gunther, 6" f/8 refl., +0"2202; #2, Alan Devault, 4" f/10 refl., +0"0705; #3, Richard Nolthenius, 6" f/8 refl., ±0"0000; #4, Susan Beran, 5" f/5 refr., -0"0612; #5, Pat Harvey, 6" f/8 refl., -0"2417; #6, Robert Fischer, 8" f/7.5 refl., -0"2923; and #7, Paul Gordon, 3" f/16, -0"4710. All observers succeeded in making timings of A, B, and C components, with estimated accuracies ranging from 0^{s}10 to 0^{s}30. Roughly speaking, for each observer, the disappearance of C was followed, in about 11 or 12 seconds, by the disappearance of A, which, in turn, was followed by the disappearance of B, after another second or so.

Comments were recorded at three stations, as follows: #3, 5.1 magnitude C component appeared to take between .05 and .10 seconds to disappear completely. AB system was suspected to have faded by .1 or .2 magnitudes 4.8 seconds before the disappearance of A. C system was expected to fade by .1 magnitude .2 second before final D. Though watched for, it was not detected. Estimated magnitude of B component was 6.3, compared to 5.1 of C and 6.5 of distant companion of ν Scorpii nearby. No unusual color seen; #4, 5.1 magnitude C component appeared to take . seconds to disappear completely. Fade appeared more or less gradual, but conditions at this station were not so favorable as to rule out a quick step, #6, 5.1 magnitude C component appeared to disappear instantaneously. B component estimated to be of magnitude 6.5.

All observers noted that A and B both disappeared sharply, with no fading. Only Beran and I saw C fade gradually.



The fadings seen at stations 3 and 4 may indicate a close companion to C. The limb plot suggests that such fadings might result if the primary disappeared on the mountain shown on the station 3 and 4 star tracks, leaving the companion visible in the valley above. If this were the case, the secondary would be about 0".2 north of the primary. The magnitude of the secondary probably would be faint enough that if it disappeared first the system would fade by not more than about 0.4 magnitude (an estimate of the smallest magnitude step observable at the other stations, especially the experienced observers at stations 5 and 6, who noted a rather sharp disappearance). This would put the secondary at about 7th magnitude. This is probably the 7.6 magnitude component (discovered photoelectrically during the 1971 occultation by Io) at PA 308 listed in the University of Texas Special Double Star List. The position angle has most likely changed due to orbital motion since 1971.

Less likely, considering the contact angle, is the possibility that the fadings were due to a distorted Fresnel diffraction effect. Limb plots were made for both possibilities. Assuming it was a diffraction effect, the times of final disappearance were used. Assuming duplicity, the times of first fading would correspond to the brighter component seen by the other observers, and thus it was these that were used in the second limb plot, which is the one shown. This enhanced the mountain - valley difference in elevation. In the plots, the hatched areas represent the accuracy of the timings. Error due to round-off of the a, b, and c factors is not included.

The sharpness of the disappearances of A and B suggests that there are no companions south and east of these stars brighter than about 9th magnitude, unless they are closer than about 0".05.

The B component was considerably brighter than expected. The estimate of 6.3 is considered accurate to within about half a magnitude. It was considerably brighter than 8.1 magnitude SAO 159684, which was a few minutes of arc away, but definitely much fainter than the 5.1 magnitude C component. Considering the Rhodesian observations indicating a magnitude of 7 or 8 last year, perhaps B is variable.

Most observers attempted to time the reappearance of β Scorpii A on the bright limb. However, only two doubtful timings were obtained, both probably a second or two late due to the difficulty of finding the star against the bright limb irradiation.

Not including the reappearance of β Scorpii A, timings of five other occultations were made that night. Among them was that of ZC 2296, magnitude 7.1. Harvey and I both made accurate timings of the disappearance. I saw the star fade gradually to invisibility over 0.15 seconds. As this may indicate duplicity, a limb profile (not shown) was drawn. The four others were SAO 159660, -662, -684, and -691.

THE REVISION OF *THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC* AND *THE ASTRONOMICAL EPHEMERIS*

U. S. Naval Observatory

Tentative plans have been made to revise the contents of *The American Ephemeris and Nautical Almanac* and the *Astronomical Ephemeris* beginning with the 1984 edition.

The revised *A.E.* will be a single, unified publication prepared by the French, German, British and American ephemeris offices.

New astronomical constants and new fundamental planetary and lunar theories will be introduced in the 1984 edition.

Since these revisions are planned so that the publications might better serve the requirements of all astronomers, the suggestions and comments of as many astronomers as possible are being sought. The principal modifications planned for the 1981 *A.E.* are as follows:

1. Replace the hourly apparent lunar ephemeris by daily short power series which permit the direct determination of the lunar position for any time.
2. Eliminate 1st differences.
3. Eliminate Independent Day Numbers.
4. Eliminate fixed tables for unit conversions.
5. Give longitudes and latitudes of the moon and planets to 0°.01 accuracy only.
6. Organize the volume into sections which have their own pagination.
7. Provide times of sunrise, sunset, moonrise, moonset for southern latitudes.
8. Provide times of civil twilight in addition to astronomical twilight.
9. Expand the list of occultations to include lunar occultations of radio sources and planetary occultations of stars.
10. Include transformation matrices for reduction of apparent places.
11. Include an ephemeris of the barycenter of the solar system.
12. Include a BIH polar motion table.
13. Include physical ephemerides for all planets, commensurate with current knowledge.
14. Give satellite ephemerides to observing accuracy for all satellites, generally for the entire year.
15. Provide minor planet ephemerides to 1" for as many as 20 minor planets.
16. Expand the star list to about 1600 stars.
17. Include standard lists of variable stars, radio sources, pulsars and X-ray sources.
18. Give locations of observatories to reduced precision in the annual Observatories List, and periodically publish for each observatory a list of accurate astronomic and geodetic locations of each instrument.
19. Introduce a rewritten explanation with a glossary of terms used in the volume.
20. Introduce tables of new values of astronomical constants as appropriate.
21. Introduce chapters for a new version of the *Explanatory Supplement* as supplements to the *A.E.* prior to the publication of the new volume.

Suggestions, comments, or requests for additional information can be sent to Dr. P. Kenneth Seidelmann, U. S. Naval Observatory, Washington, D.C. 20390.

FROM THE IOTA SECRETARY

Berton L. Stevens, Jr.

Quite a few observers have written me, to the effect that they have not received their predictions for the third quarter. They are mainly in the A3, D, F, and XB regions.

These regions were assigned to Gary Ringler, of Cleveland, Ohio, who was ready to run the predictions when an administrative problem prevented him from using the computer.

A3 has been assigned to Joe Sowers. D, F, and XB were reassigned to Wayne Green, of Jacksonville, Florida. Both computors expect to have the predictions and profiles out shortly.

Predictions and profiles for the fourth quarter should be in the hands of observers soon. If you have not received your predictions, please send me a postcard, so I can investigate.

You no longer need to request profiles; they are generated for each prediction, as part of the prediction process. If you are receiving limit data without profiles, please let me know.

Finally, if you are an IOTA member, and are not getting predictions, it may be that you did not return the Observer Information Form. We need the information on it, not only for computing grazes, but also for computing special events, such as occultations of planets by the moon, occultations during lunar eclipses, etc.

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Chicago, IL 60613

NEW DOUBLE STARS

David W. Dunham

The table lists additions and corrections to the special double star list of 1974 May 9 not listed in previous issues. The columns and general format are the same as in previous issues, except that as none of the stars listed are previously known doubles or triples, the usual columns for third components have been omitted.

The most interesting occultation of a double star since the last issue was the occultation of β Scorpii on July 8. I have learned second-hand that high-speed photoelectric records of the occultation were obtained at Davis, CA, Mt. Hopkins Observatory, AZ; and McDonald Observatory, TX. Other photoelectric records were likely obtained at other observatories. The information about the star in the special double star list will be updated as soon as results of the photoelectric observations are available. Unfortunately, the photoelectric data probably will not be of much help in deriving more information about the companion to the C component (Z.C. 2303), which was occulted before the bright AB components (Z.C. 2302) disappeared. Consequently, there was a high noise level since all components were in the observing diaphragm. But it will be possible to determine the magnitude, separation, and position angle of the B component to high accuracy, information needed for precise analysis of the light curves obtained when the system was occulted by Jupiter in 1971. A letter from Graham Blow states that the occultation of 1975 September 11 was recorded photoelectrically at Auckland, New Zealand.

Several reports of the total occultation of β Scorpii have been received from visual observers. The consensus seems to be that the B component is about magnitude 6½, considerably brighter than the estmates by Rhodesian observers during the occultation last October. Francis X. Hart led a team of four visual observers, but the most ambitious visual project was that organized by Richard Nolthenius, described on pp. 83-84. His group's observations indicated an A-B distance of 0".42 projected in the position angle direction 123°.

F. K. Reed, Scottsdale, AZ, reports an unusual observation: "In observing the occultation of β Scorpii, I noticed some scintillation (2 or 3 bright flashes of 2 or 3 magnitudes increase in brilliance) of the C component some 20 or 30 seconds before its disappearance. Seeing was excellent (steady diffraction rings around the stars in my 15-cm reflector). This scintillation was also seen by Ed Grath, observing the event with a 9-cm Questar, several kilometers distant."

Michael Reynold and Thomas Campbell, Jr. made extensive preparations to observe the southern-limit grazes of the components of β Scorpii from several sites across northern Florida. There was heavy cloudiness in the area, so they set up at several stations separated by large intervals across Florida in the predicted path, hoping that someone could observe the graze through a break in the clouds. Unfortunately, there were no breaks during the graze. Astronomers at Kitt Peak National Observatory, Arizona, who tried photoelectric observations, had the same bad luck with the weather, as did many others. Richard Nolthenius mentions that he tried to observe two earlier occultations of β Scorpii. On March 20, he could not find the star at 8° altitude with the sun 20° up. On May 14, he timed the bright-limb immersion of AB at 9° altitude, with the sun at -2° and the moon 99% sunlit.

Guillermo Mallén recorded the June 8 occultation of Spica photoelectrically using the 102-cm reflector at Tonantzintla, Mexico. The disappearance was at the dark limb of the 80% sunlit moon. He writes that the light curve "shows a strong diffraction pattern, typical of point sources. The observation was made through a thin cloud in the middle of a hole in thick clouds." This casts some doubts on the observations of other components noted during the graze of Spica in Australia last November, but a detailed analysis of Mallén's data will be needed before reaching firm conclusions. Hopefully, more photoelectric data will be obtained during the occultation of August 28 in Canada and the U.S.A., or perhaps during the few remaining favorable occultations in the current series, none (except Aug. 28) visible in North America and ending with an Arctic event on December 16. The photometer used by Mallén was made by Mauricio Tapia, and is simple enough that amateurs might be able to use it. Mallén writes: "An op amp picks up a voltage from the load resistor of the photomultiplier. A vco converts this signal into a square wave modulated in frequency. The frequency is adjusted to about 3 kHz for the sky and 9 or 10 kHz for the star, so it is in the audio range, and is recorded in a stereo tape recorder, with WWV on the other track. After the observation, we obtain a punched tape which is loaded to a computer. We simply count the number of pulses in 0.^{s}001, using an xtal clock and standard cmos chips. I think, in the future, many amateurs may have the photometer, and they may send the recording to centers with the second device, and a computer." A detailed description of the equipment will be published in English in *Revista Mexicana de Astronomía y Astrofísica*.

Paul Couteau, Nice Observatory, France writes, saying that he observed SAO 78778 to be single on 1972 January 31, using a 50-cm refractor visually. A photoelectric observation of an occultation at Hamburg, Germany, on 1971 April 4, showed the star to be double, with a separation of 0".25. It is probable that the separation decreased due to orbital motion, so that Couteau could not see the companion in 1972. The Hamburg observation was in the list on p. 73 of the last issue.

During the graze of Z.C. 2079 observed near Villiers, South Africa, on 1975 September 9, M. D. Overbeek timed some events of a companion at least one magnitude fainter (so that it would be about 9th mag.) and at least 30" away. It is certainly a wide double; the companion is likely listed separately in the B.D. or Astrographic Catalog.

NEW ZODIACAL SPECIAL DOUBLE STARS, 1976 AUGUST 14

SAO	ZC	M	N	MG1	MAG2	SEP	PA	DATE, DISCOVERER, NOTES
95127		G	K	8.4	8.4	0".02	0°	1976 July 24, H. Povenmire, FL
146412	3370	G	X	6.5	7.8	0.02	157	1976 June 18, R. Nolthenius, Eden Springs, CA
158992	2147	T	V	7.2	9.0	0.32	163	1976 July 7, R. Nolthenius, Long Beach, CA
159540	2264	T	V	7.4	7.9	0.30	80	1976 Aug. 4, R. Nolthenius, Long Beach, CA
159655	2296	T	X	7.6	8.3	0.03	160	1976 July 8, R. Nolthenius, Pomona, CA
163460		T	X	9.4	10.3	0.06	125	1976 Apr. 21, R. Nolthenius, Tucson, AZ

PLANETARY OCCULTATIONS

David W. Dunham

The occultation of SAO 80046 by Saturn's satellite Iapetus was observed by F. M. Strauss in Porto Alegre, Rio Grande do Sul, Brazil, according to I.A.U. Circular No. 2969. The disappearance occurred at 21^h 32^m 24^s U.T. of 1976 June 16. The duration was at least 15^s, after which clouds began to interfere. I have heard of no other observations of this, or other events listed on p. 79 of the last issue.

Observers in western North America are reminded of the occultation of 8.9-magnitude SAO 153844 at about 13^h 00^m of October 10, by Pallas. Improved predictions for the path will be distributed to affected IOTA members as soon as they are supplied by Gordon Taylor, H.M.N.A.O. Hopefully, the event will be recorded photoelectrically from one or more of the large observatories in western North America. In any case, observations by large numbers of visual observers stationed at intervals across the possible area of visibility would be valuable for determining the asteroid's exact size and shape. Coordination of plans among various groups of observers would be useful to ensure good coverage, as was attempted for the occultation of Mebsuta by Phobos last April.

Working at U.S.N.O. during evenings during the past few weeks, using programs and help from Paul Janiczek and others, I have developed a capability for routinely calculating accurate astrometric ephemerides of minor planets, given accurate orbital elements for some epoch. These can be compared with star catalog data on magnetic tape to find possible occultations. This work should eliminate the need for H.M.N.A.O. to laboriously keypunch astrometric ephemerides supplied by the Institute of Theoretical Astronomy in Leningrad, U.S.S.R., so that it should be possible to hunt for occultations by many more minor planets than are being considered in current searches. Hopefully, a few hundred minor planets can be involved. Since each minor planet occults about one SAO star each year as seen from somewhere on the earth's surface, this should result in many more predictions and observations. Accurate diameters of a few asteroids determined from such observations would be valuable for calibrating the relative diameters which have been determined for many minor planets from polarimetric and infrared observations.

Precise photographic observations will be needed in order to refine the relative positions of minor planets and stars to be occulted by them, often taken only a week or two before the event (so that both objects appear on one plate). Coordination with observatories to obtain such observations is in the planning stages. Of course, coordination with observers in the predicted regions of visibility will also be needed, to disseminate last-minute improvements in the prediction and to set up observing fences to ensure good coverage.

Many occultations by minor planets are very short, lasting only 1 or 2 seconds, so that visual observations become marginal for determining diameters. For this reason, an inexpensive, easy-to-use photoelectric system which amateurs could build and use becomes imperative. A number of people are working on such systems, some of them mentioned in previous issues, such as Seville Chapman's photodiode-loudspeaker-taperecorder combination stimulated by the occultation of κ Geminorum by Eros; see p. 19 of the 1975 January issue (#3). Apparently, the photodiodes are sensitive enough to be used only for the brightest stars. Observers in Montreal who built copies of Chapman's equipment were going to test it on lunar occultations, but I have heard of no successful attempts. Astronomers at Cornell University are working on what probably will be a more useful scheme, involving a beam splitter, fiber optics, photomultiplier, and electronics for a cassette taperecording system. Guillermo Mallen's system is described on p. 85. Mark Trueblood, Washington, DC, has plans for a system utilizing the increasingly widespread and relatively inexpensive Altair 8800 microcomputer to control data acquisition. Richard Gomer's equipment was used to record the occultation of Mebsuta by Mars, as briefly mentioned on p. 79 of the last issue. Any of these systems duplicated on a large scale would not only be useful for planetary occultations, but would also be a boon for lunar occultations, including grazes.

Only about a minute before Mebsuta disappeared behind Mars in April, Thomas Campbell, Jr. saw an artificial satellite cross his field of view. He observed from a site in northern Florida to avoid clouds which foiled other observers in the Tampa area.

GRAZES REPORTED TO IOTA

David W. Dunham

Graze reports should be sent to my current address, P.O. Box 488, Silver Spring, Maryland 20907, U.S.A. As usual, if possible, a copy should also be sent to H.M.N.A.O.

Few graze reports have been received since the list for the last issue was prepared, partly due to the moon's low altitude during summer evenings for northern observers, partly due to the short time since the last list was made, and partly due to mail forwarding delays. Recent letters mentioned a graze of a 9.2-mag. star observed by Richard Nolthenius on June 20 and a suspected double (see the New Double Stars section) whose graze was seen by Harold Povenmire on July 24, but not enough details were given to include them in the graze list.

Due to my move to Maryland and other work mentioned elsewhere in this issue, I have not had a chance to prepare the new graze report forms mentioned in the last issue. The new forms will have high priority when I return in September.

Wayne Loskrey, Starkville, MS, has done a good job keypunching graze reports during the last couple of months. Progress with the overall project, however, is slow, and more volunteers to help with some of the keypunching would certainly be welcome. Whenever possible, observers are encouraged to keypunch their own observations.

If skies are clear, the graze of Spica on August 22 seems destined to set a new record; see pp. 113 and 122 of the August issue of *Sky and Telescope*. In addition to the Florida effort, I know of daytime expeditions planned by Walter Morgan in Nevada, Richard Nolthenius in Arizona, and Paul Maley in Texas.

Paul Maley has plans to observe three grazes in one night in September. If he can do it, it will be a first, as far as I know. Robert Sandy's expedition for the graze of Z.C. 495 on Mar. 7 was listed in the last issue. Mr. Sandy notes that it was the 6th graze which he has been able to observe from his back yard.

[Ed: Bert Stevens successfully observed grazes on three consecutive morn-

Mo	Dy	Star Number	Mag	% Snl	CA	Location	# Sta	# Tm	C C	Ap cm	Organizer	St	WA	b
1976														
4	10	1397	5.5	75+	8N	Theriot, LA	1	5	7	20	Robert Schiffer	0		
5	5	1106	3.6	23+	-7S	St. Augustine, FL	4	6		25	Harold Povenmire			
5	9	1611	5.7	74+		Canberra, Austrl.	6	22	9	15	David Herald			
5	19	Z22248	9.3	65-	1S	Pontiac, IL	1	4	2	25	Berton Stevens, Jr.		179	-60
5	20	Z23262	8.7	55-	3N	Kankakee, IL	1	4	5	25	Berton Stevens, Jr.		355	
5	21	3290	7.3	45-	1N	W. Kankakee, IL	2	2	7	25	John Phelps, Jr.	5N	0	-55
6	1	1072	6.2	9+	N	Ehren, FL	4	26	9	20	Thomas Campbell, Jr.			
6	18	3370	6.2	61-	0N	Eden Springs, CA	2	6	9	15	Richard Nolthenius	6N	0	-49
8	2	Z13041	8.3	40+	6S	Johnston City, IL	1	8	7	20	Homer DaBoll	0N	173	3
8	5	2394	6.5	74+	S	La Porte, TX	2	4		20	Paul Maley	10N		
8	19	0726	6.8	36-	-1S	New Lebanon, IL	3	6	7	20	Homer DaBoll	2N	179	43
8	20	Z04575	7.4	28-	-1S	Wing, IL	2	5	6	20	Homer DaBoll	5S	178	54

LUNAR OCCULTATION OF (89) JULIA ON 1976 OCTOBER 1

David W. Dunham

Donald Davis, Planetary Science Institute, Tucson, Arizona, points out that a lunar occultation of this minor planet will be visible under fair conditions from western Europe on 1976 October 1. Donald Wells, Kitt Peak National Observatory, supplied the predictions using a copy of my prediction computer program and data supplied by me. Julia's magnitude (V) will be 10.3 and her diameter is assumed to be 137 km, based on recent polarimetric results. Julia's apparent position at the time of the occultation will be R.A. $19^h\ 51^m\ 35^s$, Decl. $-16°\ 29'.3$. The moon will be 65% sunlit waxing, so that disappearance will be at the dark limb. The southern limit of the occultation apparently crosses Iberia and northern Italy; detailed predictions of its location will be computed soon. The predicted quantities in the list below are the UT of disappearance, the duration of the fade at disappearance due to the size of Julia, the Position angle of disappearance, the Cusp angle measured around the moon's limb from the southern cusp, the altitude of Julia above the horizon when it is occulted, and her Azimuth measured clockwise from north. High-speed photoelectric observations of Julia's disappearance would be valuable for accurately measuring her diameter. (1976 August 14)

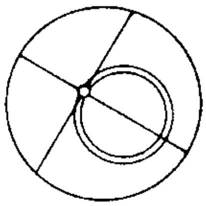
Location	UT	d	P	C	a	A
Grenoble, France	$22^h\ 52^m.7$	$0^s.49$	131°	40° S	7°	238°
Herstmonceux, United Kingdom	22 32.4	0.30	103	68 S	9	229
Saint Michel, France	22 57.7	0.63	139	32 S	7	239
Meudon, France	22 38.5	0.33	111	60 S	9	232
Pic du Midi, France	22 51.2	0.53	131	39 S	12	234
Strasbourg, France	22 45.2	0.36	119	52 S	5	238
Zurich, Switzerland	22 48.5	0.40	124	47 S	5	239
Jungfraujoch, Switzerland	22 51.3	0.44	128	43 S	5	240

ings (1976 Aug. 19, 20, and 21). This surely must be a record for Illinois. Has it been topped elsewhere? With the moon only 16° up in the western sky, Bob Sandy observed the Z.C. 830 graze on May 3 (see *O.N. 1*, 74) from a point 25 feet east of railroad tracks. The freight train did not arrive until $2^m 23^s$ after his final timing, Murphy's Law notwithstanding. For other good luck enjoyed by that expedition, see *Sky and Telescope*, *52*, 225-226 (September 1976).]

ANOTHER WAY OF LOOKING AT EMERSIONS

James H. Van Nuland

The larger circles are scaled to 16'.8 and 14'.7, the maximum and minimum radii of the moon; the small circle is actually a hole, scaled to 2' radius and centered on the mean radius of the moon, 15'.8. The hole exposes 15° of lunar limb. The pattern is off-centered ¼ moon diameter to avoid the poor focus at the edge of the 75°-wide field. The pattern is scribed on the back of a frame of unexposed processed Kodachrome, which passes just enough light to see the moon. The film is glued to the end of a short tube, which is padded to a snug fit in the skirt of my 20-mm eyepiece. Index marks on the tube and skirt allow ready re-alignment and proper focus on the reticle. A 360° scale made of a strip of paper divided into 36 equal parts is taped to the outside of the eyepiece to complete the construction.



In use, I set the eyepiece to the predicted P.A. by using the scale and an index mark on the focuser, then prefocus on a star. Next, I center the moon within the large circles, then sit back and wait for the reappearance, guiding as needed to center the moon. The drawing shows the reticle at a P.A. of 240°.

The removable tube allows normal use of the Erfle at 61× in my 8-inch Newtonian. In an earlier version, I had scribed the markings on the film emulsion, but this allowed far too much light to come through. However, with the marks on the film backing, this problem is solved.

Now if I could design away the morning haze, I'd be able to hunt down lots of R's, if I could get up in the morning.

MAP PRICES INCREASE

We note with regret that the Geological Survey has had to increase prices on several classes of maps, effective 1976 July 15. Inter alia, standard topographic 7.5- and 15-minute maps went from 75¢ to $1.25, and 1:250,000 maps went from $1.00 to $2.00.

A cheerful thought: Formerly, the 30% discount applied to orders of 400 or more topographic quadrangles; now you can get it on an order of only 240.

OBSERVATIONS OF OCCULTATIONS DURING THE 1975 NOVEMBER LUNAR ECLIPSE

David W. Dunham

General comments about observations of occultations during the lunar eclipse of 1975 November 18-19 are given on p. 80 of the last issue. The tally of eclipse occultation timings given here is in the same form as the one for the 1975 May 24-25 eclipse in issue #5, p. 38. The lower rank number is given to the observer who timed the most reappearances, if their total number of timings is the same. If the total and # of R's is the same, the ranking is then based on the # of non-SAO stars timed. If necessary, the number of non-BD star timings is considered. Finally, if all these numbers are equal, the observers are listed in alphabetical order of last name. Under Telescope, L, R, and C indicate reflector, refractor, and catadioptric, respectively. I am indebted to H. M. Nautical Almanac Office for supplying me with copies of reports from which most of this tally was prepared. I also thank the many observers who sent me reports directly. (Cont. on p. 88)

1975 NOVEMBER 18-19 ECLIPSE OCCULTATION TALLY

Rank	Observer	Telescope	Total	R's	Non SAO	Non BD
1	G. Appleby, Herstmonceux, England	30-cm R	9	4	3	2
2	K. Blackwell, Pevensey, England	15-cm R	9	3	3	2
3	R. Rutten, Eindhoven, Netherlands	40-cm L	8	1	4	2
4	L. Pazzi, Nigel, TVL, S. Africa	10-cm L	7	4	4	0
5	L. Morrison, Herstmonceux, England	33-cm R	7	3	0	0
6	A. Hilton, Salisbury, Rhodesia	15-cm L	7	2	4	2
7	S. Pattinson, S. Croydon, England	21-cm L	7	2	1	0
8	J. Van Zyl, Johannesburg, S. Africa	25-cm L	6	3	6	0
9	J. Osório, Vila Nova de Gaia, Portugal	15-cm R	6	1	1	1
10	L. Quijano, San Fernando, Spain	18-cm L	5	2	1	0
11	L. Brundle, Haywards Heath, Sus., England	22-cm L	5	2	0	0
12	I. Pablos Quiros, Madrid, Spain	15-cm R	5	0	3	2
13	M. Overbeek, Johannesburg, S. Africa	31-cm L	4	2	4	0
14	M. Abdul-Ahad, Bradhiya Basra, Iraq	30-cm L	4	2	0	0
15	D. Schmidt, Huizen, Netherlands	12-cm R	4	0	0	0
16	D. Gibbon, Umtali, Rhodesia	15-cm	3	1	1	0
17	S. Rayner, Weymouth, England	16-cm L	3	1	1	0
18	A. Jones, Gillingham, England	25-cm L	3	1	0	0
19	J. Ripero, Madrid, Spain	15-cm C	3	0	1	1
20	G. Marshall, Johannesburg, S. Africa	15-cm L	3	0	1	0
21	I. Broadbank, Weymouth, England	22-cm L	3	0	0	0
22	P. Ellis, Herstmonceux, England	15-cm R	3	0	0	0
23	G. Taylor, Cowbeech, England	50-cm L	3	0	0	0
24	D. Dunham, Lebanon, Ohio	25-cm L	2	2	1	1
25	F. Bateman, Johannesburg, S. Africa	15-cm L	2	1	2	0
26	B. Fraser, " "	15-cm L	2	1	2	0
27	J. Hers, " "	20-cm L	2	1	2	0
28	G. Papadopoulos, " "	20-cm L	2	1	2	0
29	G. Paxton, " "	15-cm L	2	1	2	0
30	A. Voorvelt, " "	30-cm L	2	1	2	0
31	S. Sack, Highland Park, New Jersey	20-cm	2	1	1	0
32	J. Barata Araujo, Recife, Brazil	15-cm L	2	1	0	0
33	R. Laureys, Diepenbeek, Belgium	25-cm L	2	1	0	0
34	T. Vinvent, Salisbury, Rhodesia	13-cm R	2	1	0	0
35	J. Azcona Crespo, Madrid, Spain	27-cm R	2	0	1	0
36	R. Blissett, London, Spain		2	0	0	0
37	G. Buss, Arundel, England	15-cm L	2	0	0	0
38	G. Kirby, Weymouth, England	22-cm L	2	0	0	0
39	A. Morrisby, Causeway, Rhodesia	22-cm L	2	0	0	0
40	C. Pither, Weymouth, England	30-cm L	2	0	0	0
41	C. Reid, Arundel, England	21-cm L	2	0	0	0
42	R. Stebbage, Maidstone, England	15-cm R	2	0	0	0
43	W. Verhaegen, Wetteren, Belgium		2			
44	R. Clyde, Streetsboro, Ohio	15-cm L	1	1	0	0
45	R. Durette, Suncook, New Hampshire	15-cm L	1	1	0	0
46	R. Hays, Chicago, Illinois	15-cm L	1	1	0	0
47	V. Slabinski, Washington, D. C.	15-cm L	1	1	0	0
48	J. Rodriguez Bravo, Madrid, Spain	27-cm R	1	0	1	1
49	N. Brynildsen, Horten, Norway	11-cm L	1	0	0	0
50	I. Cohen, K. Yavne, Israel	10-cm L	1	0	0	0
51	L. Felipe Hurtado, San Fernando, Spain	15-cm R	1	0	0	0
52	D. Hall, Leicester, England	25-cm L	1	0	0	0
53	B. Innerny, Weymouth, England	16-cm R	1	0	0	0
54	R. Kalleberg, Tromso, Norway	12-cm R	1	0	0	0
55	M. Knitsch, Hannover, DBR	15-cm R	1	0	0	0
56	J. Mason, Arundel, England	21-cm L	1	0	0	0
57	C. Morse, Maidenhead, England	15-cm L	1	0	0	0
58	C. Ost, Hannover, DBR	10-cm R	1	0	0	0
59	M. Pascual Martinez, Madrid, Spain	27-cm R	1	0	0	0
60	N. Wright, London, England	13-cm R	1	0	0	0
61	F. Van Loo, Itigem, Belgium	15-cm L	1	0	0	0
62	A. Salazar, San Fernando, Spain	18-cm L	1	0	0	0
			176	50	54	14

The only possible double star discovered during the eclipse was BD +19° 554A, seen during a graze observed by L. Pazzi in Nigel, South Africa, as noted at the bottom of the list on p. 73 of the last issue. The only known grazes observed during the eclipse involved this star and its relatively distant B component, also observed in South Africa as recorded in the list on p. 74 of the last issue. All timings made by observers in Johannesburg involved the graze stars; variable cloudiness prevented other timings there. Most of the observers had my detailed predictions of all Astrographic Catalog stars, but even so, J. Pablos Quirós of Madrid, Spain timed the unpredicted disappearance of a star that was not even in the Astrographic Catalog. Similarly, Richard Nolthenius and I were able to time a couple of unpredicted occultations of stars indicated as 13th mag. on the X Scorpii variable star chart during the 1975 May 25 eclipse.

I have received no observations of occultations made during the small partial lunar eclipse of 1976 May 13, but David Herald, Woden, Australia, made another interesting occultation observation that night several hours before the eclipse. He was waiting for an occultation of 6.6-magnitude Z.C. 2160, predicted to disappear at $11^h 46^m 02^s$ U.T. He followed the star in, but it didn't disappear until $11^h 50^m 06^s\!.1$! By checking his USNO total occultation predictions for other months, he correctly guessed that the star he observed was 5.3-mag. Z.C. 2159. It disappeared very close to the terminator of the nearly full moon, but apparently with a hairline of darkness separating the star from the sunlit features. The moon was 100% sunlit, elongation 175° from the sun, at a cusp angle of 18°N, so the occultation of Z.C. 2159 was rejected from the USNO predictions with a zero observability code. Consulting the chart on p. 26 of issue #3 shows that the theoretical terminator was only 0".4 from the dark limb, which would almost certainly be extended to the dark limb by irradiation, and the "worst" terminator would be beyond the limb. A detailed analysis of Herald's timing gave a very reasonable residual of -0".3, indicating that foreground mountains must have shaded the area which would normally be sunlit. It appears that our cusp angle rejection criteria should be loosened slightly near full moon. I made a somewhat similar observation of an occultation of μ Geminorum a few hours before the total lunar eclipse of 1963 December.

The next total lunar eclipse will occur on 1978 March 24, just before Easter, when Australian amateurs will be holding a convention in Canberra. David Herald has taken photographs of the eclipse star field, noting over 150 stars down to about 11th magnitude, and plans to measure their positions for occultation predictions.

1976 JUNE 2-3 M67 OCCULTATION TALLY

Jean Bixby Dunham

Poor weather clouded-out most of us for the M67 passage of June 3. Many observers were hampered by haze or cirrus clouds which prevented timings of at least the non-SAO stars. A weather satellite photo for June 2 shows clouds over most of the area for which observations were possible. Chet Patton actually reported an astounding total of 56 timings, but his timings on most of them were uncertain, and may well be events beyond the capability of a 15-cm scope. Observers with clear skies found many of the non-SAO stars difficult to observe against the earthshine of the 24% sunlit moon. Many people have written complaining of observing only clouds, and you have our sympathy; that's all we saw too!

The next passage of the moon through M67 will occur on September 20 in the U.S. and Canada (see table in the last issue, p. 77). We do not plan to distribute special predictions for this because the earthshine will be so bright with the 15% sunlit waning moon that most of the reappearances on non-SAO stars will be extremely difficult to time. Observers who have the USNO total predictions who want to try can plot the path of the moon for their stations on the chart of M67 in the last issue and determine approximate predictions.

The next good passages will be on October 17, observable in Japan, and on November 14 for the U.K. and Europe. We will prepare predictions for those events.

Rank	Observer	Telescope	Total	Non SAO	Non BD
1	Chet Patton, Buchanan, Michigan	15-cm L	14	9	6
2	Robert H. Hays, Jr., Chicago, Illinois	15-cm L	12	6	2
3	Paul Murn, Milwaukee, Wisconsin	32-cm L	12	3	2
4	Edward Halbach, Milwaukee, Wisconsin	32-cm L	9	4	0
5	Joe Horvath, Buchanan, Michigan	6-cm R	8	2	0
6	Ben Hudgens, Clinton, Mississippi	25-cm L	7	4	3
7	Frank Olsen, Cedar Rapids, Iowa	20-cm C	4	0	0
8	Robert Sandy, Kansas City, Missouri	15-cm L	2	0	0
9	Wade Eichhorn, San Angelo, Texas	20-cm L	1	0	0
10	Ronald Henderson, Farmington, Illinois	15-cm L	1	0	0
			70	28	13

ERRONEOUS TOTAL OCCULTATION PREDICTIONS

David W. Dunham

Reports of timings where the star was occulted well outside the predicted range (predicted U.T. ± the accuracy value given in the USNO predictions) are listed below. All events were disappearances. Acc. is the predicted accuracy from the USNO predictions and Diff. is the difference between the predicted and observed times, a negative value indicating that the immersion was earlier than predicted and a positive value showing that it was later than predicted.

The source position for Z08240 was the old General Catalog, whose star positions are often more than 1" in error at the current epoch due to accumulation of the error in the proper motion and the early epoch (late 1800's) of the observations used for the catalog. On May 6, the star position error probably combined with a large error in the limb correction, since the event occurred at an extreme longitude libration of -7°.8, over 1° outside the coverage of Watts' data.

Z06958 is a wide double, A.D.S. 5816, with component magnitudes of 8.3 and 8.4 separated by 6".9 in P.A. 355°; watch the double star code column of the USNO predictions. Again, the position source is the G.C. Both components are listed in the AGK3 (AGK3 numbers are +16° 731 and 732), whose positions are 9" and 2½" north of the current GC position used for the prediction. If the AGK3 had been used, the prediction would have agreed with the observed time in each case. Van Nuland notes that the star will be occulted again (emersion) for his station on 1976 September 18.

The GC and ZC positions of ZC 2591 are in agreement to better than ½". The observation of ZC 2591 was communicated by Robert Sandy, who was observing with Mr. Yoksh. Although the moon was 97% sunlit, and the sun only 1° below the horizon, the 6.5-mag. star was not too difficult to see in the 15-cm reflector. Yoksh claims that the event was a definite disappearance not caused by poor atmospherics.

David Herald has taken plates of the stars he observed, plus SAO 138528 (see p. 78 of the last issue), and found no significant discrepancy at his approximately 2" measurement-accuracy level.

1976 Date	Observer	Star	Acc.	Diff.	Notes
May 6	C. Scott, Panama City, Florida	Z08240	5s	-10s	P.A. 55°
June 7	J. Van Nuland, San Jose, Calif.	Z06958A	4	-12	P.A. 166°
June 7	J. Van Nuland, San Jose, Calif.	Z06958B	4	-37	
July 8	D. Herald, Woden, Australia	ZC 2346	8	+15	C.A. 8°N
July 9	D. Herald, Woden, Australia	SAO 160504	3	+17	C.A. 83°N
July 10	L. Yoksh, Kansas City, Missouri	ZC 2591	2	--60	C.A. 68°N

MORE PUBLISHED PAPERS ABOUT OCCULTATIONS

David W. Dunham

G. W. Amery, "Report of Lunar Section Meeting, J. Brit. Astr. Ass. 86, 241-243 (April 1976). This meeting was held on 1975 November 1 at Read-

ing, Berkshire, now regarded as the Section's occultation centre, so it was appropriate that the afternoon papers were all concerned with this topic, as follows: L. V. Morrison, "Lunar Occultations: The Motion of the Moon and the Rotation of the Earth," mainly about the utility of occultation timings for studying tidal friction. E. G. Moore, "Stars which Appear to Fade at Occultations," during which, among other topics, the use of a portable cassette tape recorder was discussed. He noted that the recorder should be kept upright to prevent variation in speed of the flywheel drive mechanism. I feel that this is not crucial if time signals are clearly recorded simultaneously; during cold weather, the upright condition is not as important as keeping the recorder warm, such as by hanging it inside a jacket with a cord arond the neck attached to the recorder's handle. The advantage of a portable stereo tape recorder, for recording time signals on a separate channel, was noted. J. C. D. Marsh, "Fringe Benefits," a discussion of the information which can be obtained from study of the fringes in the diffraction pattern recorded during occultations with high-speed photoelectric equipment.

Chr. de Vegt, "Angular Diameters of Stars from Lunar Occultations," *Astron. & Astrphys. 47,* 457-459 (March 1976). The angular diameters of the following stars have been determined from photoelectric occultation observations with the 60-cm refractor of Hamburg Observatory; uniformly illuminated disks were assumed: ZC 105 (δ Piscium, m_v 4.4, sp K5III), diameter ".0042 ± ".0010; ZC 1486 (31 Leonis, 4.4 K4III), ".0028 ± ".0006; ZC 1030 (ε Geminorum, Mebsuta, 3.0, G8Ib), ".0056 ± ".0006; and of inferior quality, ZC 885 (m_v 5.5, gG7), ".0024 ± ".0012; ZC 1197 (1 Cancri, 5.8, gK3), ".0021 ± ".0006; and ZC 3017 (υ Capricorni, 5.1, M2III), ".0086 ± ".0020. de Vegt notes that the ".0018 diameter for Mebsuta determined by Beavers and Eitter would lead to an unrealistically high effective temperature. An occultation of υ Capricorni was also observed with the 107-inch reflector at McDonald Observatory, yielding a diameter half of that obtained by de Vegt (Dunham et al., *Astron. J. 78,* 199).

Chr. de Vegt and U. K. Gehlich, "Results of Photoelectric Lunar Occultation Observations Obtained at the Hamburg Observatory during 1969-1973," *Astron. & Astrophys. 48,* 245-252 (April 1976). 195 observations, including four Pleiades occultations and 49 reappearances, were recorded photoelectrically. Duplicity is indicated for 11 stars, 4 of which were not previously known and are in the list of new doubles (*o. N. 1,* 73). The results for the triple star ZC 399 (μ Arietis) are especially interesting. A useful discussion of local lunar slopes is given.

J. L. Elliot, E. Dunham, and C. Church, "A Unique Airborne Observation," *Sky and Telescope, 52,* 23-25 (July 1976). Most readers undoubtedly already have read this interesting article about these Cornell University astronomers' observations of the occultation of Mebsuta by Mars from the Kuiper Airborne Observatory. The curious record of the central flash is shown and discussed.

R. G. French and P. J. Gierasch, "Diffraction Calculation of Occultation Light Curves in the Presence of an Isothermal Atmosphere," *Astron. J. 81,* 445-451 (June 1976). The character of the resulting curves is determined by the scale height $\underline{H}$, the Fresnel zone size $\underline{l}$, the surface atmospheric refractivity, and the planetary radius. An exact general solution and two approximations valid when H>>l are presented. It turns out that the diffraction effects of the planetary limb are unimportant for planets with significant atmospheres, including Mars, but this theory may be needed for some of the satellites of the outer planets which may have thin atmospheres. The only non-lunar photoelectric occultation record showing diffraction fringes is the one obtained by Bartholdi and Owen during the occultation of β Scorpii C by Io in 1971, and even there, the identification is not certain. A range of stellar magnitudes for detecting diffraction fringes for different solar system objects is given in a table; if the star is too bright, its diameter will be so large that the diffraction fringes will be washed out, but such events are rare. Consideration of diffraction effects of atmospheric inhomogeneities, turbulence, scintillation, and other complexities will ultimately be important, but seems premature at this stage. The authors note that surface irregularities significantly distort lunar occultation diffraction patterns, but the extensive results of the University of Texas program show that this is very rarely the case; the moon's limb seems to be quite smooth, in general, to the $\underline{l}$ scale of a few meters.

I. S. Glass and L. V. Morrison, "Angular diameter of 31 Leonis from a lunar occultation," *Mon. Not. R. Astr. Soc. 175,* 57P-60P (May 1976). A high-speed photoelectric record was obtained with the 70-cm refractor at the Royal Greenwich Observatory, Herstmonceux, on 1971 May 3. The dc signal from the photomultiplier was amplified and recorded on a high-speed ultraviolet photographic recorder. The tracing was digitized using a D-Mac pencil follower and the data analyzed by A. Walker at the University of Cape Town using a copy of the University of Texas photoelectric occultation analysis program. The diameter of the spectral-type K4 III star was found to be 0".0031 ± 0".0006 assuming a uniformly illuminated stellar disk.

R. F. Griffin and H. A. Abt, "Radial-Velocity Measurements of the Lunar-Occultation Binary HR 2013," *The Observatory 96,* 54-56 (April 1976). A fairly noisy photoelectric record of an occultation of this star obtained at Flagstaff Observatory on 1970 March 15 indicated a possible companion 0".01 away; a record obtained at McDonald Observatory the same night showed no evidence of duplicity. The authors show that, with 0.99975 confidence, the star is single based on numerous spectroscopic observations. This emphasizes the care with which photoelectric occultation data must be analyzed.

D. Herald, "Observations of Baily's Beads from near the Northern Limit of the Total Solar Eclipse of June 20, 1974," *The Moon 15,* 91-107 (1976). These visual timings of 72 Baily bead events were made with a 6-cm refractor using eyepiece projection at a location near Quirinup, Western Australia, about 6 km south of the predicted northern limit. Lunar features based on Watts' limb correction data were identified by calculating the solar and mean lunar limb intersection points for each event time. Nearly all features were uniquely identified this way. A least-squares analysis showed that the corrections to the solar ecliptic longitude and latitude, and radius (assuming the lunar values as known), were -0".19 ± 0".13, -0".21 ± 0".10, and -0".05 ± 0".17, respectively. The observations show a highly probable 0".6 discontinuity in Watts' limb correction reference datum at 95° Watts angle, and a deep valley in a plateau 2" above the mean limb at Watts angle 169°.2 not present in Watts' data. The topocentric lunar librations were -3°.05 in longitude and +0°.23 in latitude.

D. A. Howe, "The Feasibility of Applying the Active TvTime System to Automatic Vehicle Location," *Navigation 21,* 9-15 (1974). The National Bureau of Standards, Boulder, CO, has worked with the three major American television networks to provide a source of accurate time and frequency in television transmissions. These can be used, with suitable equipment, in areas with three or more suitably placed transmitters, to determine locations using a technique similar to that used in LORAN navigation. Tests in the Denver area showed that automobiles with the equipment could be located to about 40 m accuracy, but that this could be improved to about 15 m in rural areas, beginning to make the system useful for graze work, which is usually done in rural areas. Multipath effects degrade the accuracy in cities, but these can be calibrated with some work to achieve rural accuracies. Hopefully, interest in this field will increase, and the price of the equipment will decrease as it is manufactured in commercial quantities for potential users, such as police departments and taxi fleets. But it probably will be several years before something is available for the average occultation observer. Planned precision artificial satellite navigation systems also show some promise.

S. L. Howe, Editor, "Of Special Interest," *NBS Time and Frequency Serv-*

...ces Bulletin No. 224, 8-17 (June 1976). This is an extensive list of publications, with abstracts, about time and frequency dissemination.

S. I. Howe, Editor, "How to use the Line-10 Television Time Transfer Measurements," *NBS Time and Frequency Services Bulletin No. 224*, 7-11 (July 1976). This tells how to obtain or build equipment for obtaining precise time and frequency from ABC, CBS or NBC network transmissions. Prices are not unreasonable, and a diagram of the electronics is given.

D. Wallentine, "Asteroidal Occultations", *Minor Planet Bulletin 3* 41-44 (1976 January). This mentions the value of occultations of or by minor planets for determining the diameters of these objects, and mentions some recent predictions. He describes observational problems and how events might be recorded. Dr. Clark R. Chapman (Planetary Science Institute, Tucson, AZ) points out that hundreds of occultations of non-SAO stars by faint minor planets occur each year and are not being predicted. There is a need to try to predict these events; watching minor planets move through rich star fields waiting for an occultation to happen, without predictions, is a waste of time. I have some comments, mostly about observing procedures, in the April issue of *Minor Planet Bulletin*, p. 56.

A GRAZE OF THE SUN

David W. Dunham

Observers are reminded of the total eclipse of the sun visible from parts of eastern Africa and southeastern Australia on 1976 October 23. If one observes near the northern or southern limit of the zone of totality, but within the zone, prolonged multiple Baily's bead phenomena can be observed, analogous to the multiple contacts observed during grazing occultations of stars by the moon. Timings of these events are valuable for determining the relative declinations of the sun and the moon to high accuracy, and for studies of Watts' lunar limb correction data. See the abstract of David Herald's article, "Observations of Baily's Beads from near the Northern Limit of the Total Solar Eclipse of June 20, 1974" on p. 89. The visibility of the chromosphere is also greatly prolonged near the path edge, often during the full length of totality (which typically would be a fourth to a third that as seen from the central line). Mr. Herald also plans observations near the path edge during this October's eclipse. He is coordinating the efforts of many Australian observers to establish several stations at varying distances from both the northern and southern limits. Observers traveling to Australia interested in this worthwhile project should write to Mr. Herald at Box 254, Woden, A.C.T. 2606, Australia in order to coordinate plans. [Ed: A note from Mr. Herald adds, "It is my desire to obtain as many timings as possible from as many different places as possible. I would be most appreciative if any observer who makes successful timings of Baily bead events would write to me."] Dr. A. M. Sinzi, Director, Astronomical Division, Hydrographic Department, Japan, writes saying that his office is planning expeditions to two sites in South Australia, one near the central line and one near the northern limit, to obtain high time-resolution photography of Baily's beads and the flash spectrum for astrophysical and accurate positional studies, while a team from the Mizusawa Observatory plans to make similar observations from Portland, Victoria, near the southern limit.

FROM THE PUBLISHER

Occultation Newsletter continues to be priced @ 50¢, but only thru this issue. Future issues will be priced @ $1.00 each (including first class surface mailing), or $4.00 per year (4 issues), until further notice. Air mail delivery is available at added cost: add 16¢/year in Canada and Mexico; add $1.28/year in Central America, Colombia, Venezuela, the Caribbean Islands, Bahamas, Bermuda, St. Pierre and Miquelon; add $1.76/year in all other countries. Back issues are still available @ 50¢ each. See IOTA NEWS for information about the Spanish edition of *Occultation Newsletter*.

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

HEATHKIT DIGITAL ELECTRONIC STOPWATCH

Wayne R. Coskrey

Several months ago I bought and assembled a Heathkit GB-1201 Programmable Digital Stopwatch (latest catalog price $84.95 plus postage, from the Heath Company, Benton Harbor, MI 49022). Its main attraction to me was its great versatility, with seven functions, although only two are useful in occultation work, the "Total Activity Time" and the "Split Time."

In both of these functions, the stopwatch is started by pressing the "Start/Stop" (S/S) button, or alternately, by using the remote Start/Stop relay input jack, possibly by means of a WWV synch circuit. In the "Total Activity Time" mode, the stopwatch may be stopped at the first timing event with the S/S switch and at the second event with the separate "Final Stop" (F/S) switch. Both timings are then contained in two internal counters and can each be displayed by alternately pressing the S/S switch. In the "Split Time" mode, any number of consecutive events may be timed by stopping the stopwatch with the S/S switch. However, the counters are inoperative in this mode, and only the last timing can be displayed.

The main disadvantage of this stopwatch is that Heath sells it only as a kit. However, assembly is not particularly difficult if you've used a soldering iron before, and it should be possible for a novice kitbuilder to construct it in 10-15 hours (hopefully spaced out in three or four sessions).

The only assembly procedure that requires extreme care is the installation of three *very* static electricity-sensitive IC's. In assembling my stopwatch, I accidentally dropped one of these IC's on my pants leg and blew out one whole function; and since two of these IC's are $18 apiece, and the other is $4.60, it becomes an expensive proposition to replace the whole IC if part is damaged. The main thing to remember in installing these IC's is to be sure to gently squeeze the pins against the body of the IC to place the pins the correct distance apart, so that the IC can be pushed into its socket with minimum effort.

The only other problem I've encountered after extensive use of the stopwatch is a slight malfunction of the programming function of the F/S switch (a new one would cost $5.10). This occurred just after the 90-day guarantee ran out, too. If you need any replacement of parts near the end of the guarantee period, be sure to request an extension of the guarantee.

The stated accuracy of the stopwatch is ± 0.006%, typically better than 0.003%, obtained by simple adjustment of a trimmer capacitor. In my first tests, I determined that the accuracy of my stopwatch was about ± 0.002%. However, after several months of use, I re-tested the stopwatch, and it had fallen to an abysmal ± 0.18%. After a painstaking day of trial-and-error adjustments, I was able to return the stopwatch to ± 0.005%, which is quite workable. I would suspect that all electronic stopwatches would need such periodic readjustment, due to quartz crystal aging, shocks, etc. My tests also indicate that the stated temperature effects of +0.0% to -0.003% from 25° F. to 120° F. when calibrated at 80° F. are probably correct.

Both light and moderate pressure switch springs are provided. Use the moderate springs if you want to forestall premature tripping.

If you want a stopwatch that you can use for almost any conceivable timing purpose, this one comes pretty close. As this article only scratches the surface of this stopwatch's features, write to Heath (Dept. 322-17) for their free catalog. Also, I would be happy to answer any questions.

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