Occultation Newsletter

Volume I, Number 11 July, 1977

The Occultation Newsletter is published by the International Occultation Timing Association (I.O.T.A.)
Editor and Compositor: H. F. DaBoll, 6 N 106 White Oak Lane, St. Charles, Illinois 60174, U. S. A.

IOTA NEWS

David W. Dunham

The issue "#11" described on p. 91 of issue #10, containing information and charts about passages of the moon through the Hyades cluster, and abstracts of several published papers concerning occultations, has been delayed due to shortage of time. It is expected to be issued as #12 in about a month, while this issue is a regular issue, counted as the first of 1977. The April deadlines for the issue in #10 slipped by a month and a half. We hope to adhere to our schedule better for issue #13, for which the deadlines for sending material to Mike Reynolds, David Herald, and me will be September 1, and the deadline for submitting articles to H. F. DaBoll will be September 15. Our publication delays cause a problem for membership renewals, which we will resolve in your favor. You do not have to renew your membership unless you receive a note with this issue of *O.N.* stating that a payment is due. Members whose address labels contain expiration dates of 0377 or later will receive graze predictions for the remainder of this year. Members in Latin America do not need to make any payments, as described below.

The standard-coverage total occultation predictions mentioned on p. 92 of the last issue are now available (for Canada and the U.S.A.) from Walter V. Morgan; 407 Park Way W.; Las Vegas, NV 89106. A note about this service will appear in the July issue of *Sky and Telescope*. These predictions can also be computed for other areas of the world; data for the rest of 1977 for several Scandinavian stations have been sent recently to the Scandinavian Union of Amateur Astronomers. Those who have small telescopes or who observe relatively few occultations each year are strongly encouraged to use these predictions, rather than the much more computer-time-consuming USNO predictions of total occultations. Rick Binzel, Washington Court House, OH, has written a comprehensive description of these predictions. The material which has been included in the *Sky and Telescope Occultation Supplement*, for all the U.S.A. and southern Canada, will be published only in *the Observer's Handbook* of the Royal Astronomical Society of Canada for 1978 and later years.

A Latin American section of IOTA has been formed. Membership will be free for occultation observers in the Spanish- and Portuguese-speaking countries in the Western Hemisphere, Spain, and Portugal, including regions I, J, L, P, XD, XF, and XR. The Institute of Astronomy of the Universidad Nacional Autonoma de Mexico, which has been distributing *Occultation Newsletter en Español*, will provide total and grazing occultation predictions to members and cover all costs. Dr. Enrique Daltabuit, Instituto de Astronomia, Universidad Nacional Autonoma de Mexico, Apartado Postal 70-264, Mexico 20, D.F., Mexico, will handle duplication and the routine mailings. Sr. Guillermo Mallén, at the same address, will make the computer runs, and Sr. Francisco Diego Q., Ixpantenco 26-bis, Real de los Reyes, Coyoacan, Mexico 21, D.F., Mexico, will take care of correspondence. The Spanish translation of *Occultation Newsletter* will still be done under Eduardo Przybyl's direction in Rafaela, Argentina. Special bulletins requiring rapid distribution will be translated in Mexico City. I gave programs and data for computing grazing and standard coverage total occultation predictions for the areas described above, to Sr. Mallén during my recent trip to Mexico City (see PLANETARY OCCULTATIONS), when many of the details of IOTA/LAS were worked out. I was shown the prototype of a cheap field "occultometer" for recording an occultation with a photodiode, whose signal is amplified and recorded directly by FM with a cassette recorder. It is expected to record 6th-mag. stars; fainter stars should be recordable when more sensitive diodes become available. A high-speed digital system utilizing a photometer and a minicomputer is being developed for observatory use.

One would think that the organizers of amateur and professional astronomical meetings would make an effort to select dates which would avoid important astronomical phenomena, especially those requiring a wide distribution of observers (or, if the event is very local, such as a good graze of a bright star by a thin crescent moon, plan the meeting to nearly coincide with the event). Unfortunately, this is not the case. Important meetings were held in Washington, DC, on May 13 and 14, making it impossible for me to try to observe a rare nighttime graze of Venus near Winnipeg, Manitoba, the morning of May 14. A worse conflict occurs for the July 8 occultation of a star by Pallas (p. 96-7 of the last issue), since there will be a national Scientists Congress, from July 6 to 13, in Fortaleza, Brazil. I hope that scheduling disasters like these, which can result in the loss of valuable astronomical data, can be avoided in the future. Dates for astronomical meetings, especially large ones, are often set over a year in advance. Unfortunately, we can rarely compute predictions that far in advance. The dates of lunar eclipses, and of occultations of Aldebaran (and the Hyades) and of major planets, during 1978 are available, and I hope they will be avoided by at least two days by planners in the areas involved. These 1978 U.T. dates and areas are as follows: Feb 16, N. America, N.W. Europe; Mar 15, E. Europe, Asia, N. America, Mar 24, E. Hemisphere; Apr 11, N. America, Europe; May 9, Cen. and E. Asia, N. America; May 29 (Memorial Day weekend), U.S.A. (occultation of a star by Pal-

FROM THE PUBLISHER

We are two issues behind in our publication schedule. For subscription purposes, consider this issue to be the first one of 1977.

O.N. is priced @ $1.00 per issue, or $4.00 per year (4 issues) including first class surface mailing. Air mail delivery is available at added cost outside the U.S.A.: 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, #1 thru #9, are available @ 50¢, #10 @ $1.00. See IOTA NEWS for information on *Occultation Newsletter en Español*.

The foregoing applies only to separate subscriptions. IOTA membership, subscription included, remains @ $7.00/ year for residents of North America (including Mexico) and $9.00/year for others, to cover costs of overseas air mail. However, European (excluding Spain and Portugal) and U.K. observers should instead join IOTA/ES, sending DM 10.-- to Hans J. Bode, 3000 Hannover, Bartold-Knaust Str. 6, German Federal Republic. Spanish, Portuguese, and Latin American observers should see IOTA NEWS for information about IOTA/LAS.

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.

ia), July 2, N. America, N.W. Europe; July 29, Cen. and E. Asia, N. America; Aug 8, E. Asia, Hawaii, Aug 8 again, S.E. Asia, N.E. Australia, Aug 26, N. and W. Africa, Europe, Cen. Asia, Sept 16, E. Hemisphere, E. Brazil; Sept 22, Hawaii, N. America, Oct 19, N.E. Africa, S.E. Europe, Asia, Nov. 16, N. America, Europe, N. Africa, Dec 13, Asia, N. America, and Dec 26, N. America, W. Europe, N.W. Africa.[Ed. postscript added by D. W. D.:] Jorge Polman, Recife, Brazil, reports that the Brazilian Scientists' Congress in July has been postponed for several days, so that observers can be at their home observing sites for the occultation by Pallas on July 8.

Preliminary information about the first IOTA meeting, to be held in conjunction with the National Amateur Astronomers convention in Boulder, Colorado 1977 August 10-13, was given in the last issue on the front page. As noted there, the preregistration fee, payable to National Amateur Astronomers, is $18 and should be sent to: Denise Nye, NAA Convention Registration, 5604 Bowron Pl., Longmont, CO 80501. Further convention information is available by sending a stamped, self-addressed envelope to Denise Nye. After August 1, the registration fee will be $20. An IOTA business meeting has been scheduled for Friday evening, August 12, from 8:30 P.M. to 10:30 P.M. Andrew Gassmann, the NAA Papers Chairman, has distributed forms, requesting primarily short abstracts and equipment needs, which he wants returned to him by July 10 (which is before this issue will be distributed). The papers, which should be submitted during the convention in a form suitable for duplication, will be published in the procedings of the convention. Send me a stamped, self-addressed envelope if you plan to give a paper and need a copy of the instructions for the typed papers for the procedings; it is also available from Mr. Gassmann. The completed registration form should be sent to Denise Nye before the convention. I know of at least five papers that are planned to be read by IOTA members. Two of these deal with pocket calculator applications, for which a special session probably will be devoted during the convention. Berton Stevens has computed predictions for grazes within 500 miles of Boulder during August. On August 6, at 10:45 U.T., a favorable graze of 7.6-mag. Z.C. 372 will be visible from Boulder. The moon will be 54% sunlit, waning, the star's spectral class type is A2, the moon altitude will be 54°, and the cusp angle 5°N, for those who arrive in the area several days before the convention. As the August 12th graze of 5th-mag. 68 Geminorum is at 5:30 A.M. MDT and is about 300 miles from Boulder, it is doubtful that there will be an expedition for it (if you would be interested in such an expedition, let me know; there will be a paper session that morning from 9 to 11:30 A.M.). If the convention were to be held in Casper, Wyoming, an expedition would be more feasible. Paul Asmus, 4332 S. Dover Ct., Littleton, CO 80123 (phone 303, 973-0290) is organizing an expedition for a graze of 7.1-mag. ZC5002 by an 18% sunlit moon on August 10, near Colorado Springs. Central graze is at 5:07 A.M. MDT at a cusp angle of 1°N (so most of the graze will be on dark features for such a crescent). The moon will be 29° up and the sun 11° down. Since Colorado Springs is 100 miles south of Boulder, observers might consider staying overnight there, then drive to Boulder to arrive in time for the first paper session of the convention later that morning. Those interested in this graze should contact Mr. Asmus for details.

My office at Computer Sciences Corp. has been moved again. The phone number is still 301, 589-1545, but my extension is now 358.

There is a small error in the 1975 total occultation tally on p. 105 of the last issue. The name of the observer whose rank is given as 394 is A. Talalaev. One of his timings was of a reappearance, so that his value should be 4.03, and rank 2995. This changes the value total for the USSR to 913.98 and the number of R's to 143 for the USSR and 2179 for the world. The ranking by country remains unchanged.

LETTERS

To the Editor:

I read Clifford Bader's article entitled 'Analysing HMNAO Residuals' in the March issue of *Occultation Newsletter* with considerable interest. I would like to make a few points of clarification about the significance of the "preliminary residuals" which you might like to publish in [#11].

In computing the residual for the observed time of an occultation we require to know four quantities:

1 Position of moon from the ephemeris
2 Correction for limb profile
3 Position of star from catalogue
4 Position of observer.

The contribution from the lunar ephemeris to the error in the residual is mainly systematic arising from the constants of the theory. Efforts are made to remove these systematic errors from the residuals, but there is probably still some contribution left. This may introduce a small bias in the residuals extending over several years. A more serious and continuous source of systematic error is caused by the off-set between the origin for the measurement of the moon's position in its orbit and that of the star positions in the catalog. Ideally, these origins should be coincident, but it is known that they are displaced from one another by about 0".8. Attempts are made to remove the effect of this offset from the residuals, but the correction that should be applied is probably uncertain by about ±0".05. Therefore, in the analysis of the preliminary residuals of any individual's observations extending over a few years one might well expect there to be a bias of at least 0".05.

However, apart from this caution, the statistical analysis of observers' residuals as described by Mr. Bader is very useful for detecting systematic errors due to personal equation or faulty coordinates and we would be very pleased to hear from observers who find that the mean of their residuals (after changing the sign for the disappearances) lies outside the range -0".05 to +0".05 with greater than 68% confidence; i.e., outside the range -e-0".05 to +e+0".05, where e is the standard deviation of the mean.

L. V. Morrison
H.M. Nautical Almanac Office
Royal Greenwich Observatory
Herstmonceux Castle, Hailsham,
East Sussex BN27 1RP, England

Dear Mr. Bailey:

Thank you for your April 11, 1977 letter confirming the unavailability of "Halloween" mechanical crickets, whose use for producing event markers is described in your article, SOME COMMENTS ON READING OUT GRAZE TAPES, in *O.N.*, *1*, 75 (June 1976).

I now find that American-made mechanical crickets which meet the child safety laws can be obtained wholesale from Monarch Novelty Co., 1331 14th St., N.W., Washington, DC 20005.

The store did not have a sample to show me because salesmen keep walking off with the samples, as happened with your stock of crickets. The plastic cover (total area about 45 mm X 22 mm) is hot stamped with any message we like, at the factory. There is no reduction in price if the crickets are not stamped, so we could have something like "International Occultation Timing Association" stamped on [them].

The minimum order is [$45.00 for 250] (18¢ each), plus shipping.

How many crickets do you think we could sell through *Occultation Newsletter*, at cost plus a stamped, self-addressed envelope? How many would graze groups like yours order, just to keep on hand? If you think there is enough demand, I am willing to [place a minimum order] for distribution.

Victor J. Slabinski
3457 South Utah St.
Arlington, VA 22206

[Ed: Please reply directly to Mr. Slabinski, who is hereby authorized to order 250 IOTA crickets immediately. Send him a 13¢ stamp, plus a 5¢ stamp, plus a stamped self-addressed envelope, for each cricket ordered, or make appropriate payment, postage, and packaging arrangements for large or foreign orders. If delivery time is short, we may be able to show samples at the N. A. A. convention.]

ANALYZING HMNAO RESIDUALS - II

Clifford J. Bader

In my original article (p. 106 of the last issue), I suggested the application of statistical methods by the individual observer as a means for assessing performance and coordinate accuracy. I also expressed my own uncertainty as to the extent of systematic error inherent in the residuals.

The latter question has been answered, and an insight into the reduction process has been provided, by L. V. Morrison, in his letter, which appears on p. 112. In addition, sufficient observer data have been collected to permit a few tentative conclusions to be reached, and to establish some interesting new avenues for future exploration.

Through the courtesy of Gerry Kellock, of Curtin, A.C.T., I received residuals for a number of Australian observers, of these, the 239 timings (1972-76) by David Herald were sufficient for statistical purposes. Doug Hall, of Leicester, England, supplied statistics for 205 timings (1971-76), and in addition, provided data for those timings which he felt were of highest quality. Also, I added my 1976 residuals to the previous results, for a total of 166 timings over the period 1973-76. Thus, at present, the data base encompasses 610 timings over the period 1971-76.

For each observer, three quantities were tabulated: the mean m, the standard deviation s, and the standard deviation of the mean e, the units in each case being seconds of arc. The results were surprisingly uniform, and in all three cases the means were positive but fell within the 0.05+e limit defined by Mr. Morrison. When all 610 observations were combined, the resultant values were 0.074, 0.69, and 0.028 for m, s, and e respectively. The high confidence that the aggregate parent mean was positive suggested the possibility of an observer-independent bias in the residuals, but this interpretation was shown to be premature.

When the high-quality (i.e., HMNAO accuracy code 1) timings and the lower-quality timings (code 2 and higher) were separately analyzed as suggested by Mr. Hall, a quite different picture emerged. Mr. Hall categorized 144 high-quality timings, to which I added 131 from my records; the aggregate values were 0.016, 0.58, 0.035 for m, s, and e, with both observers showing a greatly reduced mean as compared to that for all codes combined. For the combined total of 96 less-certain observations, the results were 0.180, 0.67, and 0.068, with both observers showing a prominent positive shift in the mean.

The positive shift for the less certain timings suggests the disturbing hypothesis that both observers tend to underestimate personal equation for difficult events (in my case, at least, despite an effort to individually estimate PE for each event). The corresponding average time shift between the two angular means is quite large, on the order of 0^{s}4. Unfortunately, the number of observations is too small to permit practical exclusion of the possibility of a common parent distribution, and data from other observers are needed to see if a general trend exists.

On the theory that eye-ear timings might be less vulnerable to unaccounted delay, I separately analyzed 57 of my timings made by eye-ear as opposed to manual methods (the accuracy class was not recorded). The mean and standard deviation obtained were almost identical to those for the overall total. The implication is not clear; again, more data are needed.

In the original article, I suggested the publication of statistics for various observers. It now appears that it would be of more general usefulness to emphasize aggregate information showing correlations with event difficulty, timing methods, disappearances vs. reappearances, and other variables, leaving the individual observer to assess his own results in comparison to the average, and to notify HMNAO in the event of an unsatisfactory mean. I will be pleased to receive and compile any statistical information which observers can supply, and will acknowledge all contributions in future articles. In addition, I will attempt to reduce any residuals sent to me to statistical form, and to communicate individual results to the relevant observer. Please include such information as accuracy code and timing method, if available.

1209 Gateway Lane
West Chester, PA 19380

SOUTHERN ASTROGRAPHIC CATALOG PROJECT

David Dunham and David Herald

Recipients of USNO occultation predictions with O-codes of 5 or less will have noted that although the limiting magnitude for their predictions is set at 9.6 or fainter, there are virtually never any predictions of stars fainter than about 9.3. The reason for this is simple. The source catalog for the predictions is the SAO, which nominally extends to mag. 9.0. In fact, many stars of 7th and 8th mag. are omitted, whilst a few fainter stars are included. Since there is no other catalog available for the Northern Hemisphere with a significantly better coverage and with the star positions presented in a convenient form, the predictions have been restricted to stars in the SAO except for special events. During the next few months, the AGK3 catalog, covering the sky north of -2°5 at a density nearly twice that of the SAO, will be converted into a format suitable for occultation predictions. The next (and last) order of catalogs after the SAO and the AGK3 is the Astrographic Catalog, which is generally inconvenient to use directly in that instead of right ascension and declination, it gives the x-y coordinates of the stars on photographic plates taken early this century.

There are several good reasons for wanting to include occultation predictions for faint stars. Obviously, the main effect will be a large increase in the number of occultations observed, particularly for those with larger telescopes. Additionally, as with occultations in open clusters, a significantly large number of occultations during several hours may be obtained to undertake better studies of the shape of the moon. The star positions may also be used for other predictions, such as those of occultations by minor planets, as mentioned on p. 97 of the last issue, and for predictions of planetary occultations, which may become of great importance in the case of Uranus. As noted on p. 97, the Astrographic Catalog is being converted to RA and dec. for several zones of the catalog, but it is not intended to extend the work at Strasbourg into the Southern Hemisphere, thereby excluding the extremely rich star fields in Sagittarius, where star densities for 11th mag. and brighter are of the order of 100 per square degree. This region could be of great interest, and given predictions, one could imagine a huge number of events being recorded at one sitting.

Because of these particular advantages, and noting the imminent entry of Neptune into the region (and Uranus in several years), it has been decided to undertake, as an IOTA project, the conversion of the AC coordinates to RA and dec. in the ecliptic occultable region between RA's 17^h and 19^h, for incorporation into the USNO predictions. To keep the project within reasonable limits, stars fainter than mag. 11.6 in the AC will not be reduced, except perhaps in special regions.

For this project, we will need volunteers. At this stage, the prime requirement is for people willing to undertake the necessary labors involved in the reduction process. Needed are the desire to take part in a project requiring desk work, a bit of time to spare, and access to the calculating capacity of at least the HP 67/97 or the SR 52. Herald has written a (hopefully) foolproof program for the HP 67/97. Volunteers for this project are requested to write to Herald, who will be coordinating the project, at PO Box 254, Woden, ACT 2606, AUSTRALIA. Documentation and a copy of the HP 67/97 program (if a card is supplied) will be made available. Although desirable, access to either the Astrographic or the SAO catalog is not prerequisite to participation. A start already has been made on the project by several people in Canberra, Australia. A chart will be included in *o.n.* periodically, to show current status. If progress is sufficiently rapid, serious consideration will be given to extending the coverage.

The following gives an indication of the magnitude of the project. It will require the reduction of some 120 plates in the odd zones -17° to -29°. With a magnitude limit of 11.6, and excluding SAO stars, about 1 in 4 AC stars will be reduced. Typically, between 100 and 400 stars will be reduced on a given plate. Using the HP 67, Herald has found that it takes about 1 to 1½ hours to derive the 1950 plate constants, and then about 90 stars per hour can be reduced from the AC coordinates to 1950 RA and dec.

In the near future, we may also require volunteers for keypunching the positions. Hopefully, the bulk of this work can be done at USNO. Volunteers with access to keypunches are requested, at this stage, to write to Dunham.

As part of the S. A. C. Project, a full and ready capacity to easily identify the positions of unpredicted stars, from the time and approximate PA of the event has been attained, using an HP 67 calculator. If any occultations are observed of stars which are not in the SAO, please let Herald know for future reference. One of the greatest problems in utilising the A. C. is determining the magnitudes of the stars. Apart from inherent inaccuracy of the magnitude equations used, the magnitudes are photographic, so that stars listed as mag. 12 may quite easily be of 9th magnitude. By noting any unpredicted occultations, we can assure that amongst other things, these stars will be included in future listings.

IDENTIFICATION OF UNPREDICTED STARS

Wayne H. Warren, Jr.

A computer program recently has been developed (with the help of existing routines supplied by David Dunham) to aid in the identification of faint occulted stars not included in observers' USNO predictions. The computer is given an observer's geographical coordinates, timing, approximate position angle, and estimated visual stellar magnitude. It then finds the moon's position at the time of the event, and using the estimated position angle, finds the right ascension and declination of the limb at the point where the event occurred. Identifications for observed stars should be made before their timings are reported to HMNAO for reduction.

As I do not have copies of observers' predictions, you should provide certain information when requesting identifications. I need: (1) geographical position and altitude of observer; (2) observed time of event, including UT date; (3) estimated PA of event (CA cannot be used unless both PA and CA are reported for a predicted occultation on the same night); (4) estimated visual magnitude of star; (5) miscellaneous comments such as double star, stepwise event, or nearby predicted star would be helpful. Also, the same information supplied for predicted stars observed the same night would be very helpful (a few predicted stars observed nearest to the unknown would be sufficient). If CA and not PA is reported for the unknown, then both CA and PA should be reported for the predicted stars so that the difference for that night can be used to find the PA for the unknown.

Identification requests should be sent to me at Code 681, NASA-Goddard Space Flight Center, Greenbelt, MD 20771. A copy of the computer output, with identifications, will be returned to you for your report to HMNAO.

PLANETARY OCCULTATIONS

David W. Dunham

The discovery of the rings of Uranus during the occultation of SAO 158687 on March 10 is now well known and documented by J. Elliot, E. Dunham, and R. Millis in their article on p. 412 of the June issue of *Sky and Telescope*. Not mentioned was the small role played by the lunar occultation of both the star and planet on February 10. The partial occultation of Uranus was observed from four stations near Drexel, Missouri, with Robert Sandy the expedition leader; and was observed by Berton Stevens (s.e. Missouri) and Harold Povenmire (S. Carolina). Several others timed the total occultation reappearance, with photoelectric records being obtained at Fick Observatory, Ames, Iowa, and at Goddard Space Flight Center, Greenbelt, Maryland. The 8.8-mag. star was much more difficult to see due to glare from the gibbous moon. Three observers from Rolla, Missouri, one using a 41-cm reflector, did not see the star until several minutes after the graze. Visual timings of the reappearance were obtained by Robert Bolster, Alexandria, Virginia; Robert Hays, Chicago, Illinois; and Wayne Warren, Greenbelt, Maryland. Quick analysis of these observations essentially confirmed those obtained at Lowell and U. S. Naval Observatories, and ruled out the result of the Australian photographic observations, which indicated that the March 10 occultation shadow would miss the earth entirely.

Detailed analyses of the observations of the March 10 occultation are continuing. The timings of the occultations by the rings at different observatories establish the location of the center of Uranus relative to the star quite well. Combining this with the 25-minute duration observed from the Kuiper Airborne Observatory, Brian Marsden deduces a radius of 26,450 ±70 km for Uranus, assuming a circular cross section (I.A.U. Circular #3061). Two more observations of the occultation by the planet are reported in *M.N.A.S.S.A. 36*, p. 38, obtained photoelectrically by J. Churms and P. J. Booth at Cape Town, South Africa, and visually by A. G. F. Morrisby, J. V. Vincent, and A. S. Hilton in Salisbury, Rhodesia. The latter observations indicate that Salisbury was only about 500 km from the northern limit, considerably closer than the others.

It soon became apparent that occultations of fainter stars by the rings could be observed with large telescopes, so astronomers at the Lick, McDonald, and Smithsonian Observatories examined plates to check for possible events in the near future. R. McCroskey, Smithsonian, noted that Uranus would pass about 6" north of two 11-12 mag. Astrographic Catalog stars on May 30 and 31; accurate positions of the stars were obtained by A. Klemola at Lick (I.A.U. Circ. #3068). The outermost ring has a radius of 4".0, but J. Elliot notes that there could be as-yet-undetected rings up to about 5" from Uranus. Fritz Benedict's and Peter Shelus' plate-scanning technique at the University of Texas was briefly described on p. 97 of the last issue. They have found the following approaches less than 10":

Date	U.T.	Sep	mag	RA-14^h(1950)	Dec
July 3	14^h	4"S	14.3	20^{m}39^s.2	-13°33'31"
Aug 26	2	0.4S	14.1	23 07.0	-13 47 36
Sep 12	0	8 S	13.6	25 44.9	-14 00 58
Sep 21	18	7 S	14.0	27 35.2	-14 10 13
Sep 28	11	5 S	14.2	28 57.2	-14 17 02
Oct 17	0	7 S	14.5	33 08.0	-14 37 27
Oct 17	19	1 S	14.8	33 19.3	-14 38 30

Sep is the minimum separation, with Uranus South of the star. The magnitudes are only estimates. The late May events were also found, with magnitudes 1½ fainter than those reported in I.A.U. Circular #3068. According to I.A.U. Circ. #3079, the star occulted by Uranus on Aug. 26 has a spectral type of about A5. The predicted U.T. of first occultation by the outer E ring is 1^{h}49^m and last occultation by the same ring 2^{h}56^m. The times vary by ±2^m across the earth's surface, but are uncertain by several minutes. The event is visible from most of North America and western South America. Twilight interferes in the western U. S.A., while Uranus sets before the final event in cities such as Washington, Caracas, and La Plata. Chile is the most favored location. Walter Nissen, Arlington, VA, calculates that the first event occurs at only 7° altitude in Washington, while in Texas, Uranus' altitude goes from 30° to 18°.

The occultation of γ Ceti A by 6 Hebe is briefly described on p. 427 of the June issue of *Sky and Telescope*. More information about this event is given in POSSIBLE OBSERVATION OF A SATELLITE OF A MINOR PLANET on p. 115. The predicted path shifted considerably as the results of photographic observations made during the preceding month were analyzed; see the left side of the map on p. 116 (A miss was observed near Waller, Texas, approximately in the middle of the "U" in "Houston" on the map). It is clear that the minor planet and the star must be on the same photographic plate, within a degree of each other, before a reliable prediction can be made. Any farther away, and one or more individual star position errors (actually, small proper motion errors which have accumulated) can distort the reference frame by several tenths of a second of arc. This means that a good prediction can usually be made only one or two days before the occultation.

Analyses of the observations to determine the diameter of Hebe are in progress by Gordon Taylor, Guillermo Mallén (Mexico City), and me. Preliminary results indicate a diameter of about 185 km with an uncertainty of about 10 km, in reasonably good agreement with radiometric and polarimetric determinations. The Universidad Nacional Autonoma de Mexico sponsored a trip to Mexico City so that I could discuss details with the observers and give a talk about IOTA's current and planned work with planetary occultations. Paul Maley's observation was first described publicly at the AAVSO meeting in Washington, D. C., on May 14. An error in the *Sky and Telescope* article should be noted. An occultation by Juno was observed visually from Sweden in 1958 and one by Pallas was recorded photoelectrically at Naini Tal, India, in 1961, so the occultation by Eros was not the first certain case of an occultation by a minor planet. However, it was the first observed from more than one station, while the occultation by Hebe is the first observed from more than one station involving one of the larger minor planets, for which a rather spherical shape can be assumed.

The occultation of 8.3-mag. SAO 98871 by Saturn on October 3 will be visible from North America. The disappearance behind the rings will occur at about 9^h34^m U.T., visible only from the eastern part of the continent (Saturn below the horizon in the West). The planet will occult the star 18 minutes later. The star will still be behind Saturn when it reappears from the rings. The reappearance from behind the planet will occur at 10^h50^m in p.a. 307° at Texas, and will be visible from the western 2/3rds of North America, but occurs after sunrise at Toronto.

On I.A.U. Circ. #3074, A. W. Harris (J.P.L.) gives predictions for two eclipses of Iapetus (Saturn VIII) by Saturn. The sequences are as follows: Oct. 19, 12^h25^m UT, immersion, outer ring shadow; 13^h55^m-14^h25^m, in "shadow" of Cassini's Division; 19^h31^m, immersion, Saturn's shadow; Oct. 20, 5^h07^m, emersion, Saturn's shadow; and 5^h11^m, emersion, outer ring shadow. The second eclipse occurs 1978 Jan. 7, 18^h57^m, immersion, planet shadow; Jan. 8, 4^h12^m, exit, planet shadow; 8^h04^m-49^m, "shadow" of Cassini's Division; and 10^h48^m, exit, outer ring shadow. The times are uncertain by about ±15 min. James Elliot, Cornell University, says that the Kuiper Airborne Observatory will be used to monitor the October eclipse. The January event is less favorable for photometry due to the proximity of Saturn. He recommends careful visual observations for the January event. Visual magnitude measurements, if done carefully, can yield useful information about the rings due to the enhancement caused by the tilt of the rings. Similar observations in October can be compared with the photoelectric observations to assess the accuracy of the former. The magnitudes of suitable comparison stars which will be near Saturn at the times of the eclipses need to be determined and distributed to observers.

UPCOMING LUNAR OCCULTATIONS OF MINOR PLANETS

David W. Dunham

A list of lunar occultations of minor planets during 1977, prepared by H.M. N.A.O., was published on p. 99 of the March issue of *Occultation Newsletter*. Unfortunately, the June 23rd occultation of (10) Hygeia occurred after moonset for all locations in western North America. Detailed predictions for the next moderately favorable event, involving (9) Metis on July 24, have been computed with the University of Texas total occultation prediction program using data supplied by me. The northern limit crosses southern California, but the graze there occurs 6° from the north cusp on the moon's bright side, rendering observation impossible; the altitude above the horizon is also very low. The next favorable lunar occultation of a minor planet after July, according to H.M.N.A.O.'s list, is the one of (7) Iris on November 5, visible from Brazil. By then, the lunar occultation system for minor planets being prepared by Thomas Van Flandern and me at U.S.N.O. should be operational. In the table below, magnitude is visual and position is apparent of date. The predicted quantities are the UT of disappearance, the duration of the fade at disappearance due to the size of the minor planet, the Position angle of disappearance, the Cusp angle measured around the moon's limb from the Northern cusp, the altitude of the Minor planet above the horizon at the time of the occultation, and the Sun's altitude (if -12° or greater). High-speed photoelectric observations of this event with large telescopes would be valuable for minor planet diameter studies.

Location	UT	d	P	C	M	S
July 24, Metis, diam 151 km, mag 11.4, R.A. $14^h19^m02^s$, Decl. -12°43!8, moon 54%+						
Mauna Kea, Hawaii	5^h $24^m.4$	$0^s.27$	88°	69N	55°	-5°
Cerro Encantada, Mexico	6 39.5	0.39	38	19N	9	
San Diego, California	6 43.9	0.87	23	4N	9	
Palomar Mountain, California	-- no occultation (north of northern limit) --					

It was mostly cloudy in Japan for the appulse of Uranus and SAO 158687 on March 10, but Kazuyuki Yamada was able to see three occultations, possibly by the rings, from western Tokyo, using a 10-cm reflector at 200X. Unfortunately, he thought they were atmospheric, and did not get accurate timings. Brian Marsden has received some ring occultation timings from the People's Republic of China.

ERRATA

Items noted by Robert Sandy:
O.N. 1, 94 (#10); in the tabular listing for the 6/6/76 graze of ZC 1671, St should be "CO", and WA should be "T"; on the same page, col. 1, lines 6 and 7 should read:
3, when the librations were lat. -6°0 and long. -6°7. The observations show-

ADDRESS UPDATE FOR MAP ORDERS

For U. S. maps of areas east of the Mississippi, including Minnesota:

Branch of Distribution
U. S. Geological Survey
1200 South Eads Street
Arlington, VA 22202

For U. S. maps of areas west of the Mississippi, including Louisiana:

Branch of Distr., Central Region
U. S. Geological Survey
Box 25286 Denver Federal Center
Denver, CO 80225

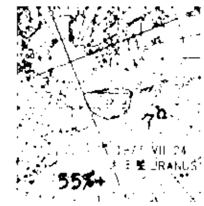
For Canadian maps:

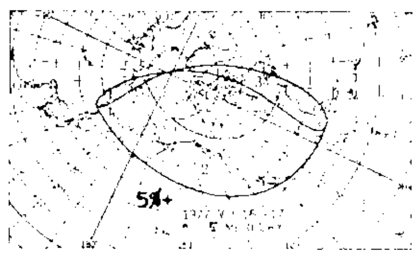
Canada Map Office
615 Booth Street
Ottawa, Ontario K1A 0E9

Approximately half of Mexico now has been mapped at 1:50,000 scale, but the maps are available only by special arrangement. If you need Mexican maps, contact David W. Dunham.

LUNAR OCCULTATIONS OF PLANETS

The maps showing the regions of visibility of lunar occultations of planets are reprinted by permission from the Japanese Ephemeris for 1977, published by the Hydrographic Department of Japan. Region 1, only R visible; Region 3, only D visible.





POSSIBLE OBSERVATION OF A SATELLITE OF A MINOR PLANET

David W. Dunham and Paul D. Maley

With all of the publicity about the rings of Uranus discovered during an occultation of a faint star by the planet during 1977 March 10, we hope that astronomers will not overlook observations of another remarkable occultation which took place five days earlier. This was the occultation of 3.6-magnitude γ Ceti A by (6) Hebe, observed from locations in and near Mexico City (see I.A.U. Circular Nos. 3040 and 3047). This is the first time that an occultation of a star by one of the larger minor planets has been observed from more than one station. The preliminary reports, all by visual observers, seem to be consistent with a diameter for Hebe of about 200 km, which is also the value obtained by modern radiometric and polarimetric methods. A comprehensive analysis of the occultation observations will be made soon. The map shows the preliminary observation reports. Estimates of the path of occultation as predicted by Gordon E. Taylor and Dunham based on astrometric observations made at the Royal Greenwich Observatory and by Robert Harrington at the U.S. Naval Observatory are indicated on the left. The observation described below indicates that double star observation techniques might be used to search for possible satellites of minor planets.

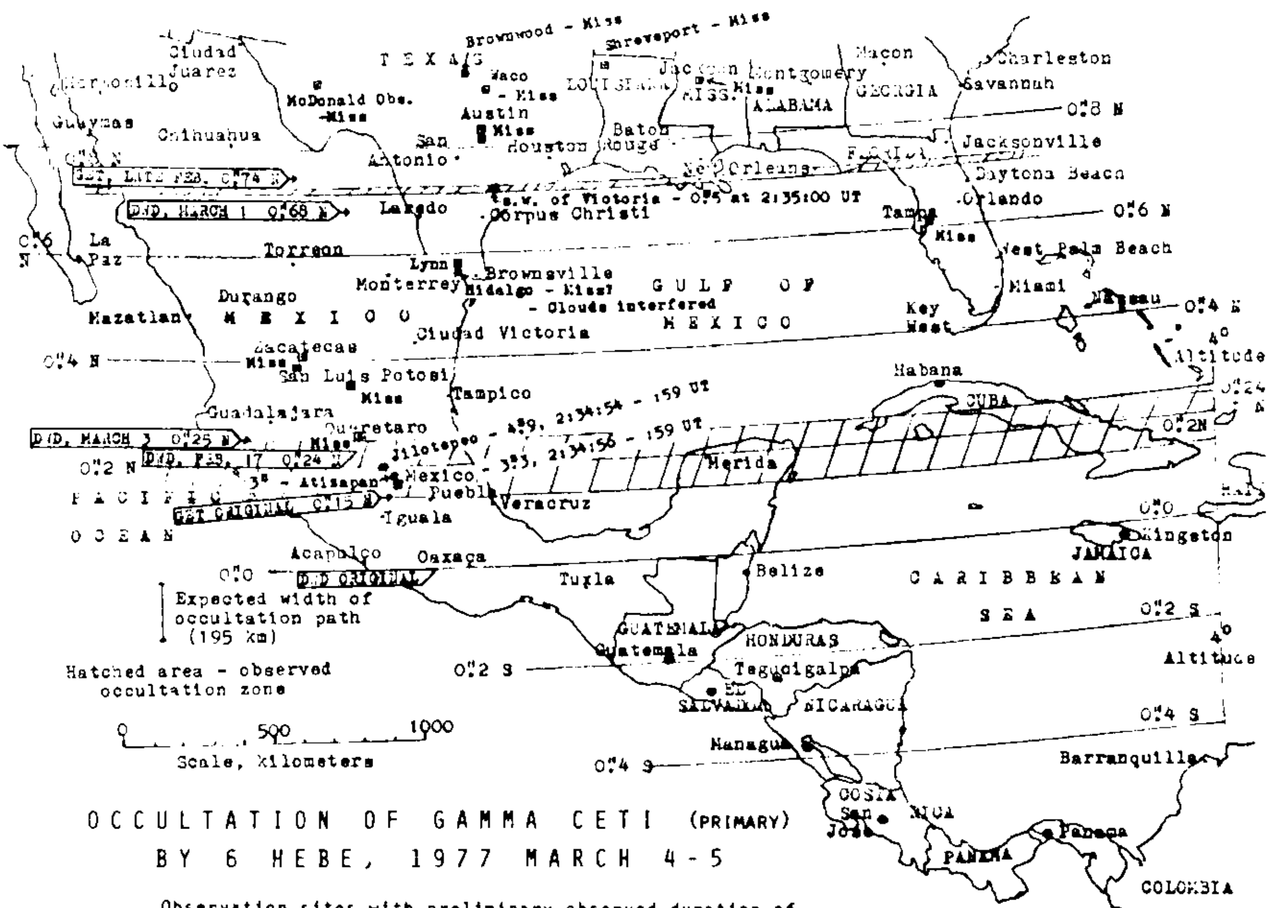
Maley, an experienced occultation observer from Houston, Texas, traveled west to avoid widespread cloudiness along the coast. He attempted observation of the occultation by Hebe from a site about 13 km southwest of Victoria, Texas (longitude 97°02'58"7 W., latitude +28°45'00"0, height 92 feet above sea level according to the "Raisin, Texas" 1:24,000-scale U.S. Geological Map), where there was a large clear area. Observation was made with a 13-cm refractor with a [illegible] altazimuth mounting. Using a 20x eyepiece, the field of view was 2'.4. Maley claims that he saw the star very well during the critical time, with no drops in the star's light of as much as 1/3 due to some cirrus present. But for 0^s.5 beginning at $2^h35^m00^s.4$ UTC, the star abruptly disappeared from view. The timing was by tape recording voiced calls and WWV shortwave radio time signals. A personal equation of 0^s.2 was applied to the timings. When we discussed the observation the following morning, we assumed that he had observed a nearly grazing occultation by Hebe, since the expected duration of a central event was 5 seconds. We assumed that Maley was near the southern limit since observers south of Austin, Texas, reported a miss (no occultation). Unfortunately, clouds prevented observation by observers in Victoria and Corpus Christi. Dunham was consequently surprised when Jose de la Herrán telephoned from Mexico City half an hour later to give some information about the successful observations of the occultation made there. The first inclination is to dismiss Maley's observation as an atmospheric effect (which he feels is not the case), but the fact that his occultation occurred at virtually the same time as the occultation in Mexico City merits further study (the prediction uncertainty was about ±60 seconds in time). This simultaneity makes a terrestrial cause, such as an occultation by a bird, seem less probable. A bird might have been noticeable in Maley's telescope due to the nearly full moon. Relative to the direction of motion of the occultation shadow across the earth's surface (indicated by the gentle east-west parallel curves on the map), Maley's site was 900 km (subtends about 0".7 at Hebe's distance) north of the occultation shadow at Mexico City. Hebe can not have a diameter this large, due to albedo considerations, but more importantly, due to the fact that no occultation was seen from stations between Victoria and Mexico City, such as at Queretaro and Zacatecas, Mexico, and probably at Lynn and Hidalgo, Texas (where there was some interference from clouds).

Duplicity of γ Ceti can be ruled out as an explanation, both in regard to the known B component and to a hypothetical duplicity of the A component. Also, there can not have been any significant effect from either Fresnel diffraction or from the star's angular diameter.

Is it possible that Maley's occultation was caused by a satellite of Hebe? At 900 km, Hebe's attraction of such an object would be about the same as that of the sun, assuming a mean density of Hebe about twice that of the sun, a reasonable assumption for a carbonaceous-type minor planet. This indicates that such a satellite is possible; the attraction of the moon by the sun is about twice that by the earth. If the orbit of such an object could be determined from future observations, it would yield a value for the mass of the minor planet. This would be especially useful for Hebe, whose diameter should be fairly well determined from the occultation observations; the mean density could then be calculated.

Maley's observation implies a satellite diameter of perhaps 20 km. This would result in a magnitude about 5 fainter than Hebe's, a very difficult object at 0".7 separation. The period of revolution around Hebe might be about two days. The next two oppositions of Hebe occur in early 1978 and 1979. They are relatively unfavorable, with Hebe being only slightly closer to the earth than it was during the occultation. The 1980 November opposition, being near perihelion, is more favorable, with Hebe's geocentric distance being 1.064 A.U., about 2.3 times closer than during the recently observed occultation. Therefore, in late 1980, the satellite might move more than 1".5 away from Hebe. The opposition will be in northern Eridanus, at 1950 R.A. 3^h54^m, Decl. -8°.8. Curiously, at about 3^h U.T. of 1980 July 25, Hebe will pass only about 11' south of γ Ceti, perhaps a useful astrometric opportunity.

If there is a satellite of Hebe, it is possible, and probably likely, that there are several others, orbiting other large minor planets as well. We will not speculate on the origins of such objects, but feel that it might be worthwhile to apply techniques of observation of close double stars to a few of the larger minor planets. Dur-



OCCULTATION OF GAMMA CETI (PRIMARY)
BY 6 HEBE, 1977 MARCH 4-5

■ - Observation sites with preliminary observed duration of occultation and U.T., or "Miss" if no occultation occurred ing future occultations of bright stars by minor planets, photoelectric observations and observations by pairs of visual observers about 1 km apart up to a thousand kilometers and more from the predicted occultation path might give confirmation of occultations by satellites of minor planets.

OCCULTATIONS OF GALACTIC-NEBULAR OBJECTS

Richard P. Binzel

During the second half of 1977, six galactic-nebular (GN) objects will be favorably occulted, with two of them, NGC 6356 and M23, occulted twice. Occultations of GN objects have been included in the 1977 USNO total occultation predictions, and are designated by G-prefixed USNO reference numbers.

In compiling the list of favorable events below, general qualifications on sun altitude (-15° or lower), moon altitude (10° or higher), and illumination of the moon (70% or less) were imposed. License was granted in three cases, denoted by asterisks, on the basis of the object's brightness or large angular diameter. Times shown are for occultation of the center of the designated object. Additional information on GN object occultations can be found on p. 107 of *o.n.* #10.

1977 Date	Approx U.T.	Object	Snl	Nighttime Area of Visibility	Mag	Type	Size	USNO Ref No
Aug 23	15^h4	NGC 6356	68+	southeast Australia	8.7	GB	1.7	G00024
Aug 24	17.3	M25	79+	northeast Europe*	6.5	OC	40.0	G00032
Sept 19	21.1	NGC 6356	45+	southern Africa	8.7	GB	1.7	G00024
Sept 20	9.1	M23	52+	Japan*	6.9	OC	25.0	G00025
Oct 17	15.5	M23	29+	northeast Europe	6.9	OC	25.0	G00025
Oct 20	22.1	NGC 7009	65+	southern Africa	8.4	PL	0.7	G00037
Nov 13	10.1	M9	6+	Philippine Islands*	7.3	GB	2.4	G00023
Nov 16	23.2	M72	39+	eastern South America	9.8	GB	2.0	G00035

OBSERVATIONS OF CLUSTER PASSAGES

Brad Timerson

Several passages of the moon across star clusters have been reported since the last issue of *o.n.*

The total occultation observations included in this article are summarized in the table, whose format is similar to that of the last issue (see p. 99). "C" stands for catadioptric.

At Randburg, South Africa, Jan Hers reported fair to poor seeing following a period of very poor weather. Magnitude 9.5 stars were only sometimes seen, and then only as isolated flashes, thus limiting the total count he could make. Robert Hays, Jr., reported clearing skies shortly before sunset, only to have haze interfere two hours into his observations, and finally stop all timings in about another two hours. He also reported that 68 Tauri disappeared in steps separated by 2.0 seconds. Two stopwatches allowed him to time each component. K. L. Liu reported haze that was accentuated by nearby mercury vapor lamps. Juan Silvestre was the most fortunate of the Hyades observers this time, with clear, good observing conditions.

Doug Hall reported that a cable fault caused problems with the drive and heaters on his telescope, preventing him from making more timings. Reports of the more recent March and April 1977 passages across M67 are now coming in. Richard Nolthenius reported that the double SAO 98174 disappeared with a 2-second step. On the other hand, Michael Mangieri did not notice stepwise disappearance in three stars listed as double. However, his observing conditions were rather poor. Although I followed several stars to disappearance, difficulty in receiving WWV time signals kept me from getting timings on any others than the one listed.

Four successful graze expeditions were mounted during the Hyades passage of 1977 Feb. 26. Three of them were for the bright-limb southern-limit graze of 3.9-mag. ZC 648, led by Derald Nye, Paul Asmus, and Emil Volcheck. The fourth was for the sub-marginal northern-limit dark-limb graze of 9.0-mag. J00162, led by Berton Stevens, Jr. This star was listed as A00111 on the total occultation predictions which he had received only several hours earlier; he was alerted by a "graze nearby" message. These expeditions are shown in the graze list on p. 118.

Date	% Sunlit	Observer	Telescope	Total	Non SAO	Non BD
M24						
1977 Feb. 14	20-	Jan Hers, Randburg, South Africa	20C	17	10	7
Hyades						
1977 Feb. 26	40+	Robert Hays, Jr., Palos Hills, IL	13C	8	3	0
1977 Mar. 25	23+	J. D. Silvestre, Quezon City, Phillipines	30L	10	5	1
1977 Mar. 25	23+	K. L. Liu, Taipei, Republic of China	22L	3	1	0
M67						
1976 Nov. 14	59-	Doug Hall, Leicester, England	20L	1	0	0
1976 Dec. 11	83-	Bill Fisher, Colfax, CA		2	0	0
1977 Mar. 2	84+	Richard Nolthenius, San Diego, CA		5	0	0
1977 Apr. 27	54+	Michael Mangieri, Lutherville, MD		4	2	0
1977 Apr. 27	54+	Alvin R. Flesher, Baltimore, MD	15L	2	0	0
1977 Apr. 27	54+	David Richardson, Bowie, MD		1	0	0
1977 Apr. 27	54+	Thomas Van Flandern, Washington, DC		1	0	0
1977 Apr. 27	54+	Brad Timerson, Newark, NY		1	0	0

GRAZES REPORTED TO IOTA

David W. Dunham

Berton Stevens is now receiving help for the predictions of partial occultations of planets by the moon from Terry Boone at Stephen F. Austin State University, Nacogdoches, Texas; Boone successfully adapted my program for doing these calculations for the computer there. Several observers from Illinois, Minnesota, and Manitoba tried to observe the partial occultation of Venus on May 14th, but only one timing was obtained due to clouds.

This spring, during a rare two-week period between publications, no work was available for the keypunch workers at the U. S. Naval Observatory. I was able to fill this gap by giving them all the graze reports for most of 1975 and 1976 which were on the University of Texas forms. Otherwise, nothing has been accomplished on this important task during the last several months. More of these data could be keypunched at USNO if the reports were transcribed to coding forms or the new yet-to-be-prepared IOTA graze report forms. Volunteers are sought for transcribing graze observations onto coding forms; I will send data and copies of instructions and forms upon request. Since access to a keypunch machine is not needed, hopefully more volunteers will take part in this project than the number who did both the transcribing and keypunching themselves.

Everyone agrees that a blink is a disappearance followed after a brief interval by a reappearance, and that a flash is a reappearance followed after a brief interval by a disappearance, but reporting procedures vary among observers. To put reporting on a standardized basis, this new rule should be followed: If accurate timings can be obtained for the separate contact events, they should be reported separately, as disappearances and reappearances, except that, for visual observers, any such pair with a time separation of less than ½ second always should be reported as a single blink or flash event. If three or more rapid-fire contact events in series are observed visually, with each interval less then ½ second, no more than one of the events should be reported as a separate disappearance or reappearance; make sure that each timed contact is represented on the report by a reported time.

A year ago, the northern Cassini region was virtually unexplored. Past scanty observations indicated that the area was not low, as predicted from an extrapolation of Watts' data, but rather that the true limb was close to, or slightly above, the mean limb. During the last couple of years, for the first time since the graze program began in earnest, the moon's orbit has been oriented so that northern Cassini grazes are occurring in the rich northern Milky Way constellations of Taurus, Orion, Gemini, and Cancer. The first well-observed graze in this area was of ZC 1234 last November, discussed on p. 93-4 of the last issue. That was a waning-phase dark-limb graze. Now, the other side of the northern

Cassini region has been well-mapped by observations of two grazes this spring, described below. The observed data for these waning-phase grazes have been sent to the computer for incorporation into ACLPPP profiles.

The first of these grazes was of 8.0-mag. Z08200 (SAO 97580), by a 46% sunlit moon. 23 timings were made by three observers from St. Paul, Minnesota. 87 timings were made by 15 observers (of whom 2 saw a miss and 3 were unable to get reportable timings) using the Milwaukee Astronomical Society's cable near Union Church, Wisconsin. The total of 110 consistent timings were plotted on a reduction profile by Homer DaBoll. This is a new record for a Cassini-region graze, for a graze of a non-Z.C. star, and for 1977. It is now the 13th most successfully observed graze. The message is clear. When conditions are good, valuable observations can be made of 8th-mag. non-Z.C. stars; they should not be ignored. Another record was set during this graze. Robert James timed 28 contacts which were consistent with observations at neighboring stations, 6 more than have been observed by anyone at a previous graze. For those who might want to try to line up the same sequence of mountains during a future graze, the Watts angle of central graze was 4.96 and the librations were 7°4 in long. and +7°52 in lat. Even if these conditions could be duplicated, however, the height on the profile would have to duplicate James' height to within 30 meters, rather difficult, considering star position errors.

The other graze was of Z.C. 1611 (65 Leonis) on May 27. The latitude libration was +4°63, in the "near" Cassini region, halfway between Watts' good coverage and the "far" region represented by Z08200, which occurred near an extreme value of latitude libration. This difference caused the profiles to be significantly different. Near 3° Watts angle, two high peaks were present for Z08200, but this was a low area for Z.C. 1611. Washington-area observers had planned to join observers from Richmond near Hanover, Virginia, not far from Richmond. But lingering clouds from a stalled front to the south made most of us decide to travel west to Rochelle, Virginia, rather than south, since the weather prospects were better at Rochelle. Wayne Warren had checked catalog data for Z.C. 1611 shortly before leaving; this showed that the secondary would be much fainter than we had expected and probably not visible in the twilight (sun alt. -5° at central graze). So we did not have observers stationed as far south with respect to the profile as the ones at Hanover. It did clear up at both locations. We recorded the northern part of the profile, while the southern part was traced at Hanover. Consequently, we probably obtained better coverage than if we had combined forces at Hanover.

On May 23, I observed the grazes of Z07800 and Z07813 from locations 7 miles apart and 20 miles west of my intended sites to avoid clouds moving in from Chesapeake Bay. The times of central graze were only 21 minutes apart, a new record for successfully moving from one graze path to another. A few minutes after the second graze, the moon was immersed in thick cirrus clouds. During the critical moments after the first graze, I couldn't find the Allen wrench needed to partially disassemble the massive mount for my 25-cm reflector. I could not lift the mount more than a few inches off the ground, but somehow managed to shove it up into my van by pivoting it about the counterweight at the end of the declination axis, which I was able to maneuver to the step just beneath the open side door. The grazes occurred at nearly the same librations as the ones

Mo	Dy	Star Number	Mag	%Snl	CA	Location	# Sta	# Tm	C C	Ap cm	Organizer	St	WA	b
1976														
9	12	2880	5.1	86-		Kilmore, Austrl.	1	6	4	20	James Trainor			
11	19	Z12975	7.4	6-	S	Painesville, OH	1	8	7	15	Gary Ringler			
12	17	Z11893	8.2	38-		East Sparta, OH	1	1	3	15	Gary Ringler			
12	27	3434	4.6	40+	-S	Canberra, Austrl.	2	5	3	15	David Herald	0	182	-45
1977														
1	2	0629	7.5	90+	15N	Waukesha, WI	1	1	6	25	Berton Stevens,Jr.	5N	8	42
1	22	Z24484	8.2	13+	0N	Kokomo, IN	2	4	4	20	Berton Stevens,Jr.	0	358	-41
1	22	Z24484	8.2	13+	N	West Dover, OH	1	9		15	Gary Ringler			
1	26	0216	8.5	40+	8N	Lenexa, KS	2	9	6	15	Robert Sandy	7N	8	-2
1	29	0663	6.9	73+	2N	Laarne, Belgium	4	3		13	Willy Verhaegen			
1	29	0697	7.2	75+	N	Baltimore, MD	1	1	5	15	Michael Mangieri			
1	30	0710	7.1	77+	-2N	Lake Wohlford, CA	1	1	7	15	Richard Nolthenius			
1	31	0934	6.4	89+	-4S	Flavion, Belgium	4	4		8	Jean Bourgeois			
2	10	Uranus	5.9	58-	4S	Braggadocio, MO	1	3	7	25	Berton Stevens, Jr.	N	182	-11
2	11	Z14996	9.3	45-	3S	Ocean Beach, CA	1	1	5	15	R. Nolthenius	21S	185	-27
2	13	Z17292	9.0	24-	1S	Mission Bay, CA	1	1	5	15	Richard Nolthenius	C	182	-50
2	23	0284	7.4	22+	6N	Immokalee, Fl	1	11	9	20	Thomas Campbell,Jr.	0	9	6
2	23	0284	7.4	22+	6N	Margate, FL	6	24		15	Harold Povenmire			
2	24	0406	7.8	31+	8N	Cheltenham, MD	1	9		15	Fred Espenak			
2	25	Z02874	7.3	41+	N	Clinton, MS	1	0		25	Ben Hudgens	S		
2	26	0648	3.9	49+	-S	Denver, CO	1	5	8	61	Derald Nye			
2	26	0648	3.9	49+	-S	Denver, CO	4	5	6	13	Paul Asmus			
2	26	0648	3.9	49+	-8S	Hewlett, VA	7	21	5	10	Emil Volcheck	0		
2	26	J00162	9.0	50+	10N	Gilmer, IL	1	4	5	25	Berton Stevens, Jr.		11	49
2	28	0951	6.8	71+		Johnstown, CO	2	4		20	Derald Nye			
3	13	Z18558	7.5	39-	S	Gluckstadt, MS	2	4	5	25	Ben Hudgens			-57
3	14	2826	4.0	29-	3S	Wesson, MS	4	30	7	25	Ben Hudgens	C	185	-60
3	14	2826	4.0	29-	1S	Reddick, FL	3	18	8	20	Thomas Campbell,Jr	1N	184	-60
3	14	2826	4.0	29-	1S	Samsula, FL	1	7		25	Harold Povenmire		184	-60
3	14	2883	5.5	25-	N	Gundaroo, Austrl.	8	26	8	20	David Herald	9N	1	-70
3	15	2969	3.2	19-	3N	Rochester, IL	4	16	8	13	Homer DaBoll	2N	1	-58
3	16	3154	7.4	9-	S	Canberra, Austrl.	4	12	7	9	David Herald	C	185	-63
3	25	0610	6.2	24+	7N	Moose Lake, MN	3	18	8	12	Richard Binzel	3S	11	48
3	25	0610	6.2	24+	7N	Porterfield, WI	1	7	7	15	Ronald Parmentier	2S	11	48
3	25	0610	6.2	24+	7N	Grand Bend, Ont.	1	7	9	15	Doug Cunningham	S	11	48
3	25	0658	4.2	27+	N	Nagahama, Japan	15	52	8	6	Yasuo Yabu	N	12	50
3	25	0658	4.2	27+	N	Shimada, Japan	14	47	8	5	Toshio Hirose	N	12	50
3	27	Z04796	9.0	41+	7N	Mt. Zion, MD	3	8	5	25	David Dunham	10N	9	64
3	27	Z04809	7.5	41+	9N	Fort Myers, FL	2	1	5	20	Thomas Campbell,Jr	5N	10	62
3	27	Z04809	7.5	41+	9N	Hammondville, FL	1	2		25	Harold Povenmire			
3	27	Z04952	7.9	42+	10N	Wimauma, FL	2	7	6	15	Thomas Campbell,Jr	4S	12	64
3	27	Z04952	7.9	42+	10N	Riviera Beach, FL	1	6		25	Harold Povenmire			
3	27	0886	7.0	42+	9N	Wimauma, FL	2	2	6	20	Thomas Campbell,Jr	4S	11	65
3	27	0886	7.0	42+	9N	Jupiter, FL	1	0		25	Harold Povenmire	S		
3	27	Z05073	9.2	43+	10N	Ocean Beach, CA	1	6	4	15	Richard Nolthenius	5N	12	65
4	23	0832	4.7	19+	N	Kemp, OK	2	8	7	20	John Wright	7N		
4	23	0836	5.5	18+	6N	Colorado City, CO	1	7	8	20	Paul Asmus	2N	11	64
4	25	1091	6.7	35+	8N	Garner, AR	1	3	8	20	Homer DaBoll	0	10	72
4	25	1091	6.7	35+	8N	Tisonia, FL	1	3		15	Harold Povenmire	N		
4	25	Z07062	9.2	35+	N	Victoria, TX	1	4	5	25	Don Stockbauer			
4	25	Z07114	8.2	35+	6N	Rising, IL	1	2	5	20	John Phelps, Jr.	10N	8	74
4	25	1106	3.6	36+	6N	Cheyenne, WY	1	2	8	20	Paul Asmus	4S	8	75
4	25	1106	3.6	36+	4N	Minturn, AR	1	8	7	20	Homer DaBoll	1N	7	75
4	26	1212	7.1	44+	9N	Pecan Gap, TX	1	2	2	6	Donald Stotz		7	70
4	26	1212	7.1	44+	9N	Matlacha, FL	1	13	9	20	Thomas Campbell,Jr	2N	10	72
4	26	1212	7.1	44+	9N	Miami, Fl	1	4		15	Harold Povenmire			
4	26	Z08200	8.0	46+	5N	St. Paul, MN	2	7	6	15	Richard Binzel	CO	5	75
4	26	Z08200	8.0	46+	5N	St. Paul, MN	1	16	9	20	James Fox	CO	5	75
4	26	Z08200	8.0	46+	5N	Union Church, WI	11	87	8	20	Robert James	CO	5	75
4	28	1518	6.3	72+	8N	George, S. Africa	1	2	8	8	Jan Hers	C	5	48
5	6	2647	6.4	84-	9S	Irene, S. Africa	1	2	8	8	Jan Hers	C	185	-66
5	14	Venus	-4.2	12-	3S	Petersfield, Man.	1	1	5	15	B. Franklyn Shinn		188	-4
5	21	0934	6.4	8+		Birds Hill, Man.	3	10	6	19	B. Franklyn Shinn			
5	23	Z07800	8.5	21+	3N	Jarrettsville, MD	1	9	7	25	David Dunham	C	7	74
5	23	Z07813	9.0	21+	2N	Pylesville, MD	1	1	5	25	David Dunham	C	7	74
5	25	1397	5.5	39+	-5	Glencoe, Ontario	2	5		10	Doug Cunningham			
5	27	1611	5.7	60+	6N	Rochelle, VA	5	22	8	20	David Dunham	C	5	46
5	27	1611	5.7	60+	6N	Hanover, VA	4	16	6	16	Emil Volcheck	C	4	46
5	28	1744	6.5	72+	3N	Victoria, TX	1	5	6	15	Don Stockbauer		0	31
6	4	2826	4.0	91-	S	Tlalnepantla,Mex.	1	12	7	20	Francisco Diego			
6	5	2969	3.2	83-	0N	Steen, TX	1	2	5	15	Don Stockbauer	N		
6	5	2969	3.2	83-	3N	Ashland, VA	13	48	8	20	Emil Volcheck	4N	354	-58

for the 2.82?? data to extend the observed profile by ?

During the graze of ? 3 Tauri (ZC 832) on April 23, John Wright noticed that the first disappearance was gradual, lasting about 0ˢ4. This was undoubtedly caused by lunar limb diffraction, which would be considerably enhanced in this case by the bright spectral type M0 star's expected angular diameter of about 0ʺ03. Four of the eleven events which Harold Povenmire observed during the graze of ZC 284 on Feb. 23 lasted about 0ˢ2, again probably due to diffraction. The star's catalog magnitude is 7.4, but Povenmire estimated that it was at least a magnitude brighter. Thomas Campbell also observed several gradual events, which he attributed to diffraction, since none of them occurred in a stepwise manner as would occur in the case of a close double.

The star whose USNO reference number is J00162, observed during the Hyades passage of February 26, is B.D. +17° 721. In the preliminary version of the Hyades catalog used for the February predictions, the star's USNO reference number was A00111.

On 1977 March 27, there were seven grazes in Florida and Georgia which provided two separate opportunities for observing three grazes that night; there were no four-graze possibilities as the moon passed through the rich Milky Way star field. Povenmire and Campbell led expeditions to observe the southern triple, where the logistics were a little simpler. Actually, nobody got timings of all three grazes, since Campbell missed the D and R for the first graze due to clouds and headlights (but he did ascertain that the star was behind the moon for a minute between these interruptions), and the others had a miss due to a south shift of the last graze. For Campbell's expeditions, the travel distances were 97 and 7 miles (3^h10^m and 51^m) between grazes, respectively.

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. As mentioned on p. 109 of the last issue, observers are asked to please send me as complete as possible information about suspected double star occultations, especially the star's SAO number, ZC number (if any), the position angle of the event, the estimated duration (time between steps) of the event, and, if possible, relative magnitude estimates. Other useful values are the cusp angle (which gives a better indication of the direction of the Moon's motion than the P.A.), and the moon's altitude (since the moon's apparent velocity is greater at low than at high altitudes). These quantities are needed to estimate "radial rate", which translates the observed duration into separation in arc seconds projected onto the P.A. of the event.

Richard Nolthenius has gone through the double star articles in all issues of O.N. to systematically document, and prepare in machine-readable form, data for all stars listed. These data, which are not now in our computer files for stars discovered during occultations (with the exception of the [illegible] data described in the last issue), include the method code, discoverer's initials, date and location of discovery, and references (usually O.N.). Some new method codes were devised, including "X" used for two stars below, and meaning that two or more photoelectric occultation observations (or one photoelectric total occultation observation and one good graze observation) were made the same night, allowing a reasonably good determination of the true separation and P.A., at least for that night. I will need to do the same thing for the data in the original "University of Texas" special list of 1974 May 9. Nolthenius also compared his observation reports with our current master list and found several previously unreported occultation doubles included in the list below.

Frank Fekel, Dept. of Astronomy, University of Texas, Austin, TX 78712, is especially interested in receiving photoelectric occultation observations of β Capricorni (ZC 2969). Observations during the next year will be especially valuable for establishing the orbit of this spectroscopic binary. Most important will be the last occultation of the current series visible from North America, a very favorable event on October 20. The series ends next year in the Southern Hemisphere. Fekel finds no photoelectric occultation evidence for a new close companion of ZC 2968, a distant 6th-mag. companion of β Capricorni.

The largest number of new doubles in the list below was observed by members of the British Astronomical Association. Geoffrey W. Amery, Reading, England, coordinates these reports for the Lunar Section of the B.A.A., and sent me the information.

Harold Povenmire feels that the step and partial events he saw during the graze of ρ Sagittarii (SAO 162512, ZC 2826) on March 14 show that the star is a close double. Ben Hudgens, observing with a 25-cm reflector near Wesson, MS, saw a faint flash which corroborates Povenmire's observation. However, Tom Campbell, observing the same graze near Reddick, FL, only saw some gradual phenomena which he attributed to diffraction effects, as I did during last November's graze (see p. 110 of the last issue). Although the evidence for duplicity is strong, I don't think that it is yet conclusive; some good photoelectric total occultation records could decide. One must be careful with graze observations where the resolution is so good that diffraction phenomena can be seen. The close components of λ Geminorum (SAO 96746, ZC 1106) are another case in point. DaBoll observed a graze, while a photoelectric record of the total occultation was made at McDonald Observatory, TX, the same night. In Texas, the altitude was low, the seeing was bad, and some clouds were present. A significant drop in the light curve occurred just before the disappearance, but the variations due to seeing reached about the same amplitudes. The magnitudes in the list assume that the drop was due to a new close component, while the separation and P.A. were determined from both observations (a vector separation of 0ʺ01 in P.A. 14° was assumed to be implied by DaBoll's observation). Late word has arrived from Mr. Amery that, on March 28, several English observers (M. Taylor, Wakefield; L. Dibden, Purlieu; L. Fry, Bournmouth; and D. Peters, Edenbridge) observed fading for a few tenths of a second at a favorable disappearance of λ Geminorum; the P.A. was around 55°. Dibden thought that the disappearance occurred in two steps. Five other observers thought that the immersion was instantaneous. If phenomena indicating possible duplicity are seen during a graze, the star's SAO number should be included on the report, even for ZC stars.

SAO 97555 is an obvious visual double which has not been included in any previous double star lists. Van Nuland clearly resolved both components before he timed their separate disappearances. The components are listed separately in the AGK3, where their numbers are +14°868 and +14°869. The data in the list were computed from the accurate AGK3 positions.

A discussion of the duplicity of 51 Tauri (SAO 76541, ZC 631) is included in H. McAlister's article on speckle interferometry starting on p. 346 of the May issue of *Sky and Telescope*. He notes that the interferometric data for η and θ Virginis (ZC 1772 and 1891) disagree with the spectroscopic orbital data, so that he might be observing new (third) close components. I reached the opposite conclusion on p. 108 of the last issue of *O.N.*, noting that the magnitudes of McAlister's companions were so bright that their lines should be visible separately in the spectra. Possibly the magnitudes are in error.

Griffin and Gunn announce the rather remarkable discovery of the bright Hyades spectroscopic binaries δ Tauri (ZC 648) and θ_1 Tauri (ZC 669) on p. 176 of the February issue of *the Astronomical Journal, 82*. Establishing duplicity of Hyades stars is important for calibration of the cluster's main sequence, upon which most galactic and extragalactic distance scales ultimately depend. the stars are one-line spectroscopic binaries, so the secondary magnitudes are rough estimates; if they are brighter, they should be fairly easy to detect photoelectrically. The occultation series of δ Tauri is moving into equatorial regions and later into the Southern Hemisphere, while the series for θ_1 Tauri begins in 1978 in the Northern Hemisphere

The bright visual double ι Arietis (SAO 75673, ZC 440) was not included in previous lists since an orbit had been determined (as noted in the Index I.D.S.) which was rejected by Finsen and Worley in their catalog of visual double orbits. Photoelectric total and graze data obtained in Texas in 1972 Nov. and 1973 Jan. were used to determine the double star data given in the list. It will be several years before the star is occulted again.

The separation of μ Arietis in early 1973 was given incorrectly as 0".49 on p. 109 of the last issue; it should be 0".049. Nolthenius notes that the method code for SAO 159752 on p. 110 should be "G", not "T". The date for SAO 75867 on p. 14 of O.N. #2 should be "1974 Feb. 01", not "1972"; the star's duplicity had already been indicated in the list on p. 5 of O.N. #1. The component mags. for 65 Leonis (SAO 118668, ZC 1611, ADS 8060) are incorrectly given as 6.0 and 7.1 in the Stockbauer visual double list; they should be 5.7 and 9.5. Wayne Warren discovered this in catalogs shortly before we observed a graze of the star in May (we did not see the secondary due to bright twilight). Photoelectric observations at McDonald Observatory, TX show that the component mags. of the visual double SAO 93085 (ZC 406, ADS 2101) are 7.9 and 10.9, not 7.8 and 11.5, and those of SAO 161848 (ZC 2731, Kuiper 88) are 7.2 and 7.3, not 7.0 and 7.7.

Although J. Trott noted that SAO 95456 might be double due to its apparently non-instantaneous reappearance in P.A. 231° on 1976 Aug. 21, the more accurate data in the list are from a photoelectric observation of the star's disappearance by John Africano at McDonald Observatory on 1977 Feb. 28.

The duplicity of SAO 145635 (ZC 3184) is rather in doubt due to clouds; duplicity was seen in the blue channel only, and the disappearance seemed sharp according to a visual observation by R. Nolthenius the same night.

NEW ZODIACAL DOUBLE STARS, 1977 JUNE 27

SAO/BD	ZC	M	N	MG1	MAG2	SEP	PA	MAG3	SEP3	PA3	DATE, DISCOVERER, NOTES
75673	0440	X	M	5.1	5.7	1".2	212°				Known double, A.D.S. 2257, not in earlier lists
76541	0631	I	V	5.9	7.9	.076	0				1975 Oct, C. Lynds, Kitt Peak, AZ
76568		T	K	10.0	10.0	0.2	90				1974 Mar 28,B. Sincheskul, Poltava, Ukraine, USSR
76972	0766	T	K	6.8	6.8	0.3	270				1974 Nov 3, R. Melley, Birmingham, England
78267		T	B	8.5	8.5	0.1	100				1974 Apr 26, P. Withers, Reading, England
78947	1062	T	K	7.1	7.1	0.04	20				1971 Apr 2, E. Kharadze, Abastumani, Georgia, USSR
80125	1253	T	K	8.2	8.2	0.1	90				1970 Mar 18, G. Hewick, Leicester, England
92659	0272	T	X	6.7	6.7	0.1	121				1976 Dec 2, W. Mellor, Sheffield, England
93118	0415	T	K	6.8	6.8	0.2	270				1968 July 19, G. Hewick, Leicester, England
93424	0495	T	K	9.1	9.1	0.2	55				1976 Feb 8, G. Hewick, Leicester, England
93536	0527	T	K	7.1	7.1	0.3	87	11.8	36".2	153°	1977 Jan 28, M. Taylor, Wakefield, England (2nd *; ADS 2661
93777	0610	G	T	7.0	7.0	0.05	358	9.3	4.4	326	1977 Mar 25, J. Fox, Moose Lake, MN (2nd *; ADS 3006)
93835		P	K	9.2	10.4	.018	154				1976 Mar 8, J. Africano, McDonald, Observatory, TX
93897	0648	S	J	3.9	13.	0.04	0				1972, R. Griffin and J. Gunn, Palomar Mountain, CA
93955	0669	S	V	4.0	12.	0.20	0				1975, R. Griffin and J. Gunn, Palomar Mountain, CA
93964		T	X	9.9	9.9	0.4	108				1977 Jan 29, J. Baguley, Derby, England
94069		C	M	9.7	9.7	0.2	44				Correct error in Stockbauer list
94222		T	X	9.9	9.9	0.3	100				1976 Mar 8, G. Hewick, Leicester, England
94422	0785	P	K	9.2	10.1	.036	281				1977 Feb 27, J. Africano, McDonald Observatory, TX
94920	0886	T	K	7.7	7.7	0.03	63				1977 Mar 27, R. Nolthenius, San Diego, CA
94961		T	K	8.8	8.8	0.02	132				1977 Mar 27, R. Nolthenius, San Diego, CA
94978		T	K	8.7	9.6	0.02	217				1977 Mar 27, R. Nolthenius, San Diego, CA
95009		T	K	9.0	9.0	0.1	146				1977 Feb 27, A. Wells, Birmingham, England
95265		P	X	9.6	9.7	.016	236				1977 Feb 28, J. Africano, McDonald Observatory, TX
95391		T	X	9.9	9.9	0.3	47				1976 Feb 11, G. Hewick, Leicester, England
95403		T	K	9.9	9.9	0.1	141				1976 May 3, G. Hewick, Leicester, England
95456	0951	T	V	7.1	8.4	.015	64				1976 Aug 21, J. Trott, Bracknell, England
95683		T	X	9.5	10.1	1.51	284				1977 Apr 24, R. Nolthenius, San Diego, CA
96515		P	V	9.5	10.1	.057	262				1977 Mar 1, J. Africano, McDonald Observatory, TX
96611	1091	G	K	7.5	7.5	0.05	50				1977 Apr 25, H. Povenmire, Tisonia, FL
96703		T	K	9.8	9.8	0.38	70				1977 Apr 25, R. Nolthenius, San Diego, CA
96704		T	K	9.5	10.8	2.0	70				1977 Apr 25, R. Nolthenius, San Diego, CA
96746	1106	X	Y	4.0	5.0	.045	300	10.7	9.6	33	1977 Apr 25, H. DaBoll, Minturn, AR (2nd *; ADS 5961)
96817		T	X	9.9	9.9	0.2	71				1976 Apr 7, G. Hewick, Leicester, England
96962		T	K	9.3	9.3	0.1	45				1974 Mar 31, F. Oliver, Guildford, England
96991		P	X	9.2	10.4	.006	85				1977 Mar 29, J. Africano, McDonald Observatory, TX
97376		T	X	9.5	9.5	0.08	281				1975 Apr 19, R. Nolthenius, Tucson, AZ
97503	1212	G	K	7.9	7.9	0.02	21				1977 Apr 26, T. Campbell, Ft. Myers, FL
97555		V	C	8.8	9.4	10.9	33				1977 Apr 26, J. Van Nuland, San Jose, CA
97564		T	K	9.7	10.1	0.04	307				1977 Apr 26, R. Nolthenius, San Diego, CA
97574		T	X	9.5	10.3	0.75	289				1977 Apr 26, R. Nolthenius, San Diego, CA
97609		P	X	9.2	9.8	.039	87				1977 Apr 26, D. Evans, McDonald Observatory, TX
98312		T	X	9.6	9.6	0.2	90				1977 Mar 30, R. Laureys, Diepenbeek, Belgium
109388		T	K	9.5	9.5	0.1	69				1976 Dec 28, M. Daly, Harrogate, England
109719		P	V	9.1	9.9	.026	286				1977 Feb 22, J. Africano, McDonald Observatory, TX
118150		T	K	8.8	8.8	0.1	49				1976 Apr 11, G. Hewick, Leicester, England
118224		P	X	8.8	11.2	.195	57				1977 May 26, B. Smith, McDonald Observatory, TX
118610	1599	T	K	5.8	5.8	0.1	90				1971 Apr 7, A. Zhitetski, Kiev, Ukraine, USSR
138610		T	X	9.6	9.6	0.2	146				1977 May 28, J. Ferreira, Fremont, CA
138664	1759	T	Y	7.3	7.3	0.1	50	11.6	74.4	195	1976 June 6, M. Taylor, Wakefield, England (2nd *; ADS 8471)
138677		T	X	9.3	9.3	0.3	76				1976 June 6, G. Hewick, Leicester, England
145567		T	K	9.3	9.3	0.03	95				1974 Oct 25, R. Nolthenius, Tucson, AZ
145572		T	X	9.5	9.5	0.06	68				1974 Oct 25, R. Nolthenius, Tucson, AZ
145635	3184	P	K	7.2	9.7	.062	260				1976 Dec 25, J. Africano, McDonald Observatory, TX
146334		T	K	9.7	9.7	0.1	28				1975 Jan 16, G. Hewick, Leicester, England
157779		T	X	9.2	9.2	0.1	66				1976 June 7, G. Hewick, Leicester, England
158151		T	K	8.5	8.5	0.1	30				1976 Aug 29, P. Anderson, Brisbane, Australia
160326	2463	T	K	7.7	7.7	0.1	334				1977 Mar 12, R. McNaught, Dundee, Scotland
161871	2733	T	K	7.2	7.2	0.2	90				1976 Aug 7, W. Fisher, Colfax, CA
161872		T	X	9.0	9.0	0.05	40				1976 Aug 7, R. Nolthenius, Long Beach, CA
162512	2826	G	X	4.5	5.0	0.02	220				1977 Mar 14, H. Povenmire, Samsula, Fl
162554		T	X	9.1	9.3	0.11	298				1976 Sept 4, R. Nolthenius, Tucson, AZ
162556		T	X	9.2	10.5	0.32	299				1976 Sept 4, R. Nolthenius, Tucson, AZ
162593		T	X	9.2	10.5	0.14	242				1976 Sept 4, R. Nolthenius, Tucson, AZ
185136		T	K	9.2	9.2	0.04	257				1975 Aug 16, R. Nolthenius, Tucson, AZ
+17°1246		T	X	9.8	10.7	0.86	315				1977 Apr 24, R. Nolthenius, San Diego, CA