Occultation Newsletter

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FROM THE PUBLISHER

For subscription purposes, this is the third issue of 1978.

Almost four years ago (see *O.N.* *1* (3), 20), we mentioned that we eventually would raise the price of back issues more than one year old; as of date of publication of this issue, all back issues of *O.N.* will be priced at $1.

O.N.'s price is $1/issue, or $4/year (4 issues) including first class surface mailing, and air mail to Mexico. Air mail is extra outside the U.S.A., Canada, and Mexico: $1.20/year in the Americas as far south as Colombia; $1.68/year elsewhere (see masthead).

IOTA membership, subscription included, is $7/year for residents of North America (including Mexico) and $9/year for others, to cover costs of overseas air mail. European (excluding Spain and Portugal) and U.K. observers should join IOTA/ES, sending DM 10.-- to Hans J. Bode, Bartold-Knaust Str. 6, 3000 Hannover 91, German Federal Republic. Spanish, Portuguese, and Latin American occultation observers may have free membership in IOTA/LAS, including *Occultation Newsletter en Español*; contact Sr. Francisco Diego Q., Ixpantenco 26-bis, Real de los Reyes, Coyoacan, Mexico, D.F., Mexico.

IOTA NEWS

David W. Dunham

A crisis developed in August, when Berton Stevens, Jr., submitted his resignation as secretary of IOTA "as soon as a suitable replacement can be found." Some inquiries found nobody both willing and able to take on this job. Noting that the secretary had too many obligations, we finally decided that the duties should be divided among two or three people, each of whom could manage one or two aspects of the operation. John Phelps, Jr., is now secretary-treasurer, handling all IOTA correspondence which comes to the Tinley Park post office box which we have rented (see masthead). The new IOTA address will be given in the December issue of *Sky and Telescope*. This will streamline the financial record keeping. John also will handle distribution of IOTA publications, including requests for back issues of *O.N.* However, he does not have access to a computer, so Berton Stevens, Jr., will remain as secretary of IOTA's computer files. He will update the files according to instructions from the secretary-treasurer. Stevens will continue to provide address labels to DaBoll for the mailings of *O.N.*, and will provide address labels and observer station card decks to the computors for the graze prediction calculations and distribution. He also will continue computation and distribution of partial occultations of planets by the moon. Starting with the predictions for 1979, Joseph Senne, P.O. Box 643, Rolla, MO 65401, will handle requests for individual graze predictions and make update prediction runs for new observers or for those who decide to increase their travel radii. Phelps will mail such requests to Senne, or will telephone him if time is short (a situation we want to avoid as much as possible; special requests should be sent well before the event). Phelps needs to receive requests first, rather than Senne, so that the financial records can be updated and any changes needed in Stevens' computer files noted before the request is filled. John Phelps, Jr.'s telephone number is (312) 532-2968. Stevens would like to turn over his duties to someone else with relatively stable access to a sizable computer (any volunteers?), but the new arrangement should be workable for the time being.

Work is progressing smoothly on preparation of the index to *O.N., volume I*. Some keypunching remains to be done for the stellar index, as well as programs written to process the data to produce the desired lists. I thank all those who have contributed to the indexing effort so far. I hope that the index can be distributed with the next issue of *O.N.*, probably in January.

USNO total occultation predictions have been distributed to observers on the U. S. Naval Observatory's active mailing list. Recipients have probably noticed that the XZ catalog was used for the predictions (see IMPORTANT INFORMATION REGARDING GRAZING OCCULTATIONS AND USNO PREDICTION VERSIONS, in *O.N., 1* (15), 155). The XZ catalog is essentially a combination of the SZ and K catalogs, with many improved star positions. It includes many of the the Yale O-proper motion southern stars, but due to an oversight, a few hundred of them (mainly the fainter ones, mostly 9th mag.) were not included in XZ. I hope to identify these missing stars in the K catalog, and compute K-catalog predictions for only these missing stars for observers being sent the extended USNO predictions for 1979. This and the creation of a new catalog for next year's lunar eclipse fields will delay production of the 1979 extended USNO predictions, work on which I will not be able to start until mid-November due to other pressing obligations. At least, I don't think that they will be delayed as much as the 1978 extended predictions were. Notice that the 1979 Occultation Supplement offprinted from the RASC's *Observer's Handbook* was not (and will not be in future years) included in USNO's mailing to North American observers. An offprint of the Occultation Supplement can be obtained by sending a long, self-addressed, *un*stamped envelope and 50¢ to the Royal Astronomical Society of Canada, 124 Merton St., Toronto, Ontario M4S 2Z2. The Handbook is available for $4.00.

A minor problem, or rather difference, with the XZ is the use of numerical double star codes (1, 2, or 3) for some non-SAO AGK3 stars. "1" and "2" seem to refer usually to "preceding" and "following," respectively, rather than "brighter" and "fainter" component.

At my suggestion, Berton Stevens has modified the partial occultation prediction program so that the inner edge (northern edge for southern limits and southern edge for northern limits) of the partial zone is computed rather than the center of the zone. This should result in a more rigorous calculation of the inner edge and eliminate the need for observers to calculate the width of the partial zone using the formula in my early paper, "Partial Occultations of Planets by the Moon." The inner edge is usually where observers want to situate themselves, since it is there that the partial occultation will have the longest duration. At the inner edge, for a few minutes around the time of maximum occultation, the edge of the planet may disappear completely behind lunar mountains and reappear in valleys. In the case of a dark-limb partial occultation (or perhaps even a bright-limb one for a planet like Venus with a surface brightness much greater than the moon's) of one of the bright planets, these multiple second and third contacts can appear much like a graze of a star and can be timed reasonably accurately, although they are always somewhat gradual. Consequently, the establishment of observing stations near the inner edge is similar to that for grazes of stars, and a predicted profile can be used. The U. S. Naval Observatory's OCC program, which is used to produce the limb correction data which serve as input for the ACLPPP, is designed to compute data for the inner contacts. The modification to compute inner edge partial occultation predictions consequently makes it possible to produce ACLPPP profiles for the events in a relatively automatic manner, at least as automatic as the procedure for stars, which has not been the case in the past. Also, an option has been built into the program to compute data for the outer edge, if that is desired, for example to prepare a map for publication showing the partial occultation zone.

The comparison of USNO's SZ catalog with SKYMAP, as described on p. 161 of the last issue, has been accomplished. However, since then, an improved version of SKYMAP, correcting several errors, has become available, as has the XZ catalog. We are now in the process of making the computer comparisons of the new version (2.2) of SKYMAP with XZ. Chao Yang is doing most of this work under my supervision.

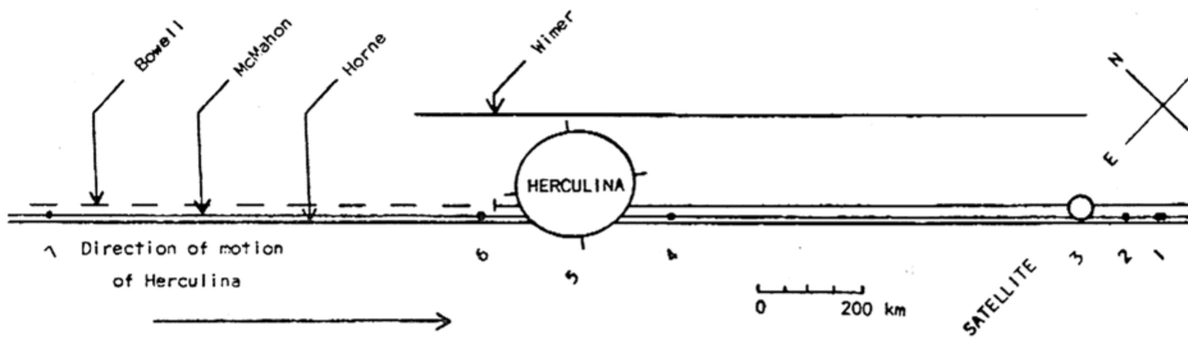
The Hyades passage of September 22 was very successfully observed from North America; see the articles on grazes and new doubles in this issue [Ed: the graze article has been postponed until the next issue]. Observers are reminded that it is useful to send copies of reports of Hyades occultation observations to *Sky and Telescope* soon after the event, since they often will publish an article about the observations a few months after the passage.

I have not had time to prepare short abstracts about articles published about occultations, as I have done in the first several issues of *O.N.* There is now a very large backlog, and I do not expect to have time to prepare them in the previous format in the near future. Perhaps for the next issue, I can at least prepare a list of the backlogged publications, including authors and titles. It would be helpful to have a volunteer help with the writing of short abstracts, someone with a good knowledge of occultations and access to a reasonably complete astronomical library. With some help, it might be possible to continue the style of abstracts used in the early issues of *O.N.*

MORE ON HERCULINA

David W. Dunham

On p. 152 of *O.N. 1* (15), it was noted that the corrected circular solution for Herculina's diameter was 243 km, but that this predicted a short occultation for Fresno, CA, where observers are confident that no occultation occurred. Edward Bowell at Lowell Observatory has fitted elliptical outlines to the observed data and derived solutions which give a better fit to the observations, leaving maximum residuals of only 1 km. Details are given in James McMahon's final report for the Astronomy West convention, entitled "The Discovery of a Satellite of an Asteroid." A good photometric rotational light curve has been determined for Herculina, based on observations made by A. W. Harris at Table Mountain Observatory and by Bowell at Lowell. These show that Herculina was near maximum brightness at the time of the occultation, indicating that the outline was most elliptical with an axial ratio (minor axis length divided by major axis length) of 0.869. The solution for the June 7 occultation observations using this ratio gives 232 km for the major axis, 202 km for the minor axis, 216 km for the mean diameter, and position angle of minor axis 321°. These values have been used by McMahon to draw a new diagram, reproduced below, which supersedes the one in *O.N. 1* (15). The ticks on Herculina mark the axes. The chart shows that Herculina missed the star by a comfortable margin at Wimer's location in Fresno. An axial ratio of 0.954 is the largest possible, as it corresponds to a graze at Fresno. The lengths of the axes for this ratio are 231 km and 242 km. The occultation mean diameter is between the diameter determined from infrared radiometry (203 km) and that from polarimetry (227 km), with mutually overlapping error bars. The derived diameter of the satellite is 45.6 ± 3.6 km.



Eduardo Przybyl made a large effort to encourage observations of the August 22nd occultation of SAO 140552 by Herculina. He distributed a special supplement of ***Occultation Newsletter en Español*** about the event to numerous observers in South America. At his suggestion, I contacted Voice of America about the possibility of broadcasting a last-minute prediction update. On August 18, they taped a four-minute interview, briefly discussing IOTA, the June 7 Herculina occultation observations, and the pending August 22nd event. The previous night, a plate was taken at Lowell Observatory. During the 18th, Bowell and Wasserman measured the plate, reduced the measures, and computed an updated path for the occultation. There was a south shift, so that the path was now expected to cross Tierra del Fuego. The interview was broadcast on August 19, but based on the Lowell result, the words "northern" when I described the path as crossing "northern Chile and northern Argentina" were deleted. The transmission was in English, included as part of V.O.A.'s general worldwide broadcast, so that few observers in Latin America, perhaps listening for an announcement during Spanish-language broadcasts, heard it. Nevertheless, it was good publicity for IOTA.

Most observers in Brazil and near Buenos Aires reported overcast skies. It was clear farther west in Argentina. Juan Jose Rodriguez, Cordoba, Argentina, and Jaime R. Garcia, Piedade Observatory, Minas Gerais, Brazil, observed photoelectrically, detecting no variation. Several observers watched the conjunction from Santa Fe and the nearby cities of Rafaela and Santo Tome. Two observers, F. Brigi and E. Minniti, estimated that Herculina passed north of the star at the predicted time, in agreement with the Lowell astrometry. Eduardo Przybyl observed with the 8-cm refractor of the astronomical observatory of the National College "Luisa Raimondi de Barreiro." Although others recorded no variation in brightness, Przybyl, saw five fadings of about 1 magnitude, one lasting 10.2 seconds, with the other four ranging from 0.5 to 2.9 seconds. Considering Herculina's motion, if these were actually occultations, they would correspond to distances of 244, 12, and 70 km, respectively. The resemblance to McMahon's observations is intriguing, but the Lowell astrometry, apparently confirmed by Brigi and Minniti, showed that Herculina should have missed the star by about 1".5 at Rafaela. It would be necessary to invoke close duplicity of the star, since Przybyl's observed fadings were much less than the 3 magnitudes expected. The star is the second star of a visual triple system, the components of which are separated by at least 35". If the star were a close double, with about equal components separated by at least 1" (which the occultation and astrometric data seem to require), it probably would have been discovered in new double star surveys by visual observers. The spectral type K0 star is too far north of the ecliptic to be occulted by the moon. Przybyl feels that the fadings he saw were atmospheric, since experienced variable star observers in the Santa Fe area saw no fadings.

Clarence Funk, one of the observers at Fresno, noted in his tape record that the star appeared dimmer for several minutes around the time of Herculina's closest approach on June 7, in rough agreement with the 8-minute period during which McMahon reported the star's image as "somewhat diffuse." Due to the 8° to 10° altitude, both observers suggested that this could have been due to haze layers which were seen directly as twilight brightened after the occultation. But low altitude can not be used to explain a 6-minute period, centered on the time of closest approach (and his 10.2-second fade), during which Przybyl reported that the star's image was "turbid" on August 22. The star's altitude was about 55° at the time. Herculina moved 8200 km during the six minutes. It is interesting to speculate on an astronomical explanation for these observations; perhaps a cloud of satellites in the several meters size range, smaller than the diameter of the star subtended at Herculina's distance and smaller than the diffraction pattern. Observers should watch closely for this phenomenon during future asteroidal occultations.

NEW DOUBLE STARS

David W. Dunham

The table lists additions and revisions to the special double star list of 1974 May 9 not listed in previous issues. The star's SAO number (BD number if non-SAO; USNO reference number if non-BD) and, when applicable, Zodiacal Catalog (ZC) number, are given in the first two columns. An asterisk indicates revised data for a known double or multiple star system. The method used to obtain the data is indicated under M. The meanings of the method codes used under this column are listed below:

A: Composite spectrum - separation given as 0".05, although it is unknown (but likely to be within the range 0".01 to 0".2)
C: Correct error
G: Grazing occultation
I: Intensity or speckle interferometry
L: Combination of two photoelectric total occultation observations made the same night, but at similar position angles so that the true separation (SEP) and position angle (PA) are poorly determined.
P: Photoelectric total occultation
S: Spectroscopic analysis - orbital elements of spectroscopic binary determined, or at least variable radial velocity noted (in which case, 0".05 is used for the separation; see A above)
T: Visual total occultation
U: Revised data of known double from photoelectric total occultation. The magnitudes are revised; the SEP and PA also are revised if they previously were only estimated by T
V: Direct visual double star observation, including visual interferometry
X: Combination of two photoelectric total occultation observations (two P's), or one P and one well determined G, obtained the same night at well separated p.a.'s
Y: Combination of P and T, or P and G, with magnitudes determined from P
Z: Combination of 2 T's, or T and G

Combined occultation solutions are preferred, since with only one P or T, and usually with only one G, the true separation and position angle are not known, but only their projections onto the p.a. of the observed event. For I, there is usually a 180° ambiguity in p.a.

The star's new double star code is given under N. A list describing the double star codes is given in the "Notice to Observers" dated 30 September 1976 distributed by the U. S. Naval Observatory with their total occultation predictions for 1977. If you do not have this notice, you can obtain a copy of the list by sending a self-addressed envelope to either J. Phelps, H. DaBoll, or me. Two new double star codes are not in USNO's list:
G: Triple; A or C, with secondary either J, U, or V (third star's data are referred to secondary)
$: Triple; M, with secondary either J, U, or V (third star's data are referred to secondary).
Numerical double star codes (1, 2, and, rarely, 3) are used for some non-SAO AGK3 stars in the XZ catalog; they usually seem to refer to preceding and following components.

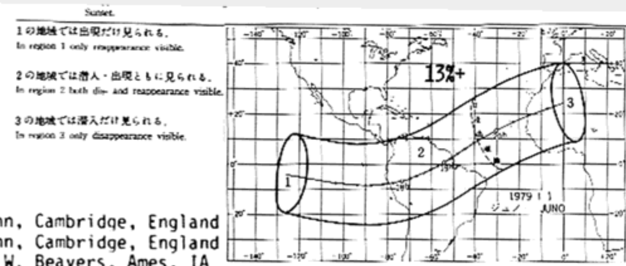
SEP and PA are the separation (in arc seconds) and position angle (in degrees) of the secondary with respect to the primary, respectively. MAG3, SEP3, and PA3 refer to a third component, if any. No entry under PA means it is changing (significant orbital motion) or has not been determined (spectroscopic or spectrum binary).

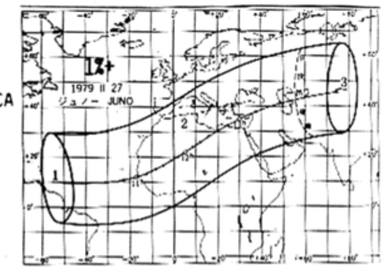
A.D.S. refers to the number in Aitken's Double Star Catalog.

Visual observers normally will not notice the duplicity of code U doubles, since the diffraction patterns of the two components will interfere, precluding definite "step" events. Visual observers should watch for disappearances or reappearances in distinct steps to signal the discovery of a close double. In the case of very close doubles, the two steps can not be resolved by the eye, so that the event appears gradual, as a quick, continuous fade. During total occultations, this often denotes duplicity, but during favorable grazes, continuous fades or brightenings are often due to diffraction of the star's light at the moon's edge. For total occultations more than 40° of p.a. away from being a graze, a fade event more likely would be due to duplicity than to diffraction, whereas the reverse would be true during a graze. Atmospheric seeing and, for faint stars, irradiation may also have an effect.

If you suspect that a star may be a previously unknown double, or if you can confirm or improve data from a previous discovery, based on an occultation observation, please send a report to me at: P.O. Box 488, Silver Spring, MD 20907, U.S.A. The report should include the star's SAO number (DM and USNO reference number, if non-SAO), the Z.C. number (if any; Z.C. numbers are four-digit numbers with no prefix number under USNO REF. NO. in the USNO predictions), the date, the position angle of the occultation, and, if possible, an estimate of the time between steps and the brightness of the secondary relative to either the primary or the total light (primary plus secondary). It is helpful also to report the star's magnitude and (if any) double star code given in the predictions. If you have the photoelectric option, also give the predicted radial rate. For those without the photoelectric option, the radial rate can be estimated from the CA and the moon's altitude and azimuth.

Hyades. The most interesting recent results have come from photoelectric observations of the waning-phase Hyades passage of 1978 September 22. J. Eitter and W. Beavers, observing with Iowa State University's 24-inch reflector near Ames, resolved three Hyades doubles, all previously known. However, the duplicity of one of the stars, SAO 93955 = ZC 669 = θ^1 Tauri, had only recently been discovered from careful spectroscopic observations by Griffin and Gunn at Palomar in 1975, as discussed in *o.N. 1* (11), 119 and 120. The separation is similar to, but the secondary much brighter than, what Griffin and Gunn estimated (they observed only the motion of the spectral lines of the primary). Robert Hays, observing visually from Chicago, IL, noticed that the star reappeared in quick steps. The p.a. for him was 202°, 10° closer to a graze than at Ames, and estimated 0.^{s}2 between the steps. He suspected that the components were of about equal brightness, while the differences in magnitude (Δm) recorded at Ames were 3.2 in V and 4.0 in red. This shows the difficulty of making quantitative estimates for such rapid events. The other two stars resolved at Ames are binaries whose orbits have been determined from visual observations. In each case, the projected separations agree reasonably well with the sep. and p.a. computed from the available orbital elements. For SAO 93925 = ZC 659, the observed Δm in V was 0.37 and in red, 0.14, in contrast to equally bright components noted by the visual double star observers. For SAO 93961 = ZC 672 = ADS 3248, the Δm in V was 0.7 and was 0.3 in red; 0.7 had been determined visually, in good agreement with V. R. Binzel, observing at St. Paul, MN, noted that the emersion of SAO 93950 = ZC 667 = 75 Tauri was gradual. This probably was caused by diffraction enhanced by the nearly grazing conditions; several observers who watched the graze of the star saw no step events. Three of the Hyades stars in the table have recently determined





NEW DOUBLE STARS, 1978 OCTOBER 30

SAO/BD	ZC	M	N	MG1	MAG2	SEP	PA	MAG3	SEP3	PA3	DATE, DISCOVERER, NOTES
76609*		S	J	7.5	10.0	".0004					1978, R. Griffin and J. Gunn, Cambridge, England
76773*		S	U	10.3	10.6	.0044					1978, R. Griffin and J. Gunn, Cambridge, England
93955*	0669	P	V	4.0	7.8	.082	212°				1978 Sep 22, J. Eitter and W. Beavers, Ames, IA
94162*		S	J	7.4	9.9	.0003					1978, R. Griffin and J. Gunn, Cambridge, England
94297		T	K	9.9	9.9	0.05	270				1978 Jul 30, P. McBride, Green Forest, AR
94309		T	K	9.8	9.8	0.1	270				1978 Jul 30, P. McBride, Green Forest, AR
94432		T	V	8.5	9.5	0.1	270				1978 Sep 23, P. McBride, Green Forest, AR
95419*	0944	V	C	6.2	6.2	0.62	137				Recent data relayed by J. Van Nuland, San Jose, CA
96810		P	V	8.7	11.0	.175	276				1978 Apr 15, D. Evans, McDonald Observatory, TX
98627*	1409	G	V	5.3	7.2	0.1	60				1978 Sep 28, W. Nissen, Beltsville, MD
98924	1474	G	K	7.9	7.9	0.05	20				1978 Jul 9, M. Ashley, Michelago, Australia
118253		P	V	9.1	9.9	.013	175				1978 May 16, B. Smith, McDonald Observatory, TX
138298	1685	G	K	4.5	9.0	0.1	195				1977 Jul 21, R. Nolthenius, Crest, CA
146825		T	K	9.7	9.7	0.03	120				1978 Sep 16, A. Hinton, Salisbury, Rhodesia
159887		P	X	9.2	11.2	.013	33				1978 Aug 13, S. Talley, McDonald Observatory, TX
160947*		Y	V	9.0	10.2	0.55	162				1978 Jul 18, B. Smith, McDonald Observatory, TX
163844*		P	V	9.0	10.9	.065	109				1978 Oct 11, T. Van Flandern, U. S. Naval Observatory, Washington, DC
186237*	2609	I	V	5.1	5.1	.116	153	13.6	33".4	233°.4	1976.477, B. Morgan *et al*, Sutherland, R.S.A. (2nd*, ADS 11029)
+18° 922		P	V	10.2	12.0	.100	218				1978 Apr 13, J. Africano, McDonald Observatory, TX
+18° 929		P	V	9.6	12.0	.025	213				1978 Apr 13, J. Africano, McDonald Observatory, TX

spectroscopic orbits derived by Griffin and Gunn, as reported in *Astron. J. 83*, 1114 (1978 Sept.). The three stars are already in our double star files from the Wilson radial velocity catalog, but the new results provide us with new quantitative data.

Aldebaran. A few observers of the September graze noted step events, but these were undoubtedly caused by fortuitously aligned small lunar features. The total occultation was recorded photoelectrically by Eitter and Beavers at Ames, IA; K. Horne at Mt. Wilson, CA (he recorded both immersion and emersion); N. White at Flagstaff, AZ; and S. Ridgway at Kitt Peak, AZ; no duplicity was detected. However, the diameter was well determined, everyone apparently getting answers near 0".021, in agreement with (but more accurately measured than) the result obtained at Hannover, Germany, in April (*o.N. 1* (15), 155). For example, White, observing in two colors, obtained 0".0212 and 0".0208, both with ± 0".0006 uncertainty. Ridgway observed in at least eight colors ranging from 0.3 to 2 microns.

Other stars. The results for SAO 184336 = ZC 2609 = W Sagittarii = ADS 11029 are from speckle interferometry reported by B. Morgan *et al.* in *Mon. Not. Royal Astron. Soc. 183*, 701 (1978); it had been in our files due to suspected duplicity noted in Wilson's catalog. W Sagittarii is a Cepheid variable with a magnitude range from 4.3 to 5.1. They also obtained a separation of 0".33 in p.a. 292° for the occultation-discovered component of SAO 184336 = ZC 2349 = σ Scorpii (*o.N. 1* (5), 41 and 45). The possible close duplicity for SAO 98267 = ZC 1341 = α Cancri was shown to be most likely spurious by McDonald Observatory astronomer J. Africano, who recorded both the immersion and emersion of the star photoelectrically under nearly grazing conditions in 1977 September. The traces for both events are published in the tenth Texas paper on photoelectric occultations in *Astron. J. 83*, 1100 (1978 Sept.). Other McDonald results, which have been published in recent issues of *o.N*, are documented in that paper.

More recent McDonald observations show that the magnitudes of two known visual doubles need to be revised. For SAO 138788 = ZC 1786 = ADS 8552 AB, the magnitudes were found to be 8.5 and 9.4 (secondary 0.3 mag. fainter than expected). The magnitudes for SAO 118981 = ZC 1692 = ADS 8261 were determined to be 6.9 and 10.1 (secondary 1.4 mag. brighter than expected). The McDonald observation for SAO 160947 gave a distance of 0".483 in p.a. 133°.2. This was combined with Nolthenius' discovery observation of 1977 Aug. 24 (*o.N. 1* (13), 140) to obtain the separation and p.a. given in the table; for such a large separation, there probably would be very little orbital motion during the 11 months between observations.

Nolthenius' observation of a faint component of SAO 138298 = ZC 1685 = ν Leonis is based on a faint flash which he observed during a southern-limit graze of the star. But two observers several tenths of a mile south of him did not see the bright primary during the corresponding interval. There are similar problems for observations of the 7th-magnitude companion of SAO 98627 = ZC 1409 = ξ Leonis, claimed to have been seen by W. Nissen and me during the September 28th northern-limit graze of the star. Nevertheless, our observations show that the secondary is now probably well north of the primary, with a much greater separation than one might expect from the projected separation observed photoelectrically during an occultation at McDonald Obs. in 1973, when the duplicity was discovered. Unfortunately, the air was moist and the seeing poor for most observers during the Sept. 28 graze, so that more observers did not see the secondary.

The occultation of SAO 146825, which occurred during a total lunar eclipse, was noticed to be gradual by A. Hinton and A. Morrisby in Salisbury, Rhodesia.

Robert Sandy points out that his discovery of the possible duplicity of SAO 97843 = ZC 1271 = 29 Cancri (*o.N. 1* (15), 159) was actually predated by a 1976 observation by E. Przybyl (*o.N. 1* (10), 110).

Van Flandern photoelectrically resolved the components of SAO 163844 during the occultation of October 11, as indicated in the table. The star's duplicity had been suspected based on a "gradual" total occultation observation made in South Africa about fifty years ago and published in a Union Observatory Circular list, which has been included in our double star files. The photoelectric trace for the primary's disappearance shows a decline which is slower than that for the secondary, indicating that the primary itself may be a close double of perhaps 0".012 projected separation.

XZ catalog errors. The number zero was given for the double star code for all non-SAO stars in the XZ when the USNO predictions for 1979 for many observers were computed. I noticed the error, which was corrected (the zeros replaced with blanks) in time for most observers. The non-SAO stars have "00-0000" given for the SAO number. Be careful not to confuse the rounded zeros with valid letter O double star codes (the computer prints the letter with less rounding, more like a rectangle, than the letter zero), which are given only for SAO stars. Most of the XZ double star codes are correct, but Robert Sandy found three doubles for which the code was not given. These errors are being checked, as are the reasons for some missing stars, so that hopefully a note of explanation can be published in the next issue. We have found one non-SAO AGK3 star which is in the K-catalog, but not in the XZ (currently being occulted), and do not know yet how many others there may be in this category. It seems that all of the non-SAO Yale stars with no proper motions are missing from XZ.

The stars for which no code was given in Sandy's predictions are: SAO 93955 = ZC 669 (code V), SAO 161871 = ZC 2733 (code K), and SAO 162133 = ZC 2774 (code X). I found the three stars in my predictions, where the code for ZC 669 was correctly given, but the codes for the other two stars were blank. A listing of the XZ catalog agrees with what I found in my predictions.

The magnitude of the non-SAO star X05404 = AGK3 +15°346 = BD +14°0660 =

K02130 is incorrectly given as 5.8 in USNO's 1979 predictions. The star's magnitude is 11.3, according to AGK3. The spectral type is also in error.

I could find no messages indicating variable stars in my 1979 predictions, even for ZC 1442 = SAO 98769 = R Leonis, the brightest Mira variable which is occulted by the moon, and the star with the largest measured angular diameter (0".067) after the sun. The magnitude range for this spectral type M8 star is 10.5 to 5.0.

On the 4th line of my article, NEW DOUBLE STARS, *o.N. 1* (1), 4, ". . . since 1971 Jan. 1," should be ". . . since 1974 Jan. 1."

BD +18° 922 = J01288, and is in neither the SAO nor the AGK3 catalog. BD +18° 929 = J01314 = K02912 = AGK3 N18°0486.

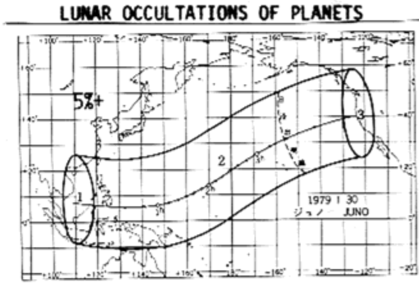
Harold McAlister reports that KPNO speckle interferometric observations of SAO 145537 = ZC 3166 = ζ Aquarii marginally resolve the one-line spectroscopic binary at a separation of about 0".03.

ERRATUM

Robert Sandy notes the following correction to an item in *O.N. 1*, #15:

p. 155: col. 2, line 28 should read: curred on 1977 December 29 at Freder-

LUNAR OCCULTATIONS OF PLANETS



The map showing the regions of visibility of a lunar occultation of Juno is reprinted by permission from the Japanese Ephemeris for 1979, published by the Hydrographic Department of Japan. Region 3, only D visible. West of dashed line, event ends before sunset.

TOTAL SOLAR ECLIPSE OF 1979 FEB. 26

David W. Dunham

IOTA's plans for observing this eclipse were briefly described in *O.N. 1* (14), 144 (note to letter by Fred Espenak). Detailed calculation of the edges of the path of totality is now in progress. We plan to prepare a map showing the edges of the path, taking into account Watts' limb corrections, and publish this, hopefully in the January issue of *Sky and Telescope*. As far as I know, this will be the first time that this has been done; all previously published maps of the paths of total solar eclipses have been in error due to the neglect of lunar limb corrections.

Most potential observers of this eclipse are aiming for sites near the center of the eclipse path. The only advantage of doing this is to obtain the darkest possible sky to observe the corona, and perhaps search for comets. Astrometrists might try to observe the general relativistic bending of star light, but the environment for this eclipse will be difficult for such a delicate experiment; radio experiments with spacecraft have measured the equivalent relativistic shift to much better accuracy than classical astrometry can ever hope to achieve during a solar ecipse. My question is, why should 99% of eclipse observers concentrate on photographing the corona?

Observation from sites in the path of totality, a few miles in from the edge, has many advantages, when one considers the circular geometry of the eclipse shadow. Totality would last generally from half a minute to over a full minute, while all edge phenomena, including shadow bands, visibility of the chromosphere and flash spectrum, and Bailey's beads, can be prolonged by a factor of five or more over their durations at the center line. IOTA is especially interested in timings of 2nd and 3rd contact, and timed photographic and visual observation of Bailey's beads. Readers interested in making such observations near the path edge should write to me at P. O. Box 488, Silver Spring, MD 20907, giving approximate equipment and general desired area of observation (which, understandably, might change due to weather). We will try to coordinate plans to give the best coverage of the lunar limb. A few volunteers for intermediate locations between the center line and the edge area are also sought for these observations; at such locations, totality will last 80% or more of the center-line duration and there will be only slight prolongation of edge phenomena. Logistics will be a little easier if observers from Washington and Canada plan to observe from the northern part of the path of totality (the northern edge passing near Olympia, WA and Regina, Sask.), while observers from elsewhere (and in the Winnipeg area) plan to cover the southern part of the path.

[Ed: Added November 11] I recently calculated the locations of the edges of the path of totality, using Watts' limb data and several refinements to lunar and solar data supplied by USNO. These calculations show that the northern limit will be 1¼ miles north (measured perpendicular to the path) of the northern limit published in USNO Circular Number 157, while the southern limit will range from 4 miles (in OR) to 4¼ miles (in Manitoba) north of the Circular 157 southern limit. For each 1000 feet of height above sea level, the northern edge will shift southward (perpendicular to itself) by 2250 feet, while the corresponding south shift for the southern edge will be 2000 feet. Limit data interpolated to 15-minute intervals of longitude by F. Espenak and me, and other information about observing the eclipse near the edges of totality, will soon be available from IOTA.

USNO MEETING ON PLANETARY SATELLITES; 1979 GALILEAN SATELLITE MUTUAL PHENOMENA, ETC.

David W. Dunham

A meeting on observations and ephemerides of planetary satellites was held at the U. S. Naval Observatory in Washington, DC, on September 21. The upcoming Galilean satellite mutual events and other items of interest to occultation observers were discussed. Prof. Ferraz Mello, chairman of I.A.U. Commission 20's working group on natural satellites, and Thomas Duxbury, from Jet Propulsion Laboratory (to report on the latest spacecraft plans), were present along with representatives from various American observatories which are making astrometric observations of planetary satellites.

Dr. Robert Millis, Lowell Observatory, P.O. Box 1269, Flagstaff, AZ 86001 (reporting by letter since he could not attend), noted that most of the Galilean satellite mutual phenomena next year will occur relatively close to the time of Jupiter's conjunction with the sun. Consequently, the series is not as favorable as the last series and only a few events will be observable from one observatory. In order to obtain sufficient observations of these events, it will be necessary for many observatories with a wide geographical distribution to attempt observations. The observations will be valuable for refining the orbital elements of the Galilean satellites, which will be needed for the Galileo mission which will orbit Jupiter and use the satellites to change the spacecraft orbit. Photoelectric observers can obtain predictions for the mutual phenomena favorably visible at their observatories by sending coordinates to Dr. Millis.

F. Benedict, University of Texas, reported that predictions of occultations of about 30 stars by the satellites of Saturn had been submitted for publication in the *Astronomical Journal*. The predictions were found by using a PDP-11 computer and a microdensitometer to scan Saturn's predicted path on a Palomar sky survey plate. During the next few months, they hope to use the same equipment and ephemerides supplied by me to find occultations by some of the minor planets.

Robert Harrington, USNO, described a program being undertaken by European astronomers to photograph the sky and measure accurate positions for approximately 2 million stars down to 12th magnitude. The northern hemisphere is being photographed by Hamburg Observatory, Germany, while the southern sky will be photographed at Cape, South Africa. There will be a 10° zone of declination overlap at the equator. The Royal Greenwich Observatory will be involved with much of the plate measuring and data reduction. Harrington said that USNO planned to undertake an astrometric program which would concentrate first on the zodiacal regions (and probably first on the paths ahead of the outer planets) that might reach fainter magnitudes than the European program. As results from these programs become available, they will be valuable in providing second epoch data when used in conjunction with the Astrographic Catalog.

Pat Seitzer, Leander McCormick Observatory, Charlottesville, VA, reported that while photographing the Galilean satellites on 1976 Dec. 14, he noticed that Io probably occulted a close double listed in AGK3, with magnitudes 8.7 and 9.8. They could have been missed since Taylor uses the SAO for his searches for occultations by the Galilean satellites; if the brighter star were in the SAO, it actually might not have been occulted from the earth's surface. An occultation of a 10th-mag. star by a relatively bright Galilean satellite might be too difficult to record even photoelectrically.

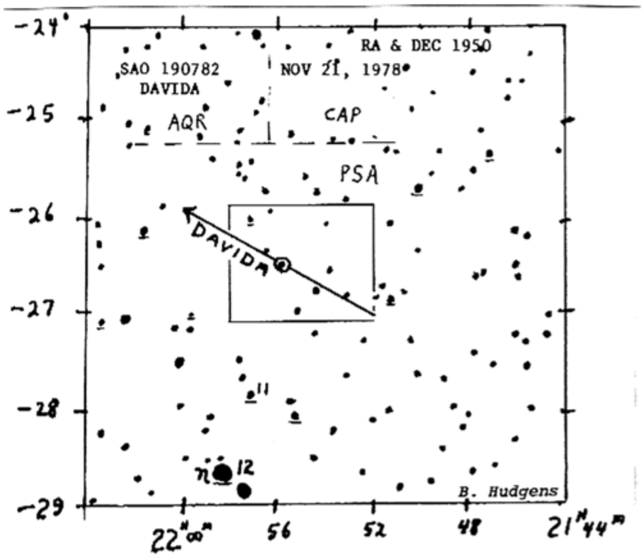
Considerable interest was expressed in satellites of minor planets. Dr. William Brunk, from the Planetary Programs office at NASA Headquarters, said that the presence of satellites would certainly affect NASA plans for any future missions to asteroids. Photometric light curves of minor planets are being examined for satellite eclipse phenomena and double star observers have added some of the more favorably placed asteroids to their observing programs.

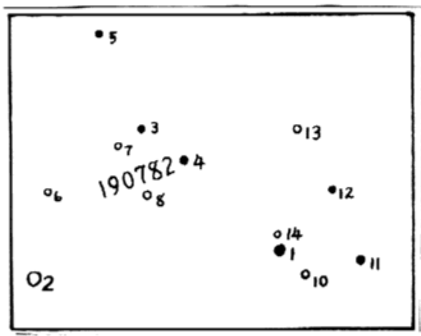
OCCULTATIONS OF STARS BY ASTEROIDS

David W. Dunham

Pages 9 and 10 of this issue were prepared in advance and sent to observers in western North America in mid-October so that they would have finder charts for the occultations by (12) Victoria and (2) Pallas before the occultations late in October. Unfortunately, address labels for this purpose were prepared only for IOTA members receiving lunar grazing occultation predictions, since this was the only way that they could be produced automatically sorted geographically. We apologize to those *o.n.* subscribers who do not receive graze predictions in the area; we did notice the problem at the last minute and DaBoll added the addresses of a few *o.n.* subscribers who had been missed to envelopes for the mailing. A method for producing geographically sorted address lables for all *o.n.* subscribers, not just those receiving graze data, is being prepared by B. Stevens.

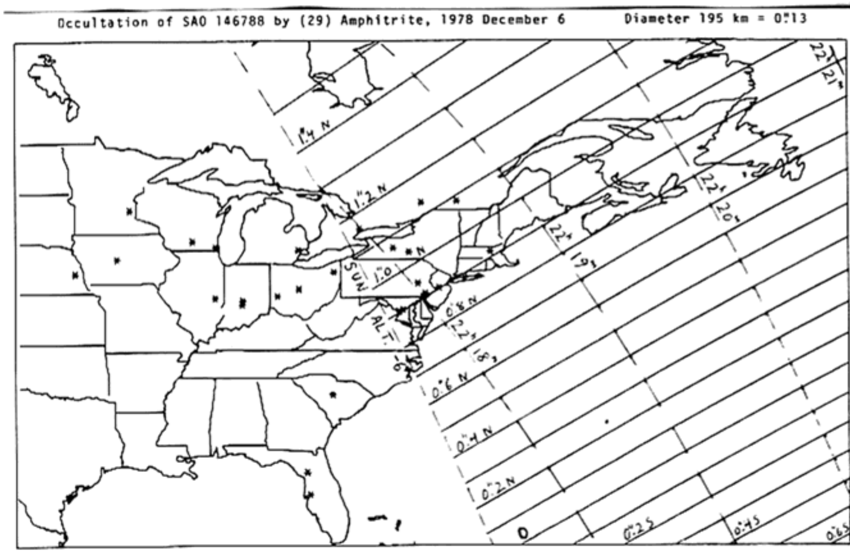
Don Stockbauer had trouble using the finder chart for the Victoria occultation. Some stars were dimmer or brighter than indicated; some double stars shown on the Atlas Eclipticalis couldn't be found with his 25-cm reflector. Dr. J. Gunter had similar difficulty locating SAO 114159 using our original chart. Preparers of finder charts should take care to indicate the relative brightness of the stars correctly; when possible, the charts should be used to locate the star before being published, so that appropriate changes can be made. Stockbauer has done that for some of the charts published in this issue. [Ed: Stockbauer's star field checks, showing stars visible to him with a 25-cm reflector, are shown next to the finder charts for SAO 190782 and Davida, SAO 146788 and Amphitrite, and SAO 114159 and Melpomene. Rectangles on the large-scale finder charts show the approximate regions represented by the Stockbauer sketches. Filled circles represent stars on the finder charts; open circles represent stars added by Stockbauer. Keys: for 190782, 1 is bright, 2-5 are medium bright, 5 is a very wide double, 6-14 are faint; for 146788, 1 and 2 are fairly bright, 3-6 are medium bright, 7-9 are faint; for 114159, B = bright, M = medium, F = faint, FD = faint wide double.]





Robert McCutcheon obtained astrometric plates for the October events at Yale Observatory's Bethany station. Unfortunately, Victoria was very faint, darkening only a few grains, on a plate taken October 18. By the time twilight ended, the altitude was only about 20° in the southwest, where there was bothersome light pollution from New Haven. He was lucky to find the asteroid's image at all in the crowded Milky Way field. From McCutcheon's data for the star and Victoria, I computed a 0.″1 south shift for the path with the event about one minute early, a large north shift for the star (0.″75) being compensated by an opposite shift due to the asteroid. Considering the astrometric difficulties and the large separation of the objects seven days before the event, I estimated that the prediction was accurate to perhaps ½″, so that the event probably would occur in the western U.S.A., but with no good idea where (California seemed to be favored by the formal calculation). Three nights before the event, skies in Connecticut were very clear, but McCutcheon could not arrange transportation to Bethany to get a plate. He was able to do this the next night, but haze and some cirrus darkened the plate enough that Victoria did not register. So there was no last-minute photometry; rain prevented such an attempt at

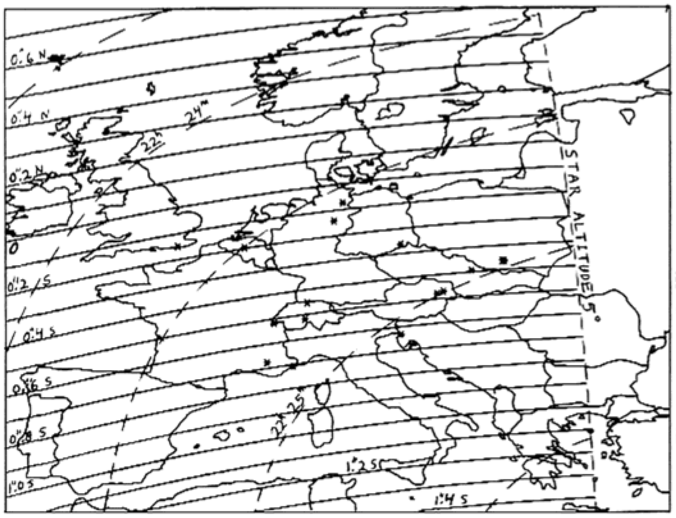
Occultation of SAO 146788 by (29) Amphitrite, 1978 December 6 Diameter 195 km = 0.″13



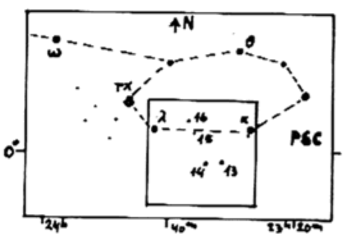
Lowell Observatory. I felt that the event was favorable enough that some effort should be made, although not a large-scale one. Observers in central California reported no occultation. A 3.8-second occultation was recorded by Jerry Berndt at Battelle Observatory, Richland, WA, starting at $3^h40^m14^s$ U. T. of October 25. The implied shift was 0".37 north, or 0".5 north of what I calculated from McCutcheon's data. Unfortunately, a polarimeter and photometer with a $0^s.4$ integration was installed for the night's scheduled observations, and had to be used for the occultation. Although the duration and time are about what would be expected, the record showed a deeper occultation than expected. Adding further doubt was the fact that no occultation was recorded at the nearby University of Washington's Manashtash Observatory, nor seen by observers farther north, at Seattle and Ellenburg, WA. However, this could be the case considering the narrowness of the occultation zone. An observation from northern or western Oregon would be valuable, but none is known at the moment. Photometric observations are in progress to see if the occultation could have been as deep as the Battelle record shows.

[Ed: Added November 11] A plate of (12) Victoria and SAO 161878 was taken at Royal Greenwich Observatory (RGO) $1^d.3$ before the occultation. This did not allow Gordon Taylor time to measure the plate, reduce the measurements, compute a new prediction, and telex it to the USA before the event, but he was able to compute a *post*diction which indicated a 0".45 north shift, across western and northern WA. The Battelle observation implies only a 0".1 south shift from this calculation, well within the astrometric uncertainty, considering the low altitude of the object at RGO. The event recorded at Battelle was about $0^m.7$ later than Taylor's calculation. As noted above, observers a little to the north within Taylor's path saw a miss.

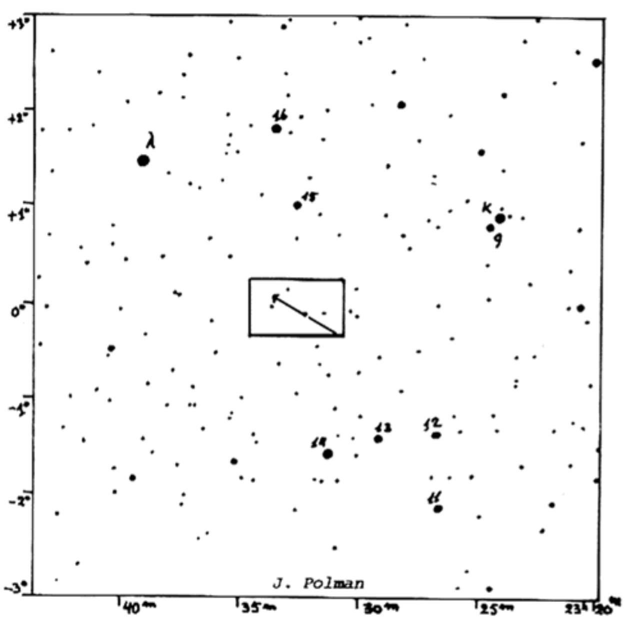
Occultation of SAO 146788 by (29) Amphitrite, 1978 December 6 Diameter 195 km = 0".13



A plate of SAO 122731 by McCutcheon showed no path shift for the occultation by (2) Pallas on October 31. He obtained a plate of both objects for a last-minute prediction three days before the event, but was not able to measure the plate until the day preceding the event because another large plate was on the measuring engine and had to be completed for another project. My calculation based on the astrometric data telephoned to me by McCutcheon showed that there would be a 0".3 south shift with the event occurring 1.3 minutes early. This showed that Hawaii probably would be in the occultation path. I telephoned the Institute of Astronomy there, asking that the information be relayed to Mauna Kea Observatory and to amateurs on Oahu. They promised to do this, but noted that persisten rain probably would prevent observation. Richard Nolthenius, Mountainview, CA, was able to follow the star reasonably well from his observing site until about two minutes after expected closest approach, in spite of the low altitude. He saw no occultation, as we would expect from McCutcheon's astrometry.

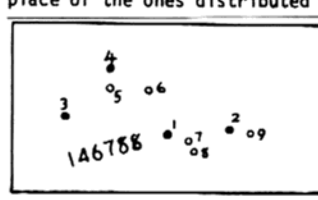


A plate of the star to be occulted by (511) Davida was obtained by McCutcheon in early October. It showed the star to be about 2" south of its predicted position, implying that the occultation path would shift off the earth's surface to the north. Astrometry of Davida and the star at Lowell confirmed the result for the star, but the asteroid correction shifted the path 1" south, so the event is now expected to occur at very low altitude in central British Columbia (shift about 1" north). Since errors of ½" may still remain, observation from Washington and Alberta still may be worthwhile. We are waiting for astrometric observations planned at McDonald Observatory in early November to see if there is any change in the Lowell result; in the meantime, the possibilities for the event look poor.



29 AMPHITRITE - SAO 146788 Dec. 6, 1978

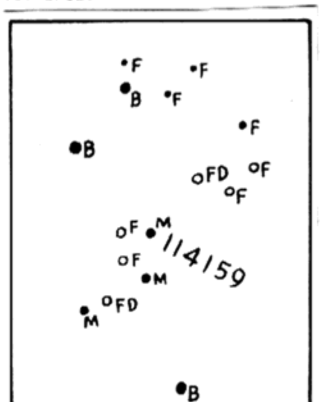
A plate by Penhallow in September showed (29) Amphitrite to be running about 0".6 north of prediction. The star to be occulted on Dec. 6, SAO 146788, is in the XZ catalog; according to data supplied by R. Schmidt, it is 1".2 north of the SAO position. Penhallow's and the XZ data combined indicate an overall shift of 0".6 south with the event occurring 3 minutes early, implying that southwestern Europe is favored. Hans Bode and Jean Meeus have pointed out that the wrong star is indicated as the star to be occulted on a finder chart which was sent by Bode to about 40 European observers and by me to over 100 observers in the northeastern USA. The error apparently was due to a wrong indication of the star by me on preliminary data supplied to Przybyl. The chart by Polman published here shows the correct star. All finder charts published in this issue should be used in place of the ones distributed by Bode and me in October.



R. Binzel, St. Paul, MN, has measured the photoelectric V magnitude of SAO 114159, the star to be occulted by (18) Melpomene on December 11, to be 8.35, brighter than indicated by the SAO.

Hence, there should be a drop of about 1.0 magnitude if an occultation occurs, a large enough drop to be readily noticed visually if seeing conditions are not unusually bad. Preliminary astrometric results from Lowell Observatory show that corrections to the ephemeris and star position are small, so that it is virtually certain that the occultation will occur in the USA. The event will occur at a high altitude and the motion is relatively slow, so that a good last-minute prediction most likely will be possible. It should be a good event worth organizing for. Last-minute improved predictions can be obtained by telephoning me at 301, 585-0989 during the weekend preceding the event. If there is no answer, it probably means that I have left to lead an expedition somewhere within 400 miles of DC to observe the occultation; in this case, the message center will be 301, 474-0814, in Greenbelt, MD.

[Ed: The following update was phoned in on 10 November.] Gordon Taylor discusses the occultation by Melpomene on December 11 in Bulletin 13 of the IAU Working Group on Planetary Occultations. He has calculated a prediction based on astrometric plates of Melpomene and the star taken at R.G.O. on September 30 and April 5, respectively. His central path is 0".2 south ± 0".6 of my nominal prediction (NC to OR - CA border, but could be as far north as Long Island to Seattle, or as far south as southern GA to Santa Cruz, CA), with the event occurring $4^m5 \pm 1^m0$ earlier than my nominal prediction. Using last-minute astrometry, he plans to improve the path to better than 0".25, but, unless all astrometrists have bad weather during the critical few days before the event, I think that ± 0".1 can be achieved. Taylor will telex his last-minute predictions to me, and they will be available by telephoning me at 301, 585-0989 or Green Belt, MD 301, 474-0814, or Lowell Observatory, 602, 774-3358; if there is no answer, phone 602, 774-3654. In any case, observers throughout the contiguous United States will be in a position to see occultations by at least possible satellites of Melpomene. I hope that all observatories which can monitor the event photoelectrically will do so, and that as many observers as possible with portable equipment can be mobilized to form a dense observing fence in the expected area.



It will not be possible to obtain astrometry in the USA for occultations by (10) Hygeia in November; the stars are very low in the southwest by the time evening twilight ends. Astrometric observations from the Southern Hemisphere are needed for such events.

Paul Maley has devised an "Asteroid Intercept Plan" for asteroidal occultations in southeastern Texas. The plan calls for observers, or pairs of observers, to be set up near lines separated by 20 miles, the lines being parallel to the direction of motion of the occultation shadow. For a pair of observers, one would be more experienced than the other; their stations would be about a mile apart, so that secondary events could be confirmed. But they would be close enough so that the experienced observer would have time to help set up and find the star at both stations. He points out that coordination with observers in adjacent regions would be desirable to avoid duplicate coverage.

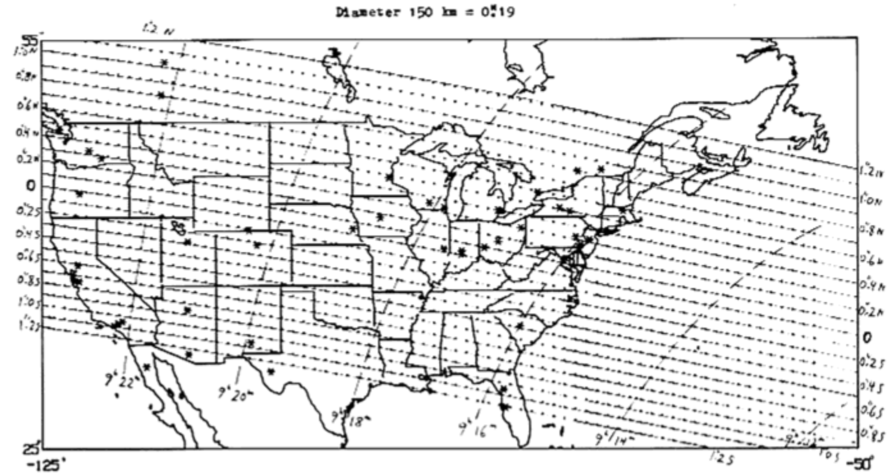
Considering the separation of pairs of stations, in order to confirm secondary events, I now feel that a separation of 2 to 5 km, rather than only 1 km perpendicular to the direction of the occultation shadow motion, might be more appropriate. With the slightly larger separation, the diameters of asteroidal satellites can be determined from the observed times, while this usually can not be done with only a 1-km separation.

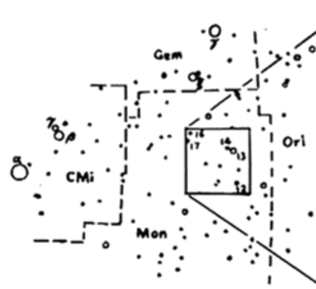
In Bulletin 12 of IAU Commission 20's Working Group on Planetary Occultations, Gordon Taylor lists 25 occultations by asteroids which he predicts will occur during 1979. 49 asteroids were compared with the SAO and AGK3 catalogs. There are not as many possibilities for 1979 as there were for this year. The first three events are: Jan. 27, SAO 110311 by (39) Laetitia, n.e. Australia, mid-Pacific; Feb. 28, SAO 92603 by (13) Egeria, USA or Canada west of long. 90°; and March 16, SAO 126160 by (2) Pallas, Indonesia. Details of the 1979 events will be listed in the next issue.

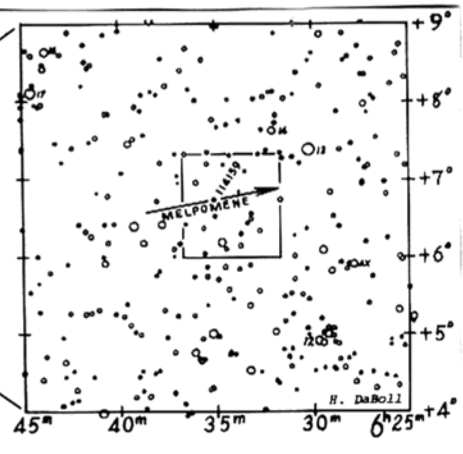
Jean Meeus has used astrometric ephemerides supplied by me to determine conjunctions of minor planets with bright stars during 1979. He published his list in *The Minor Planet Bulletin* 6 (2), 20. Closest separation is greater than 1' for all but two conjunctions: Jan. 26, (29) Amphitrite 5".6 north of 5.7-mag. 51 Piscium (ZC 68) at 15^h23^m UT (closest approach will be 2".3 for an observer near the North Pole).; and May 27, (22) Kalliope 28" south of 2.9-mag. β^1 Scorpii (ZC 2302) at 0^h UT. At least in the first case, occultations by satellites of the asteroid are possible for earth-bound observers.

Occultation of SAO 114159 by (18) Melpomene, 1978 December 11

Diameter 150 km = 0".19

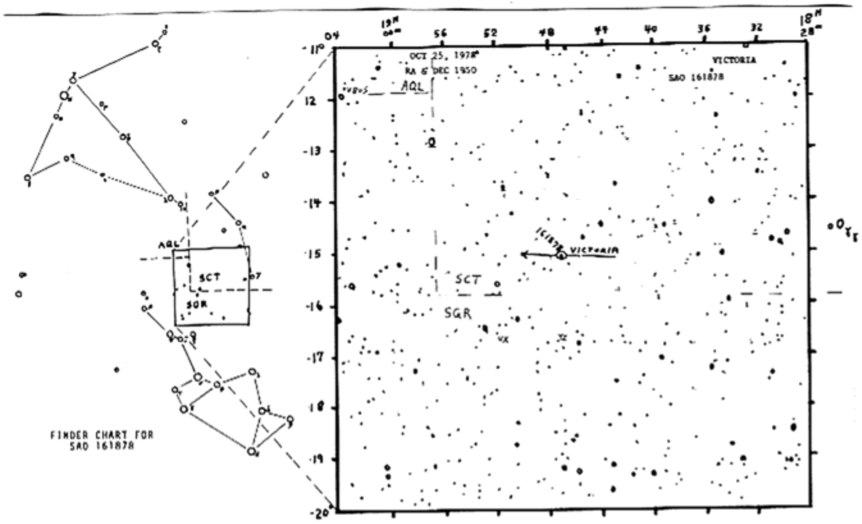




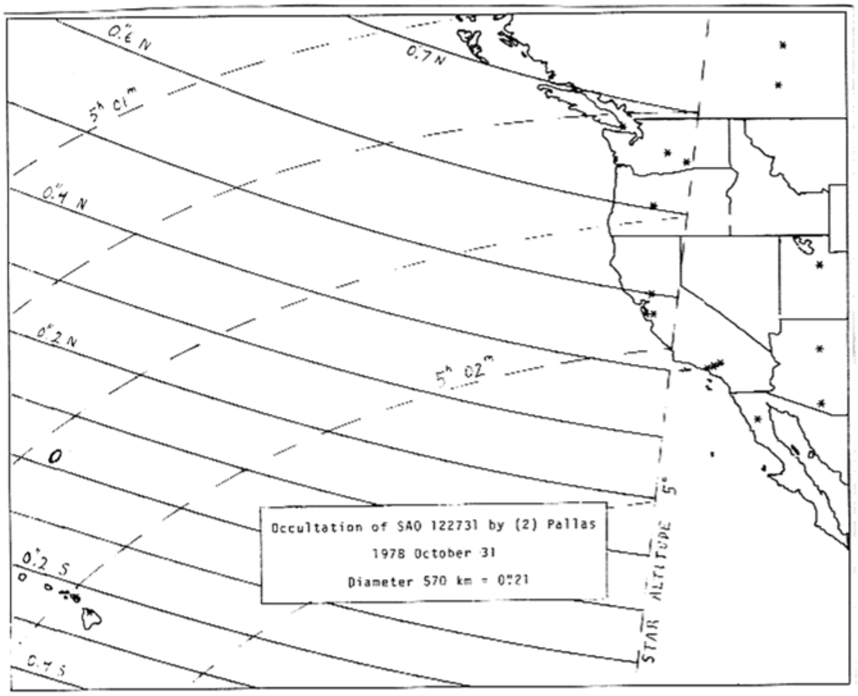


FINDER CHART FOR SAO 114159
MELPOMENE - 1978 DECEMBER 11

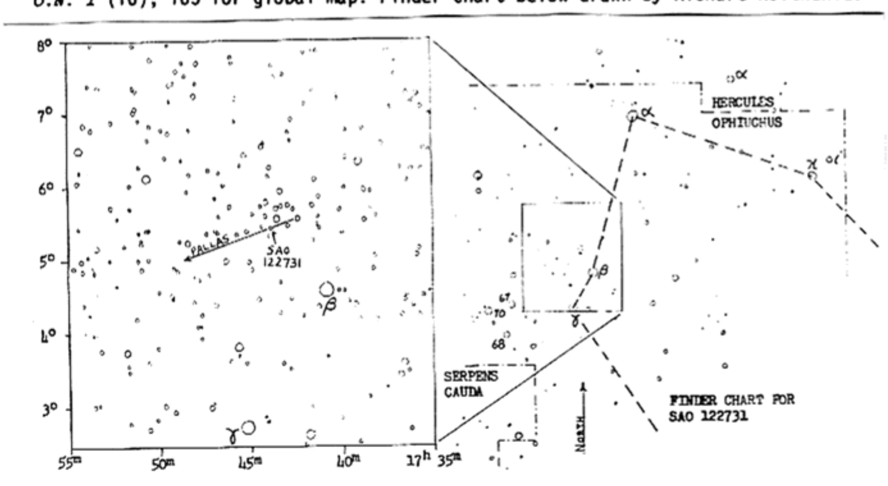
R.A. and Dec on equinox 1950



Large-scale finder chart above drawn by Ben Hudgens; small-scale portion added by Homer DaBoll. See *O.N. 1* (16), 165 for global and regional maps.



Computer-produced regional map above traced and annotated by David Dunham. See *O.N. 1* (16), 165 for global map. Finder chart below drawn by Richard Nolthenius.



BASIC INFORMATION ABOUT CALCULATING OCCULTATIONS

David W. Dunham

The most authoritative source for information about the calculation of occultations available today is the "Explanatory Supplement to the Astronomical Ephemeris and the American Ephemeris and Nautical Almanac," published by H.M. Stationery Office, 49 High Holborn, London WC1V 6HB, England. A copy of it might be found in a local university or college library. Another book which has some information about occultations is D. McNally's ***Positional Astronomy***; I reviewed the book on p. 269 of the April 1976 issue of ***Sky and Telescope***.

Dr. Niels P. Wieth-Knudsen, „Dorthens Huus", Margot Nyholmsvej 19, Tisvildelunde pr. 3220 Tisvildeleje, Denmark, has written an article about calculating occultations using a pocket calculator. A copy might be obtained either by writing to him, or by buying a copy of the Proceedings of the 1977 National Astronomers Convention, in which the article is published. The Proceedings, which has many other articles, can be obtained by sending a check for $5.50, made payable to National Amateur Astronomers, Inc., to: Derald D. Nye, 5604 Bowron Place, Longmont, CO 80501.

CORRECTION ABOUT USNO VERSIONS FOR GRAZES

David W. Dunham

The effects of recent improvements to USNO's occultation computer system versions on grazing occultation predictions were discussed in "A COMPARISON OF USNO VERSIONS FOR GRAZES" in *O.N. 1* (16), 161. The procedures for obtaining information about possible shifts for position source Z.C. and G.C. stars south of declination -3° described in the second paragraph of that article remain unchanged (note that the declination of the star is approximately, to about 1° accuracy, equal to the zone number which immediately follows the words "B.D." or "C.D." in the graze prediction heading; all "C.D." stars are south of declination -21° and are not now occulted by the moon). [Ed: also note that the USNO total occultation predictions show precise declinations.] However, the Perth 70 star positions are *not* included in version 78A. If a southern star, for which a possible graze shift is needed, is in the Perth 70 catalog, I will compute the expected shift. The ACLPPP profile calculations for grazes occurring after 1978 will be done using version 79A (or higher-numbered or lettered versions), which ***does*** include Perth 70 data.

All zodiacal Perth 70 stars south of declination -2° and which are in the SAO are listed below in 1950 right ascension order. This is the same as the order of Z.C. numbers, but SAO numbers are ordered by right ascension within 10° bands of declination. All zodiacal non-SAO Perth 70 stars were listed in Table 1 on p. 154 of *O.N. 1* (15). That table gives DM (BD or CD) numbers, which are included in the predictions. As noted on p. 161 of *O.N. 1* (16), if a star is south of declination -2° or -3°, its position source is given as Z.C. or G.C., and it is *not* in the list below, a comparison with the Yale catalog position of the star might result in an improved graze prediction.

SAO	ZC	SAO	ZC	SAO	ZC	SAO	ZC	SAO	ZC	SAO	ZC	SAO	ZC	SAO	ZC	SAO	ZC
128574	7	139287	1915	158668	2087	183837	2260	160171	2433	186377	2624	187990		163783	3019	14557[illegible]		[illegible]6272	
128599		139292		158686		183847	2261	184822	2434	186410	2626	162512	2826	163795	3021	164567		165282	3338
128607	15	157881		158696	2089	183854	2263	184825	2435	186437	2630	188079	2831	163798	3022	145583	3172	146302	
128618		157912		158701		159540	2264	184849		161172		162571		163813	3024	164580	3173	146307	3340
128621	18	139324	1924	158702	2090	159544	2266	160214		186509	2635	188101	2834	163837		190556		146308	3341
128628	20	139330	1926	158722	2092	183900	2269	184897	2443	186540	2637	188105	2836	189669	3032	164584	3174	146322	3345
128644		139342		158725	2093	183901	2270	160221		186543	2638	188112		189680		164600	3177	146323	3346
128648	25	157946	1931	182786	2098	159563	2271	184906	2445	186612	2650	188126	2841	163868	3033	145619	3179	146325	3348
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