Occultation Newsletter

Volume I, Number 13 January, 1978

The Occultation Newsletter is published by the International Occultation Timing Association (I.O.T.A.)

FROM THE PUBLISHER

Two points need to be emphasized:

1) Dues, subscription renewals, and changes of address should not be sent to the IOTA Treasurer; they should be sent to the IOTA Secretary (Berton Stevens), as it is in his office that changes of address are recorded, the roster is maintained, and mailing labels are prepared.

2) Requests for predictions should not be sent to the IOTA President; they should be sent to the IOTA Secretary (Berton Stevens). This system should give maximum efficiency in processing your requests.

O.N. is priced @ $1.00 per issue, or $4.00 per year (4 issues) including first class surface mailing. We apologize for the mailing of some copies of #12 by third class mail; if you did not receive your copy because the Post Office did not forward the third class mailing to your new address, notify Mr. Stevens, and another copy will be sent without additional charge.

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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 occultation observers may have free membership in IOTA/LAS, including *Occultation Newsletter en Español*, by contacting Sr. Francisco Diego Q., Ixpantenco 26-bis, Real de los Reyes, Coyoacán, Mexico 21, D.F., Mexico.

Please address all subscription, back issue, prediction, 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.

OCCULTATIONS BY NEPTUNE AND BY THE RINGS OF URANUS

David W. Dunham

Predictions for twelve Uranian occultations of stars brighter than mag. 16 which will occur from December 1977 to August 1980 have been published by Klemola and Marsden in the *Astronomical Journal, 82*, 849. Liller has published photographic magnitudes for the stars involved on p. 929 of the same volume of the *A.J.* It has been pointed out previously that it is advantageous to observe these events in the deep red and infrared methane absorption bands of the planet. The brightest star in their list has a red magnitude of 9.3, possibly occulted on 1977 December 23. Unfortunately, the elongation of the sun was only 46°, with the most advantageous area being the south Atlantic Ocean. The brightest star which might be occulted during 1978 is a star with a red mag. of 11.1 on April 10.

A similar list of 26 occultations by Neptune during 1978 - 1980 has been submitted for publication in *A.J.* by Klemola, Liller, Marsden, and Elliot. The table gives information for the first three events, which may occur before the *A.J.* article is distributed. The next event not in the table will occur on 1978 June 8. The brightest star occulted during 1978 is the one occulted on Feb. 8. In the table, the depth is the ratio of the star's light to star + Neptune in red. The best event during the 3-year period involves a 10.1-(red) mag. star during 1980 Feb. 10 at 16^{h}8 U.T.

1978 Date	U.T. of Conjunc.	Star R mag.	R.A. (1950)	Decl.	Depth	Star - Nep. Sep.	P.A.
Jan. 16	16^h 20^m	13.1	17^h 03^m $33^s.97$	-21° 22' 41".0	0.011	1".9	185°
Jan. 24	05 21	13.5	17 04 31.31	-21 23 43.2	0.007	1.4	4
Feb. 8	02 28	12.7	17 06 07.36	-21 25 19.2	0.016	2.9	4

1977 TOTAL OCCULTATION COUPON

Once again, total occultation observers are requested to complete and submit a coupon (enclosed), so that a comprehensive tally of timings can be compiled for publication in *O. N.*

OCCULTATIONS DURING THE LUNAR ECLIPSE OF 1978 MARCH 24

David W. Dunham

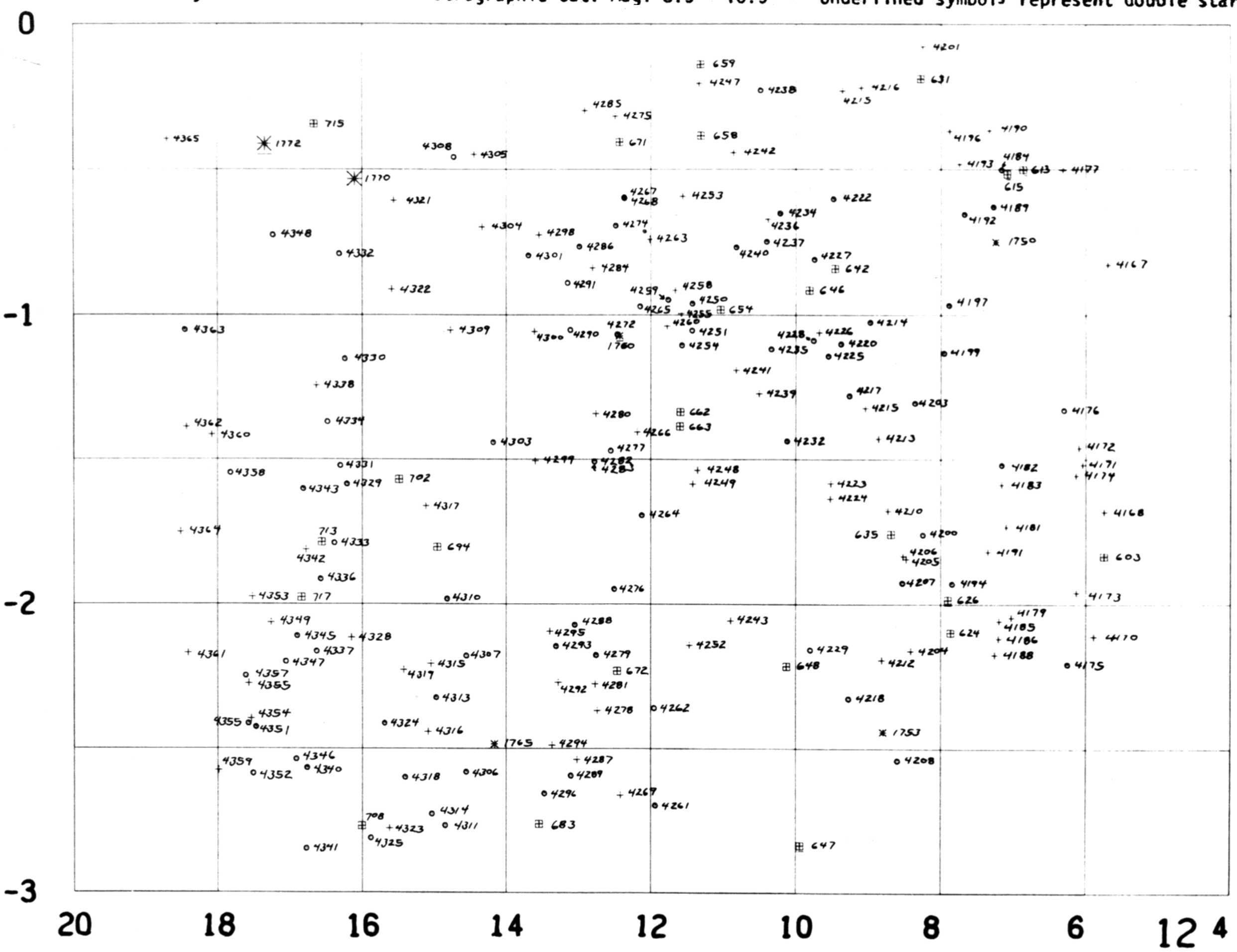
During the very favorable total lunar eclipse of 1978 March 24, the moon will traverse a relatively sparse area of Virgo. The eclipse will be observable from Hawaii, most of the Pacific Ocean (not the eastern part), and the Eastern Hemisphere except for western and central Europe, where moonrise will occur near the time of last umbral contact. General information about the value and observation of occultations during lunar eclipses is given in the article about occultations during the 1975 November 18-19 eclipse on pp. 48-50 of issue #6. Maps similar to the ones in that issue (more precisely, similar to the ones of the Hyades in the last issue) are given here. They were prepared at USNO from the J-catalog data using a version of Vincent Sempronio's Hyades plot program which I generalized. John Phelps, Jr. went over the plots, adding star numbers and topocentric path lines to make them suitable for publication.

Detailed J-catalog predictions will be computed for many observers in the area, at least for the date of the eclipse. I will try to provide them upon request if you have not received them in the "regular" J-prediction mailing by early February (see EXTENDED-COVERAGE USNO TOTAL OCCULTATION PREDICTIONS on p. 138). I plan to change the EVANS program which computes USNO's predictions so that it will print the same eclipse features that were in the University of Texas program. These are: If there is an "E" rather than a "+" or "-" following the percent sunlit, the value is the percentage of the moon's diameter which is covered by the umbra (0 during totality and 100 at first and last contact). If there is a "U" following the cusp angle value, the value is the percentage distance of the star from the center of the umbra to the edge rather than a cusp angle ("0U" would indicate that the star was at the center of the umbra at the time of the occultation while "100U" would show that it was at the edge of the umbra). The data for the numerous faint stars in the eclipse star field were provided by David Herald, who used Astrographic Catalog and his own photographic observations for the stellar information. I replaced his data with AGK3, SAO, and Z.C. data whenever possible.

If you want to use the map to try to derive occultation times for your location, I will supply a computer list of coordinates of the moon's center on request, preferably if a self-addressed envelope is sent. But with the J-catalog predictions, this shouldn't be necessary (they are much more accurate). In order to use craters and maria shown on a lunar chart to see a reappearing star, subtract 295° from the predicted position angle to obtain the selenographic latitude of the emergence point on the limb. Conrad Bardwell, Cincinnati Observatory, has checked for occultations of minor planets during the eclipse using the Leningrad ephemerides, and found none. I have not had time to prepare a list of double and variable star data, or a list of B.D. numbers of non-SAO stars, for the eclipse star field.

Reports of observations of occultations timed during this eclipse should be sent to David Herald, P.O. Box 254, Woden, A.C.T. 2606, Australia. He will tabulate the results for a future issue.

✱ Zodiacal Cat. Mag. 4.0 - 6.0
• Zodiacal Cat. Mag. 7.0 - 8.9
⊞ SAO Cat. Mag. 6.5 - about 9
+ Astrographic Cat. Mag. 8.5 - 10.5
◦ Astrographic Cat. Mag. 10.6 +
Underlined symbols represent double stars.



ERRONEOUS STAR POSITIONS FROM OCCULTATIONS

David Herald

Please send all reports of occultations which are observed to occur outside of the accuracy range of the USNO predictions to me at PO Box 254, Woden, A.C.T. 2606, Australia.

In the table is a list of the most recent reports sent to me, with a short comment dealing with the cause of the observed discrepancy. Most of the observations were made by Robert Hays, Jr., IL, USA, with others by H. DaBoll, USA, J. Hers, South Africa, R. Laureys Belgium, and me. Some stars warrant extra comment:

133877 has the greatest observed discrepancy, and no comparison catalogue is available. I attempted to photograph and measure the position of the star myself. The result of this was to confirm that a large proper motion, as given in the SAO, was not appropriate. However, I had great trouble fitting the stars on the photograph to the SAO positions, apparently due to several other stars in the field being listed with erroneous proper motions. Suspect stars are SAO 133872, 133873, and 133891.

158821 (Z.C. 2114) was not, in fact, observed. I came across it when trying to obtain information on a graze of this star. Although it is a 5th-mag. star, it is only listed in G.C. and Z.C. Yale does not list it, as it is a close double. Care should be exercised with this star if a graze of it is attempted.

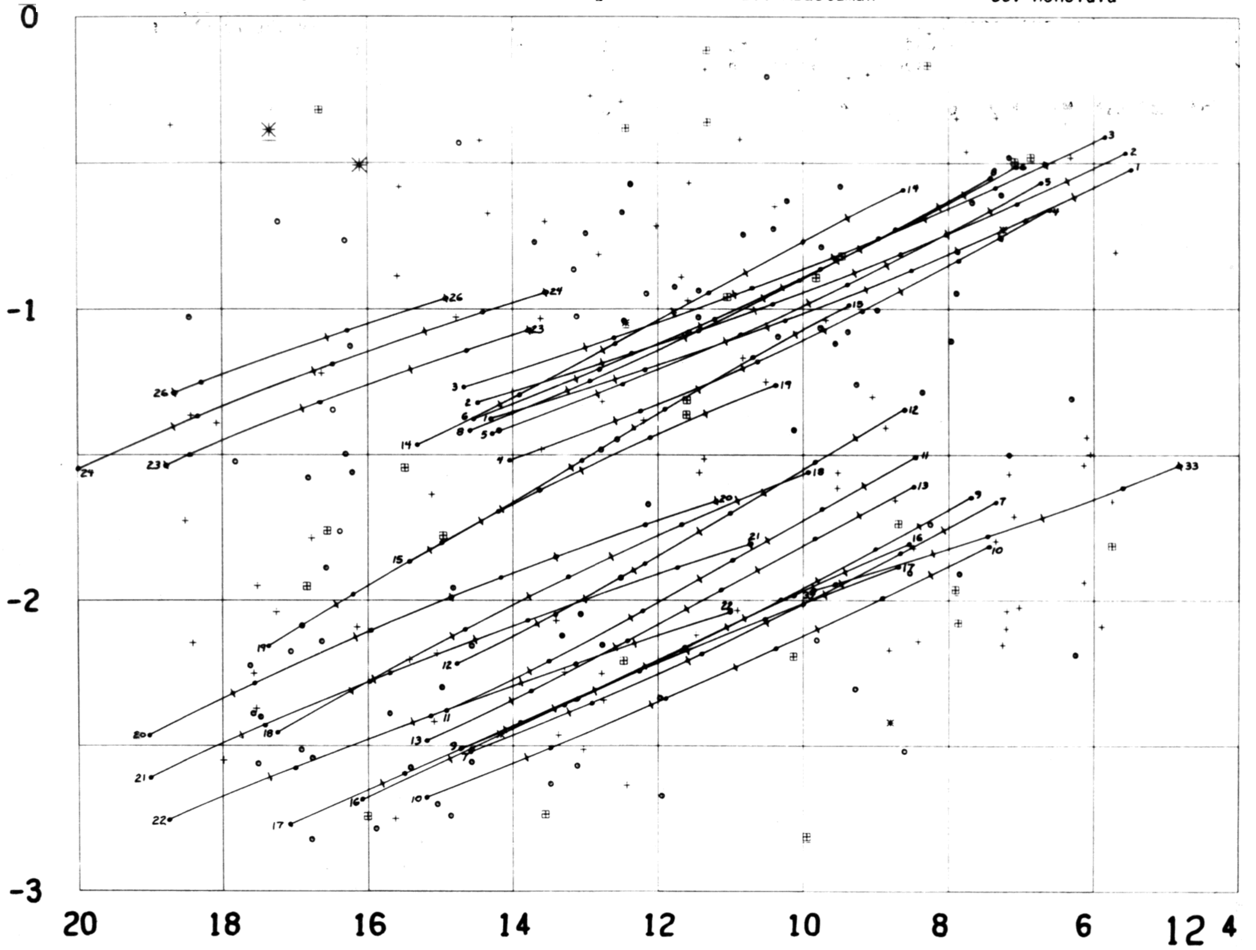
No comparison catalogue of modern epoch was available to check 159440 and 161066. However, a check on these stars will be forthcoming as a part of the Southern Astrographic Catalogue project.

In re 162852/3, Hays writes "The star has a close companion, about 10" to the SW. I timed the R of both stars on Feb. 15 and May 8. After the early event in Feb., I was curious to see if there would be a similar result in May. These observations indicate that any star position error of 162853 was enhanced by the near-graze circumstances of the Feb. event, when it actually came out first." (In May, 162852 was first.) I would be most interested to hear of any other observations of this double (the Z.C. numbers are 2870/1), since although some of the residuals are not ideal, the positions would seem satisfactory. Certainly there is no basis for for any change in relative position of these stars, as Aitken lists no change between 1825 and 1925.

One point that does seem to be emerging from investigating these observations is that an observation falling outside the USNO accuracy range is not

Topocentric Path Lines:

1. Auckland
2. Wellington
3. Dunedin
4. Brisbane
5. Sydney
6. Melbourne
7. Tokyo
8. Adelaide
9. Okayama
10. Khabarovsk
11. Taipei
12. Manila
13. Nanking
14. Perth
15. Lembang
16. Khurel - Togoot
17. Tomsk
18. Naini Tal
19. Kodaikanal
20. Basrah
21. Abastuman
22. Moscow
23. Causeway
24. Johannesburg - S. A. A. O.
26. Cape - S. A. A. O.
33. Honolulu



always unsatisfactory. A significant number of observations reported to me (say 10%) reduce entirely satisfactorily, even though outside the range; see 95070 and 185117. This would seem to be more so when the Acc. listed is relatively large. This presumably is a result of the method used in computing the predictions and of the accuracy code. It is incomprehensible to me, for example, to note largely different Acc. values for the D and R of a star in the predictions when it is a nearby graze; to my way of thinking, the values should come out as being fairly close. As an example, one star in my predictions, grazing 20 miles away, was listed with Acc. of 6 and 16 sec. for the D and R at my site. However, in spite of this, any certain observation falling outside of the USNO accuracy range is probably due to an error in the star position.

SAO #	Date	PH	AC	O-C	Observer	Comments
93350	76 Oct 11	R	3	+8	Hays	SAO proper motion too small in RA. AGK3 satisfies observation.
95070	76 Jul 24	R	2	+4	Hays	Observation has satisfactory residual.
95263	77 Jan 31	D	-	+15	Laureys	SAO wrong. See *O. N., 1,* 130 (#12) where Sandy observed the star.
97057	76 Oct 16	R	2	+5	Hays	AGK3, with more negative proper motion in RA than SAO, satisfies the observation.
109857	77 May 15	R	3	+8	Hers	SAO wrong. AGK3 correct. No obvious cause of error in SAO.
110226	77 Jul 19	R	2	+3	Hays	Poor residual, but SAO and AGK3 substantially agree.
138877	77 Jul 22	D	4	+34	Herald	No comparison catalogue. SAO lists large proper motion in Dec. If this is ignored, residual is good.
146679	76 Dec 27	D	3	+4	Hays	AGK3 better than SAO. SAO proper motion in RA too small.
146705	76 Dec 27	D	2	+4	Hays	AGK3 better than SAO. SAO proper motion in Dec. too small.
158821						ZC and GC disagree in Dec. by 1″.2. Not in Yale as it is a close double.
159440	76 Aug 4	D	3	+5	Hays	No comparison catalogue.
161066	77 Apr 9	R	3	-9	Hays	No comparison catalogue.
161754	76 Jul 4	D	2	-2	DaBoll	ZC used for prediction. ZC, GC, and Yale are in mutual disagreement. The GC position gives the best residual, for all observations. See also *O. N., 1,* 106 (#10).
	76 Aug 7	D	2	-3	Hays	
		D	2	-4	Sandy	
161842	76 Mar 23	R	10	-18	Hays	GC used in SAO: By 1977, 4" disagreement with Yale. Yale satisfies observation.
162852	77 Feb 15	R	11	+3	Hays	These stars are double, separation 10". Residual reasonably satisfactory in each case, particularly Feb 15 of 162853, which prompted the May observations. GC and Yale substantially agree. Aitken's double star catalogue shows these stars to be a fixed pair.
	77 May 8	R	4	-3		
162853	77 Feb 15	R	5	-8		
	77 May 8	R	4	-1		
185117	76 Feb 23	R	6	-11	Hays	Satisfactory residual. No comparison catalogue.

PLANETARY OCCULTATIONS

David W. Dunham

As far as I know, there were no successful observations of the occultation of SAO 99401 by Pallas on July 8. Last-minute photographic observations made at Greenwich, Lick, and Lowell Observatories all indicated that Pallas would pass about 0".2 south of the nominal prediction shown on p. 97 of *o.n.* #10. Unfortunately, this put the path in the only part of the Brazilian east coast where there are no observers. Jorge Polman and others in the northeastern part of Brazil had clear skies and reported that Pallas passed just south of the star, as expected. Observers in the Sao Paulo area and southward were clouded-out.

An occultation of 2.1-mag. Nunki (σ Sgr.) was described on p. 125 of the last issue. The event will occur on 1981 Nov. 17; I failed to mention that the occulting planet will be Venus. My calculations show that the event will occur after sunset in central Europe, the Mideast, northeast Africa, western India, and the western Indian Ocean. It will be visible in daylight from western Europe, Africa except the northeast part, the Atlantic Ocean, South and Central America, and the eastern Caribbean Sea. The elongation from the sun will be 47°

The table below gives information about planetary occultations, most found by Gordon Taylor, Royal Greenwich Observatory, to occur during 1978. The information has been taken from his articles published in the *Handbooks* of the B.A.A. and R.A.S.C., and from my calculations. Walter Nissen, Jr. helped prepare the input data for the latter. The occultations by (44) Nysa, (16) Psyche, (704) Interamnia [given as "(704)" in the table] and (92) Undina were found by Derek Wallentinsen (name changed from the Anglicized "Wallentine") using astrometric ephemerides provided by me.

1978 Date	Universal Time	PLANET Name	D,km	m_v	Δ,AU	STAR SAO No	m_v	Sp	R.A. (1950)	Dec.	Occultation Δm	Dur	df	P	Possible Area	El Sun	MOON El	%Snl	Up
Jan 18	20^h48^m	Vesta	538	7.8	2.44	159344	8.8	K2	$15^h30^m.7$	-12°38'	0.4	17^s	10	7	Western Australia	65°	174°	75+	none
Jan 19	1 10-21	Eunomia	272	8.5	1.56	97645	5.6	F8	8 09.3	+17 48	3.0	22	20	8	n.Europe,Greenl.,Canada	77	60	77+	w 60°E
Jan 28	10 05-12	Iris	209	9.0	1.43	+2°1358	9.1	K0	10 10.4	+2 36	0.7	22	25	10	USA, Canada (e.to w.)	155	22	84-	all
Feb 2	18 34	Nysa	82	12.0	3.00	160273	9.0	G5	17 03.1	-19 43	3.1	2	10	62	western Alaska	57	10	30-	all
Feb 25	15 55-62	Psyche	250	11.5	2.91	159250	8.8	A5	15 22.8	-15 16	2.8	31	41	22	Australia? n, N.Z.? n	104	46	93-	all
Mar 22	12 22-28	Vesta	538	7.0	1.68	160266	9.2	K5	17 02.1	-15 16	0.1	46	22	4	western USA, w. Canada	105	101	95+	w115 W
Apr 28	8 47-55	(704)	350	11.4	2.47	206553	8.1	A3	15 18.7	-37 22	3.3	27	24	8	nw.S.Amer.,Haiti,s.Mex.	153	55	67-	all
Apr 29	19 18	Undina	244	12.9	3.86	77784	9.0	G0	5 55.3	+23 34	4.0	7	11	27	n. Africa	50	141	51-	none
May 29	5 16-26	Pallas	608	9.2	2.34	85009	9.5	A0	17 17.6	+25 29	0.6	43	21	6	w.Africa,n.USA,s.Canada	131	83	49-	e 70 W
Jul 19	22 58-68	Juno	247	9.4	1.84	144070	7.1	A0	20 04.0	-4 34	2.4	20	21	11	se.Europe, nw.Africa	163	14	100-	all
Aug 1	11 21	Mars	6782	1.7	2.07	119114	7.1	F2	11 52.8	+1 22	0.0	176	7	1	e.China,Japan,Phil.Is.	49	78	6-	none
Oct 31	5 02	Pallas	608	10.4	3.80	122731	8.6	F0	17 44.0	+5 25	2.0	17	10	9	Alaska, Hawaii, w. USA	54	60	1-	none
Nov 9	15 20	Vesta	538	7.9	2.62	187470	8.9	A5	18 53.1	-24 59	0.4	15	9	7	Mideast,swUSSR,nwIndia	56	60	72+	all

The ranges of Universal Time are given in increasing order; if the occultation shadow will sweep across land areas during nighttime in two minutes or less, only one time is given. Under PLANET, D is the expected diameter, m_v is the visual magnitude, and Δ is the geocentric distance in astronomical units at the time of the occultation. Under STAR, m_v is the visual magnitude and Sp is the spectral type; the approximate ecliptic 1950 position is also given. Under OCCULTATION, Δm is the change in visual magnitude of the coalesced images which is expected if an occultation does occur, Dur is the duration for a central occultation computed using the expected diameter of the planet, df is a measure of the diffraction effects for a central occultation (It is the time in milliseconds between fringes for an airless planet.), and P is the inverse of the probability that an occultation will occur in the possible area, assuming a combined stellar - ephemeris positional error of 1".0 (That is, P is essentially the ratio of the width of the possible area of visibility to the width of the expected occultation path.). The combined area can be considerably reduced with modern astrometric observations, and the width of the possible area narrowed to substantially reduce P, but as explained before, this can be accomplished best when the planet and star can be photographed on the same plate, perhaps only 2 to 3 days before the event. Under Possible Area, the regions from which the events may occur with the sun below the horizon are listed in the chronological order in which the occultation shadow will sweep over them. A "?" indicates that an occultation will occur in the area just mentioned only if the actual path shifts n(orth) or s(outh) (the direction indicated by the letter following the "?") of the predicted path, usually by at least a few tenths of an arc second in the sky. The elongation of the sun from the planet is given under El Sun. Under MOON, the elongation from the planet is given under El, the percent sunlit ("+" for waxing and "-" for waning phases) is given under % Snl, and the approximate longitudes from which the moon will be above the horizon in the possible area are specified under Up. For the latter, the moonrise or moonset terminator is specified in degrees of longitude E(ast) or W(est) of Greenwich, preceded by a letter w(est) or e(ast) to specify the direction in which the moon will be above the horizon. "All" or "none" is used to specify whether or not the moon is up in the entire possible area if it is not crossed by the moonrise or moonset terminator.

One of the most important columns in the table is Δm, since it specifies the observability of the event. A value less than 1.0 in general means that the event can only be reliably observed photoelectrically. In case of exceptionally good atmospheric seeing, smaller magnitude drops might be detected visually. Consequently, the occultations of Jan. 18, Mar. 22, Aug 1, and Nov. 9 likely will not be noticed visually. The May 29th occultation may be visually observed if conditions are good, but Taylor gives 10.6 for m_v, so that the drop at occultation would be a very difficult 0.3 mag. Also, his nominal path goes rather centrally from east to west across the USA, whereas my nominal path goes across the populous southern part of Canada. The differences are due to Taylor's using data from the AGK3 catalog, whereas I used SAO data. Henry Giclas took two plates centered on SAO 85009 with Lowell Observatory's 13-inch astrograph on August 5. Otto Franz' measurements of these plates show that the star is very close to the SAO position, implying that the paths will be near the U.S. - Canadian border, but still with an uncertainty of several hundred kilometers (*IAU Circular #3141*). Photometry of the star is needed in order to assess the observability of the occultation.

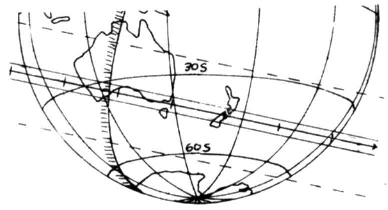
There is also some question about the position of 7.1-mag. SAO 144070, occulted by Juno on July 19. The SAO position is from the unreliable G.C. Wayne Warren, Jr. calculated a 1".6 shift using the Yale Catalog position of the star, which would put the path well to the north, crossing Europe. Brian Marsden sent me the star's position and proper motion in the new Perth 70 Catalog; it implied a 1".0 shift from the G.C. (SAO) position. The possible area in the table is based on the Perth 70 data, which should be the most reliable (The observation epoch was 1968.75.).

Small world maps of the 1978 planetary occultations given in the *Handbooks* of the B.A.A. and R.A.S.C. have been prepared by Mitsuru Sohma, Tokyo, Japan, and sent to me by Toshio Hirose. Sohma used the same star positions that I used, and his calculations agree with mine. John Phelps, Jr. traced over the copies of the maps for publication here.

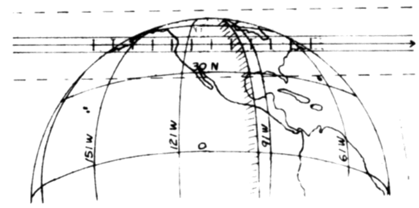
SAO 97645, occulted by minor planet (15) Eunomia on Jan. 19, is the interesting triple star ζ Cancri, component magnitudes 5.6, 6.0, and 6.2. The occultation was pointed-out by Jean Meeus, who used an astrometric ephemeris supplied by me. Due to projection, the paths should be about 500 km wide. The path for the B component (separation 0".87) will be about 900 km south of that for A, while the path for C (separation 5".76) will be very close to that for B, with C occulted about 9 minutes before B. The A and B components are so close that they probably will not be directly resolved, unless the seeing is very good. Their combined magnitude is 5.0. Hence, if component A is occulted, B only will remain visible, so that the magnitude drop would be 1.0. If B is occulted, the magnitude drop would be 0.6, perhaps a little difficult to detect visually. However, even though A and B may not be resolved visually, they would probably appear elongated. So if an occultation occurred, one part of the elongated image would suddenly disappear, which would be more noticeable than merely a change in brightness. Observability of this will depend on the seeing. The C-component is far enough from the others to be resolved readily with small telescopes (it has a separate SAO number, 97646), so an occultation of it would be most noticeable. Eunomia plus C combine to mag. 6.1, which would change 2.4 magnitudes to Eunomia's 8.5 if an occultation occurs. The northern Rocky Mountain and northeastern Plains States are in the possible occultation area. The Z.C. position was used for the mean of the A-B components, and the latest double star data were then used for each component.

Another Belgian amateur, Patrick Wils, points out another occultation, of 8.7-mag. SAO 97745 (1950 R.A. $8^h\ 18^m\!.4$, Dec. +18° 00'), by Eunomia. Geocentric conjunction will occur on Jan. 10 at $21^h\ 17^m$ UT, with the occultation visible somewhere in Indonesia, the Indian Ocean, central Africa, and possibly southern India. As no *O.N.* subscribers live there, it probably doesn't matter that most probably won't read this until after the event. Gordon Taylor and Derek Wallentinsen independently discovered the occultations by Eunomia.

Hatched side of terminator is sunlit.

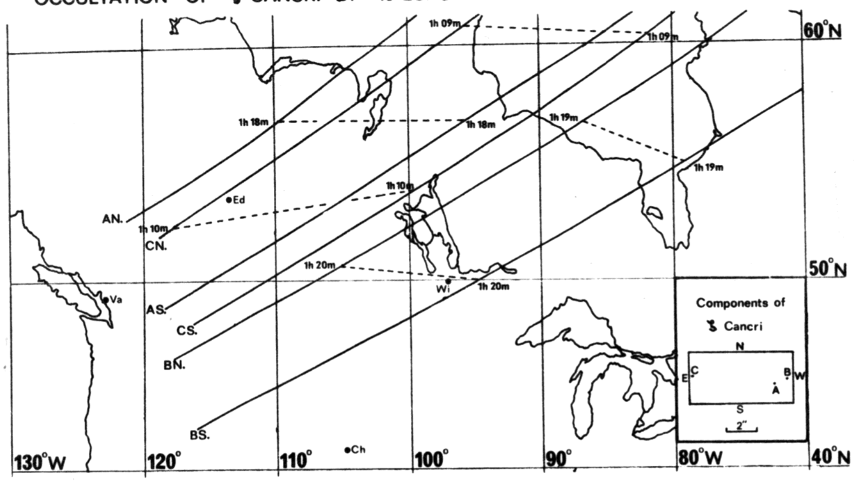


1978 Jan. 18, Vesta occults SAO 159344



1978 Mar. 22, Vesta occults SAO 160266

OCCULTATION OF ζ CANCRI BY 15 EUNOMIA ON 1978 JANUARY 19



KEY

AN. Northern limit of A component
AS. Southern limit of A component
BN. Northern limit of B component
BS. Southern limit of B component
CN. Northern limit of C component
CS. Southern limit of C component

Ch Cheyenne
Ed Edmonton
Va Vancouver
Wi Winnipeg

All times are in U.T.

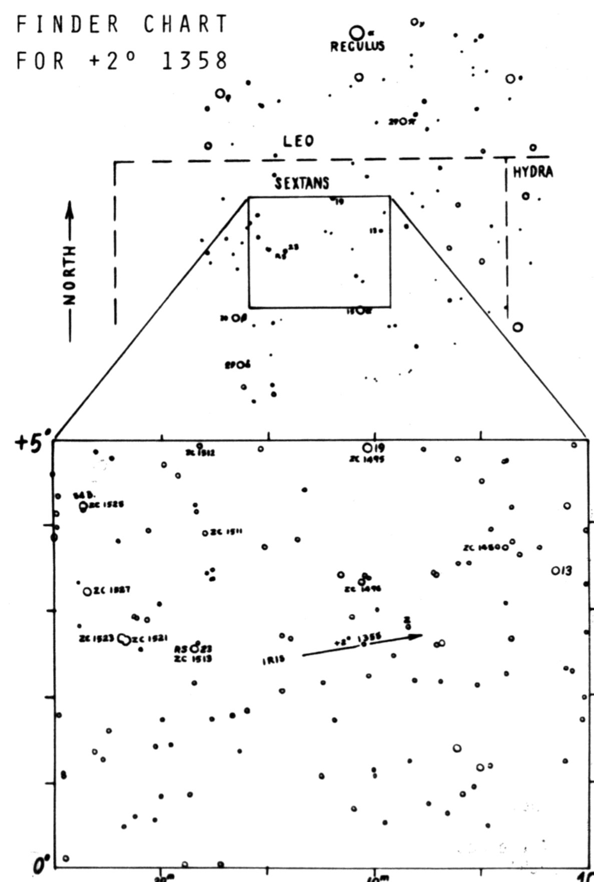
The March 22 occultation should be visible from the Rocky Mountain and west coast areas. My nominal path extends from Oregon to Colorado, whereas Taylor specifies Canada. The projection factor indicates that the path should be about 1000 km wide. The October 31 event may be visible only from the Pacific States at very low altitude.

The time scale of diffraction phenomena for all of these events is rather similar to that for lunar occultations, as can be inferred from the values in the df column, but due to the much greater planetary distances, the angular resolution is much greater, better than 0".0002. So photoelectric records would have great value for resolving very close double stars and measuring stellar angular diameters. Visual observers should also watch for effects due to close previously unknown doubles. If the star is a close double, the events will occur in two stages, with each magnitude change less than the value given in the Δm column.

Accurate osculating orbital elements for many more minor planets have been provided by V. Shor, Institute of Theoretical Astronomy, Leningrad, and P. Herget, Cincinnati Observatory. The calculations of accurate astrometric ephemerides using these data are now in progress. The numbers of these minor planets are 17, 19, 23, 24, 27, 28, 30, 33, 36, 43, 47-49, 51, 54, 61, 63, 64, 78, 85, 88, 93-95, 107, 115, 116, 132, 135, 137, 140, 144, 145, 173, 185, 187, 194, 211, 216, 230, 241, 247, 308, 313, 360, 364, 372, 385, 386, 393, 409, 419, 444, 476, 554, 588, 602, 617, 659, 747, 790, 804, 884, 911, 980, 1036, 1143, 1172, 1208, 1437, and 1583.

On p. 116 of *O.N.* #11, it was incorrectly stated that (6) Hebe is a C-type (carbonaceous) minor planet. It is actually an S-type object, so that its mean density is probably about 3 times that of the sun, making Hebe's gravitational sphere of influence about 1200 km.

FINDER CHART FOR +2° 1358



RIGHT ASCENSION AND DECLINATION ON EQUINOX 1950

PLANETARY OCCULTATION UPDATE

David W. Dunham

The following information, written in mid-December, a couple of weeks after my main article on planetary occultations above, is based mainly on new data received from Gorgon Taylor, HMNAO, and on some of my further calculations.

The map of part of North America showing the predicted paths for the occultations of the components of ζ Cancri was prepared by Gordon Taylor. My predicted path for the C component agrees almost exactly with Taylor's; my time for the event is one minute earlier than his. However, the location of my path for B is virtually the same as that for C, while I have the path for A about 600 km northwest of that for B and C. This is due to slightly different positions for the stars being used in our calculations. In general, my paths are somewhat north of Taylor's. My data are ultimately based on the Z.C position for the mean of the A and B components, while in one list, Taylor uses the AGK3 designation for the star, perhaps also indicating that he obtained the star's position from that catalog. However, in an earlier communication, Taylor indicated that he didn't want to issue a prediction until he had obtained recent astrographic positions for the objects, so it is likely that his map is based on such recent data. In any case, a prediction uncertainty of several hundred kilometers remains (this can possibly be reduced by last-minute astrographic observations), so observers from Quebec to Illinois to Colorado and northward should try to view the appulse. The altitude of the star will be 10° at Edmonton and Denver at the time of the event, so observers west of a line connecting those cities will have a hard time seeing any occultation. For North Americans, the event occurs with the objects rising low in the east, so observers should be prepared to star-hop from Gemini down to ζ Cancri. Taylor writes the following in his bulletin about this occultation: "Since C will be occulted first, observers should concentrate on it for the first mid-time and then concentrate on A-B for the second and third mid-times. The map shows that most observers should watch star C from about 1^h08^m - 12^m U.T. and stars A and B between 1^h16^m - 22^m. Please report your observations directly to me at Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, East Sussex BN27 1RP, England. If there are several observers available in one area they should endeavour to space themselves out on a line at right-angles to the track, about 10-20 km apart." In the Eastern Hemisphere, possible areas (especially with a south shift) include w. Siberia (about 1^h10^m U.T. for A and B), n. Russia, and n. Scandinavia (about 1^h 13^m U.T. for A and B).

As part of his regular observational program at USNO, Robert Harrington has taken several plates of (16) Psyche, (92) Undina, and (704) Interamnia during the past 3 years. I computed residuals for these observations and established that the ephemerides for these objects are accurate to 1".0 or better for recent epochs.

The predicted path for the occultation by (7) Iris on January 28 is very similar to the path for the occultation by Pallas on May 29; the path for the Iris event passes a little farther north in western Canada. Since Iris is in retrograde motion (as Pallas will be in May), the predicted time of the occultation, which is known to ±2 minutes, increases from the Atlantic coast (10^h 05^m U.T.) to the Pacific coast (10^h 12^m). The star is not in the SAO catalog; the value given in the SAO number column of the table is the star's AGK3 number. Gordon Taylor has distributed his predictions for this occultation before verifying the star's position due to possible delays caused by the large volume of holiday mail. But in general, he prefers to at least verify the adequacy of the ephemeris of the occulting body with fairly recent astrometric data before issuing predictions, to avoid wasted effort by large numbers of observers. In Bulletin 3 of I.A.U. Commission 20's working group on predictions of occultations by satellites and minor planets, Gordon Taylor lists very general information about 38 occultations of SAO and AGK3 stars which he has found will occur during 1978 based on computer comparison of these catalogs with accurate ephemerides of 39 minor planets. Besides the events described above, he has found several other events during early 1978, many of them only visible from the ocean or other areas with no observers. But possible occultations will occur in Africa on February 12, in New Zealand and Australia on February 16, n.e. Brazil on February 19, and South America and Japan (same event) on March 11. As the positional information for these events is verified, predictions will be tabulated here or distributed to observers by Taylor or by me, as time permits. I am rather concerned about becoming too involved with the prediction improvement and distribution for these events; my time is already overcommitted with star catalog and zodiacal double star work, and improvement of lunar total and grazing occultation predictions. A volunteer with access to *Atlas Eclipticalis* (*A. Borealis* and *Australis* may also be of some use, but *Eclipticalis* is the essential one), or perhaps the *SAO Star Catalog Atlas*, is sought who would be willing to prepare finding charts for stars occulted by Solar System objects beyond the moon, like the one prepared for the occultation by Pallas in Brazil on p. 97 of *O.N.* #10. Eventually, I should be able to prepare computer plots for these, but even then, someone will be needed to do some work to prepare them in final form for distribution to observers.

On 1978 October 8, shortly after 6^h U.T., Uranus will pass 25" north of 2.9-mag. α^2 Librae (Z.C. 2118, Zubenelgenubi). The star was discovered to be a close double during a lunar occultation; analysis of the photoelectric record gives component magnitudes of 3.4 and 3.8 with a separation of 0".01 projected in direction 110°. The occultation shadow will pass 54 earth radii north of the Arctic, so no occultation by either the planet or the rings is possible from the earth's surface. I have examined the possibility of an occultation by any of the satellites. Using data from the *American Ephemeris*, I have found that the closest approach will be by Oberon, which should pass about 6" north of the star around 2^h40^m U.T. Western North America will be the best place for viewing this appulse, but the star will be very low in the southwest after sunset since it will be only 30° east of the sun. Ephemeris errors are probably not large enough for there to be any possibility of an occultation, but I will check this by converting my Ph.D. thesis programs to run on the computer at USNO to calculate a very accurate position of Oberon with respect to Uranus.

Brian Marsden and other astronomers have been able to greatly improve the orbital elements of the new miniplanet 1977 UB by finding images of the faint object on plates taken as early as 1895. The semi-major axis is 13.695 A.U. and the eccentricity is 0.3786, osculating values for 1977 Sept. 14.0 E.T. The object is now near aphelion; the next perihelion will occur early in 1996. The period is nearly 51 years. The 18th-mag. object has not yet been officially named, but discoverer Kowal proposes that it be called Chiron, who in Greek mythology was the leader of the Centaurs and the son of Saturn. More information [Ed: appears on pp. 4 and 5 of the January issue of *Sky and Telescope*]; you may already have heard of some of these developments from the news media. The albedo of Chiron is unknown; its diameter could possibly be several hundred kilometers. Observations of an occultation by Chiron would be valuable for learning more about this newly discovered object. I have computed an accurate ephemeris for Chiron through the end of 1979 and have compared it with Astrographic Catalog data for stars to about 14th magnitude (Wayne Warren used my A.C. data processing program to obtain the needed information from the magnetic tape version of the Bordeaux zone). It happens that the closest approaches involve two tenth-magnitude AGK3 stars during 1978. On July 24 at $18^h.1$ U.T., Chiron was found to pass 7".2 south of 10.7-mag. AGK3 +13° 203 (USNO K01374) as seen from Antarctica. On October 25 at $8^h.4$, Antarctica will again have the closest approach, 5".5, to 10.4-mag. AGK3 +12° 251 (K01312). These predictions were computed with the A.C. positions for the stars, with epochs 70 years old. The proper motion of AGK3 +12° 251 is small; the prediction changes insignificantly when the better AGK3 data are used, with a path shift of only 0".3 and a time change of $+0^h.4$. However, the proper motion of AGK3 +13° 203 is large; the 1908 A.C. position for the star is in good agreement with the AGK3 position when proper motion is applied to 1908. But when the AGK3 data are used for the epoch of the July 24th appulse, there is a large time change and the path moves to the other side of the earth, with a real possibility of an occultation. According to the AGK3, the shadow will miss the arctic regions by only 1".5 at $19^h.8$ U.T. The elongations of the sun and 72% sunlit moon will be 82° and 34°, respectively. A recent astrographic position of AGK3 +13° 203 should be obtained to improve the prediction; perhaps some lunar occultation observations of the star (K01374 in the extended USNO predictions) can be made to give further positional data. The star will be above the horizon at night for most of Asia, Indonesia, and Australia. The equinox 1950 position of the spectral type G0 star is RA 2^h $28^m.3$, dec. +13° 44'. A central occultation by 18th-mag. Chiron would last 61 seconds if the diameter is 600 km.

In *NASA SP-267, "Physical Studies of Minor Planets"*, edited by T. Gehrels, Washington, D.C., 1971, A. F. Cook, of SAO, has an article entitled "(624) Hektor: A Binary Asteroid?" Based upon photoelectric light curves, Cook derives orbital elements for the components of (624) Hektor, using techniques often employed for eclipsing double stars. Other models for the light curve of (624) Hektor involve long cylinders, which Cook claims would not remain stable under mutual gravitational forces. If Hektor is a binary asteroid, the components must be nearly in contact, and separated by of the order of 300 km or less (0.1 second of arc at Hektor's opposition distance). The sidereal period is 0.2884483 days. Cook's model also indicates that the components are elongated facing toward each other, and that they librate about the line joining them. He suspects that the libration period is about one day, but future observations were requested. I have seen no follow-up study of Cook's conjecture. In any case, (6) Hebe is not the first minor planet claimed to have a companion.

[Postscript, 1977 December 26:] I have computed predictions for the occultation by (7) Iris on January 28th, using an ephemeris computed from Branham's accurate orbital elements of Iris and a position for the star measured by Robert Harrington from a plate taken at USNO in 1967. My prediction is virtually identical with Taylor's prediction, and shows that the southern edge of the possible occultation area passes over northern Georgia, southern Kansas, and northern California. Groups north of that line might try to set up a number of stations at 20-km intervals on a north-south line.

Mo	Dy	Star Number	Mag	% Snl	CA	Location	# Sta	# Tm	C C	Ap cm	Organizer	St	WA	b
1974														
4	28	3326	6.4	15-	N	Commercial Pt.,OH	5	31	9	10	Roger Cole			
1976														
4	7	Z06324	8.5	42+	N	McDonald Obs., TX	1	1	9	76	John Africano			
5	5	Z07194	8.4	28+	N	Marine, IL	1	2		20	Wayne Clark			
1977		*(The following line replaces data on p. 118 of *O. N.* #11.)												
*3	27	Z04809	7.5	41+	9N	Lauderdale L.,FL	3	14		25	Harold Povenmire			
4	21	0610	6.2	8+	N	Obihiro, Japan	9	33	6	6	Hidetoshi Yoshida			
4	21	Z03687	7.1	10+	N	Braga, Portugal	2	17		15	Jose Osorio			
4	24	Z06183	7.7	29+		Waterfall,Austrl.	9	39	8	20	Roger Giller			
6	7	Z23543	9.0	55-		Salisbury, Rhod.	2	3	7	30	A. G. Morrisby			
6	11	Z00991	8.6	27-		Salisbury, Rhod.	3	6	7	10	A. G. Morrisby			
6	22	1489	6.8	27+	S	Colorado Spgs.,CO	3	21	5	10	Derald Nye			
6	22	Z10213	8.5	28+	N	Canberra,Austrl.	3	7	8	9	David Herald	C	10S	44
6	26	Z12870	9.2	68+	S	Anahuac Spring,CA	1	1	4	15	Richard Nolthenius			03
6	27	Z14247	7.8	85+		Salisbury, Rhod.	2	6	6	10	A. G. Morrisby			
7	9	Z01746	8.7	45+	N	Fremont, CA	1	2	5	25	James Ferreira			
7	12	0648	3.9	14-	-1N	Washington C.H.,OH	1	2	6	15	Richard Binzel	0		
7	12	Z03681	8.2	13-	S	Lake Sutherland,CA	1	4	8	15	Richard Nolthenius			55
7	21	1685	4.5	23+	S	Crest, CA	4	24	9	0	Richard Nolthenius	0		35
7	21	1754	6.9	29+		Utrera, Spain	4	30		8	L. Quijano			
7	25	2170	6.8	65+	9S	Ocala, FL	1	2		15	Harold Povenmire			
8	6	0372	7.6	54-	5N	Romoland, CA	2	3	7	15	Richard Nolthenius	23N		30
8	6	0372	7.6	54-	5N	Santa Claus, AZ	1	3	8	15	Walter Morgan			30
8	7	0478	7.7	45-	5N	Katy, TX	13	44	6	25	Paul Maley	C	15N356	41
8	7	0478	7.7	45-	4N	Oak Grove, MD	5	12	8	16	David Dunham	C	15N357	41
8	8	Z03451	7.6	35-	5N	Goulds, FL	1	1		20	Harold Povenmire			
8	10	Z04970	8.7	18-	N	Clinton, MS	1	4	5	25	Ben Hudgens	0		
8	24	K07226	8.6	75+	9S	Alpine, CA	1	2	6	15	Richard Nolthenius			-57
8	25	2755	6.6	83+	S	Washington C.H.,OH	1	6	8	15	Richard Binzel			
8	25	2764	6.3	83+	12S	Rantoul, IL	2	18	8	20	John Phelps, Jr.	C	0173	-59
9	6	0823	6.6	44-	6N	Raisin, TX	1	2	7	15	Don Stockbauer	C	5S354	66
9	6	0832	4.7	42-	2N	Key Largo, FL	1	2		20	Harold Povenmire			
9	7	Z05810	7.8	33-	3N	Orland Park, IL	2	2	7	20	John Phelps, Jr.	C	2S356	71
9	7	Z05812	8.7	33-	3N	New Lebanon, IL	2	3	5	20	Homer DaBoll	C	6S356	71
9	7	0975	7.2	33-	-1S	Wilton Center, IL	1	2	8	20	John Phelps, Jr.		12S177	71
9	9	Z08178	8.3	16-	0N	Raisin, TX	1	10	9	25	Don Stockbauer	C	3S355	68
9	18	2218	5.6	25+	5S	Benevola, MD	9	42	6	25	David Dunham		0172	-34
9	18	2218	5.6	25+	5S	Marshallton, PA	3	17	6	10	Clifford Bader			
9	18	2218	5.6	25+	5S	Bordentown, NJ	1	11		10	John Church			
9	18	2218	5.6	25+	5S	Westhampton B.,NY	1	3		15	Alan MacRoberts			
9	19	2391	7.1	38+	4S	Sun City, CA	8	11	9	15	Richard Nolthenius	C		-48
9	19	2391	7.1	38+	7S	Rossville, KS	5	26	9	6	Don Stotz			
9	19	2391	7.1	38+	7S	Wallace, MO	3	23	7	15	Robert Sandy	CS		-48
9	20	Z17174	8.8	49+	S	Crest, CA	1	2	6	15	Richard Nolthenius	C		-57
10	7	Z08627	8.3	30-	2N	Elkhorn, WI	2	9	7	20	Homer DaBoll	C	2S355	68
10	7	1281	6.4	30-	S	Spring Lake, FL	1	2	5	20	Thomas Campbell		1S180	66
10	7	Z08726	8.6	30-	-1S	La Jolla, CA	1	1	8	15	Richard Nolthenius	S		
10	7	K04689	8.9	29-	2S	Ocean Beach, CA	1	2	8	15	Richard Nolthenius	S		
10	17	2497	6.6	23+	6S	Earlton, KS	2	5	8	6	Donald Stotz	C	171	-54
10	17	2497	6.6	23+	6S	Marmaton, KS	3	16	7	15	Robert Sandy	C	171	-54
10	17	2497	6.6	23+	6S	Eolia, MO	1	5	8	15	Tom Butler	C	171	-54
10	19	2826	4.0	44+	6S	Pinon, CO	3	18	8	10	Paul Asmus	C	1S175	-60
10	19	2826	4.0	44+	6S	Austin, MN	6	26	9	11	James Fox	C	174	-60
10	20	2969	3.2	56+	-6N	Leopolis, WI	3	8	6	20	Homer DaBoll		2N355	-58
10	22	3362	5.9	83+	S	Tara,Ont.,Canada	3	4	9	15	Doug Cunningham			
10	31	0944	5.9	80-	4	Sleidinge,Belgium	14	31		8	Willy Verhaegen			
11	2	Z07318	7.8	67-	9N	Pasadena, CA	2	4	9	25	Keith Horne	6S		
11	5	1465	6.3	37-	2N	Lone Pine, CA	2	1		25	Keith Horne			
11	7	1577	7.1	28-	S	Auburn, CA	3	2			Bill Fisher	S		
11	14	2764	6.3	19+	4S	Carbondale, KS	1	2	3	20	Don Stotz			
11	17	Z22465	8.4	40+	7S	Port Lavaca, TX	1	2	6	25	Don Stockbauer		8N173	-53
11	17	Z22465	8.4	40+	7S	Crystal Spgs, MS	1	4	7	25	Ben Hudgens			
12	13	Z21935	8.2	15+	2S	Hyattstown, MD	1	1	6	25	David Dunham	C	1S174	-54
12	15	3294	6.9	34+	5S	Farrington, VA	3	10	6	15	Emil Volcheck	C	3S176	-34
12	15	3294	6.9	34+	5S	Ashland, VA	6	17	8	25	David Dunham	C	3S176	-34

GRAZES REPORTED TO IOTA

David W. Dunham

Graze reports should be sent to my current address, P.O. Box 488, Silver Spring, MD 20907, U.S.A. As usual, if possible, a copy also should be sent to H. M. Nautical Almanac Office, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, E. Sussex BN27 1RP, England. There is more information about reporting data on p. 93 of #10.

Rick Binzel drew a counter-distorted master of plotting scales which, used with the Xerox machine to which I have access, produces copies suitable for use with 1:24,000; 1:50,000, 1:62,500; and 1:250,000 - scale maps. These save considerable time when plotting graze limits on maps of these scales, and can be obtained by sending me a long, self-addressed envelope.

On his report of the 1977 Sept. 6 graze of Z.C. 832, Harold Povenmire wrote: "A 10-foot alligator was in the water just a few feet away from me. Third successful graze at this site."

SOUTHERN ASTROGRAPHIC CATALOGUE PROJECT

David Herald

By the time this goes to press, this project will be well on the way to completion, with 4, and possibly 5 of the 7 zones to be reduced being completed. Already, the -17 zone has been completed and punched, and included in the J catalogue, together with 2 plates form the -19 zone; extended coverage predictions utilising the J catalogue were recently distributed to many observers. Unfortunately, few stars from the -17 zone, between RA 17 and 19 hrs, can ever be occulted as seen from the Northern Hemisphere. The other zones close to completion on writing this are the -21, -27, and -29 zones, with work on the -19 zone commencing.

As David Dunham stressed in the cover letter sent with the J catalogue predictions, feedback relating to the observability of the stars in the J catalogue is most desired. The A.C. magnitudes are not reliable (even apart from being photographic magnitudes, and hence having red stars too faint). This is particularly acute in the region of the S.A.C. project, where it is necessary to derive the magnitudes from the published 'image diameters' in the A.C. It is not uncommon for a star common to adjacent plates to have magnitudes derived from the two plates differ by well over one magnitude! This problem is especially severe for declinations south of -24°. One point to remember when utilizing the J catalogue for predictions: in the region covered by the S.A.C. project, i.e., *between 17 and 19 hrs RA, the listed magnitudes for the stars in the majority of instances should, if anything, be too faint*. Regrettably, there is no way of providing accurate visual magnitudes from the data in the A.C.

Even though the project is well on the way to completion, anyone interested in participating in this project should let me know, since it may be quite feasible to extend the RA limits of the project. Access to any computer plus a bit of spare time is all that is needed, or similarly a calculator such as the HP67 or HP97, or the TI59. Of less use, since it is not practical to solve for the plate constants, but still useful for being able to reduce a plate, given the constants, are the TI58, and the recently released HP29C and HP19C. I should perhaps stress that although in principle the calculations can be performed on much simpler calculators, due to the large number of manipulations that would be necessary, it is not practical to use them. A programmable calculator is essential.

LUNAR OCCULTATIONS OF PLANETS

Mike D. Reynolds

1977 January 1 - Occultation of Jupiter and moons Callisto, Europa, Io, and Ganymede (also see *O.N.* #10, p. 100, for earlier reports). Jose Libindo de Azevedo reports that he timed occultations of Jupiter and the four Galilean satellites, at Porto Alegre, Brazil. The timings were made as Jupiter and the four moons disappeared at the dark limb of the moon. Jaime R. Garcia reports timing the occultation of Jupiter from a location in southern Buenos Aires province, Argentina.

1977 February 10 - Occultation of Uranus. Some reports of the occultation of Uranus by the moon have been received. Homer DaBoll reports that he timed third contact at his home in St. Charles, Illinois, noting that he couldn't detect any shape or disk to the planet, so that fourth contact was impossible to observe. Two expeditions, led by Bob Sandy in Kansas and Berton Stevens in Missouri, successfully observed the partial occultation, as previously shown in graze listings in *O.N.*, pages 95 and 118. Harold Povenmire attempted the partial occultation in southeast Georgia, recording some data. I made an abortive attempt for the partial; the first flat tire was something I could handle, but the second one kept me from reaching the planned observing site!

1977 May 3 - Occultation of Uranus by the 100% sunlit waxing moon. Even with the elongation of 177°, two observers succeeded in timing first and second contacts; Robert J. Wood with a 24-inch reflector, at Cocoa, Florida, and John S. Korintus with a 12½-inch reflector, at Palm Bay, Florida.

1977 May 14 - Occultation of Venus. A major expedition for the partial occultation of Venus by the moon was headed-up by B. Franklyn Shinn of Winnipeg, Manitoba, Canada. He was joined by four U.S. observers, Jim Fox, Homer DaBoll, John Phelps, and Berton Stevens. Bert was able to brief Canadian observers (names not available) before the event. There were several nearby thunderstorms, and only a few small breaks in the clouds, one of which apparently arrived in time to let Jim Fox get a third contact timing, the only data from the entire expedition.

1977 August 17 - Occultation of Mercury. Richard Nolthenius, San Diego, California, set up his telescope the previous night, to help in locating what would be a daytime event in the West. Although cloudy weather is unheard-of in California at that time of year, the observation not only was rained-out, but the telescope was drenched before he could return to the site! Harold Povenmire timed second contact from Bradenton, Florida, but noted that the event was extremely difficult. See *Sky and Telescope, 54*, 442 (November) for a report on Robert J. Wood's timing and photograph of the event as seen from Cocoa, Florida.

Please send me your reports, even if your attempts were unsuccessful.

610 Florida Boulevard
Neptune Beach, FL 32233

EXTENDED - COVERAGE U.S.N.O. TOTAL OCCULTATION PREDICTIONS

David W. Dunham

In order to secure more observations, especially for studies of systematic errors in Watts' limb correction data, I have gathered relatively accurate coordinates of about 12,000 faint non-SAO stars and organized them into two catalogs, the J-catalog and the K-catalog, for use with the U. S. Naval Observatory's occultation programs. The K-catalog is compiled from the AGK3 and from the Yale catalogs, stars from the latter with no proper motions given (and therefore not included in the SAO). The brightest K-catalog star is about magnitude 7.4. The J-catalog consists of detailed stellar data in the vicinity of certain galactic clusters and other fields of special interest compiled mainly from Astrographic Catalog data. The background work for these data is described briefly at the bottom of p. 124 and top of p. 125 of the last issue. Since the brightest stars in the J-catalog which are also in neither the K-catalog nor the SAO are about magnitude 9.5, J-catalog predictions have not been computed for some observers with high O-code limits who are receiving the K-catalog predictions. Since the J-catalog involves numerous faint stars in dense fields, a set of chronologically ordered data is included for them at the end of the regular list, for easier use at the telescope. These predictions should considerably reduce the number of "chance" observations of unknown stars, often hard to identify.

For completeness, especially in the chronological lists, SAO stars are included in the areas covered by the J-catalog. As usual, observations of all Z.C. and SAO stars should be reported to H. M. Nautical Almanac Office at the Royal Greenwich Observatory. Observations of non-SAO stars should be written on separate forms and sent to me rather than to H.M.N.A.O., which analyzes only observations of SAO stars. In the future, I hope that it will be possible for reductions of observations of non-SAO stars to be computed at U.S.N.O. with help from the International Occultation Timing Association. For the non-SAO stars, use HMNAO's forms, putting the USNO reference number in the SAO number columns and the designation given under the "DM number" column of the predictions in col. 60 on of the forms. It is important that this be done only for non-SAO and non-Z.C. stars on separate forms to be sent to me rather than to HMNAO.

Unfortunately, the A.C. magnitudes for most J-stars are unreliable (see SOUTHERN ASTROGRAPHIC CATALOGUE PROJECT, on this and the preceding page).

Last September, I sent J and K predictions for the rest of 1977 from USNO to over 100 of the observers on USNO's prediction mailing lists, mainly to the most active observers with access to large telescopes. For computing these predictions, it is very desirable that accurate, up-to-date coordinates for your observing station be included in USNO's P-file (data file of accurate station coordinates). Unfortunately, numerous problems with the catalogs (documented below) and programs have delayed the creation of the J and K Besselian elements tapes which are needed to compute the 1978 predictions for observers using USNO's "EVANS" program. This means that the predictions for many observers unfortunately will not be mailed until late in January. It takes about 2 hours to compute a J-catalog prediction list for an O-code limit 0 station for one year using EVANS. Due to heavy commitments of computer time for other projects (such as generating data for the *A.E.N.A.*, for eclipses, sun and moon rise and set lists, and for the regular SZ (SAO) graze and total occultation data for 1979), predictions for fewer observers likely will be computed for 1978 at USNO than were computed for late 1977. It may be necessary to set up standard stations and compute predictions for many observers with a and b factors using a modified version of the standard-coverage program,

Table 1. J-Catalog Star Fields

J-number range	
5 to 455	Hyades; individual duplicity important for cosmic distance scale
393 to 700	NGC 1647, overlap in R.A. with Hyades, A18 to A20 zones
701 to 3746	Northern Milky Way, R.A. 5-7^h, AGK3 + A.C. to mag. 10.5
3748 to 4162	M67, cluster not occulted after 1977
4167 to 4365	1978 Mar. 24 lunar eclipse field, special "DM" numbers
4370 to 6070	Southern Milky Way, R.A. 17-19^h, A.C. zone B17 only
4739 to 4892	M23, from A.C. zone B19; R.A. overlap with above (M24 & M25 also)
5021 to 5243	M24, with "DH" DM#'s, see *O.N.*, *1*, 82 (#9, September, 1976)
5259 to 5788	M25, from A.C. zone B19
6075 to 6420	1978 Sep. 16 lunar eclipse field, special "DM" numbers

Table 2. K-Numbers of Stars which are in the SAO and SZ Catalogs, Deleted from the 1978 Version

70	1182	2164	2914	3856	4146	4536	4850	5760	6442	6651	6776	6957	7028	7075	7105
157	1205	2365	3010	3860	4169	4590	4873	5896	6516	6686	6832	6959	7032	7081	7527
413	1329	2537	3107	3870	4262	4595	5274	5966	6537	6716	6842	6977	7048	7083	7611
699	1664	2600	3144	3992	4279	4643	5284	6073	6540	6739	6852	6980	7058	7086	7673
806	1771	2663	3172	4029	4426	4654	5357	6187	6556	6754	6893	6991	7060	7102	
941	1903	2768	3458	4038	4473	4812	5489	6228	6563	6756	6905	6994	7067	7103	
977	2014	2859	3544	4117	4482	4840	5543	6412	6597	6768	6906	7000	7074	7104	

Table 3. K-Catalog Stars Matched with SAO (SZ) Stars but Retained due to Large Errors in the SAO

USNO K-#	USNO Z-#	SAO #	Error in SAO + *O. N.* Reference (Page # of Volume 1)
K02209	Z03535	93842	R.A. 5" in error (page 78)
K03138	Z05476	95263	R.A. now 7" in error (page 130)
K04224	Z07912	97334	Dec. 1' north of true position (pages 53, 64, & 129)

Table 4. Conversions of 1977 K-Catalog Numbers to 1978 K-Catalog Numbers

1977 #	1978 #	
1350	1351	
1351	1350	
1573*	1586	
1574 to 1586	1573 to 1585	(subtract 1 from 1977 number)
1789	1790	
1790	1789	
3560	3561	
3561	3560	
4006	4008	
4007	4009	
4008	4006	
4009*	4007	

*Large error in 1977 version, corrected by using AGK3 data in the 1978 version; see Table 5.

Table 5. AGK3 Proper Motion Errors which have been Corrected by Using AGK2 Data

1978 K-#	AGK3 #	Error at Epoch 1950
K01586	N19° 218	~ 20^m in RA, 5° in Dec
K02486	N28° 454	~ 26^s in R.A.
K04007	N28° 794	~ $0\overset{s}{.}8$ in R.A.

which is much faster than EVANS. A disadvantage of doing this is that source catalog information which is coded in the DM number columns of the regular USNO predictions, and described in information sent to the observers, is lost. Berton Stevens is using a computer very similar to the one at USNO, although with a different operating system. Therefore, it should be possible for him to compute predictions, for IOTA members who want them, with a copy of EVANS, or a modified version (without limb corrections, causing an inaccuracy of a few to many, for nearly grazing cases, seconds), in Chicago.

Initially, I will limit the predictions to the very most active observers, especially those who have reported a number of J or K or unpredicted star occultation observations to me already, and will compute predictions for the Western Hemisphere first, since I need to make some changes to EVANS before correct data can be computed for the lunar eclipse occultations which will be visible from the Eastern Hemisphere during 1978. If you have access to a large telescope and want J and K catalog predictions for 1978, and did not receive any in 1977 or have not received any for 1978 after early February although you did get such predictions for 1977, let me know and somehow we will try to produce the predictions for you. Unfortunately, I put some of the 1977 J and K predictions into the USNO envelopes for the 1978 regular prediction mailing, which was scheduled for early September 1977 but not actually done until December.

Due to the more comprehensive K-catalog, the Q-catalog predictions, like those described on p. 101 of issue # 10, are obsolete. It turned out that the following Q-numbered stars are actually in the SAO and SZ catalogs, and therefore not in K: 20, 23, 25, 48, and 55. Similarly, the J-catalog predictions lessen the need for publishing lists of predictions for G-catalog (galactic-nebular) objects in *O.N.*; in any case, the latter are included in the regular USNO total predictions, unless the center of the cluster is not occulted by the moon (or not close enough for a "GRAZE NEARBY" message).

The clusters and other star fields included in the J-catalog are described in Table 1. Charts for many of these fields, similar to the one on p. 132 for the March 24 lunar eclipse field, will be published in a special issue of *O.N.*, probably about six weeks after this issue. Neither the J nor the K catalog has been cross-referenced with Kukarkin's variable star catalog, but some notable variables are indicated. In the J-catalog, #4 has been specially added. It is V471 Tauri = B.D. +16° 516, an eclipsing binary containing a very hot white dwarf. The variability was discovered by Burt Nelson and Arthur Young at Mt. Laguna Observatory, San Diego State College, California. Although the magnitude range is only 9.6 to 9.9 in the visual, it is much greater in the ultraviolet. It is important for the information it can give about white dwarfs. If the distance is a reasonable 100 parsecs, the expected separation at greatest elongation would be only $0\overset{''}{.}0005$, which unfortunately is at or beyond the capability of being resolved by a good photoelectric occultation record. The other J variables were found by cross-referencing the Hyades and M24 clusters with Kukarkin. J00205 is W Tauri, a semi-regular variable with a 9.1 to 13.0 magnitude range, while J05133 is WZ Sagittarii, a classical Cepheid with range 8.0 to 9.2. Two variables are noted in the K-catalog, by cross-referencing with a list of bright non-SAO stars compiled by G. Kirby in England. K02468 is RV Tauri with a magnitude range of 8.6 to 11.6, while K4242 = AGK3 N22° 942 is the unusual irregular variable U Geminorum, magnitude range 8.2 to 14.9 (usually faint). If you find any of these variables in your predictions, please tell me whether the variable star message appears or not, since we are uncertain whether EVANS will print these messages for anything other than the regular SZ catalog. Volunteers who have access to Kukarkin's or the B.D. catalogs are sought to crossreference these with the J and K catalogs.

Due to a programming error when the AGK3 and SZ catalogs were matched, several SAO stars were included in the original version of the K-catalog. These were identified by Rick Binzel and eliminated from the 1978 version of the catalog used for the 1978 predictions. They are listed in Table 2; if you timed any of them in 1977, you should report them to HMNAO rather than to me, obtaining their SAO and Z (or Z.C.) numbers from the regular USNO predictions. Large errors in the SAO positions of three stars were found by Rick Binzel when he did the checking mentioned above. One was the "Tardy Star" described in an earlier issue; the other two were also noted during occultations. They are listed in Table 3. Since the K-catalog positions are much better for these stars, they have been retained in the catalog, and observations of them should include the K number and be sent to both me and HMNAO. The SAO numbers for these stars will not appear in the K-predictions for 1978, but will be included for 1979. The 1978 version of the K-catalog has been arranged in strictly increasing R.A. order for epoch and equinox 1950. This has meant some changes in numbering from the 1977 version due to errors and small changes due to proper motion, as given in Table 4. If you observed occultations of any of these stars in 1977, please tell me, since the 1977 disk version was erased to make room for the 1978 version. Errors in the AGK3 which were found during the computer test for R.A. order are listed in Table 5. There are a few R.A. order discrepancies in the J-catalog. The largest is only 0ˢ14, small enough that it was decided to preserve the 1977 numbering for the 1978 version of the J-catalog. Only the 1978 versions of the J and K data sets have variable star information.

USNO's support for certain catalog keypunching, for extensive computer time, and for prediction mailing, is gratefully acknowledged. But most of the work has been done on a voluntary basis, by members of IOTA. Since I am not an employee of USNO, most of this work has been accomplished in the evenings and weekends during the past several months. An equally important contribution has been made by David Herald, Woden, Australia, who also on a voluntary basis has computed coordinates for nearly all of the southern-declination stars of the J-catalog (see articles about the Southern Astrographic Catalog Project on pages 113 and 137). Important contributions also have been made by Michael Pine, Wayne Warren, Rick Binzel, Ben Hudgens, and others.

Predictions of lunar occultations of many minor planets brighter than mag. 13 are planned to be included in the regular USNO predictions for 1979. As soon as the programs are working, predictions for the rest of 1978 will be computed for at least photoelectric observers with large telescopes, the only ones capable of observing most of these events, and listed in the following issue of *O.N.*

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.

Much useful IOTA work can be, and is being, done by hardworking volunteers in distant locations. But many relatively small jobs, or ones using Van Flandern's and my specialized programs and data sets at USNO, can only be done practically locally. Local help is sorely needed. IOTA is in no position to give any financial help to volunteers for this work or for travel, but at least we now can provide room in our house for volunteers from distant cities who would be willing to work locally for the cause on a temporary basis.

An asterisk following the SAO number indicates that the duplicity was discovered earlier, but that various parameters have been improved with the recent observations given in the "discoverer" column. Four of these stars were observed by speckle interferometry with the 4-m telescope at Kitt Peak National Observatory (KPNO). Since this gives both separation and position angle, it is generally preferred over even photoelectric occultation data, which, however, yield better component magnitudes (which have been retained for SAO 159683 = β Scorpii CR). It should be noted that there is a 180° ambiguity in speckle interferometer p.a.'s. During the occultation of β Scorpii CE by Io in May 1971, the results of a few photoelectric stations gave a separation of 0ʺ097 in P.A. 308°. I have added 180° to the reported speckle interferometer P.A. for the value given in the list below to more closely match the 1971 P.A. Evidently, there has been significant orbital motion.

SAO 78571 and 165359 were both discovered visually during occultations observed by M. L. L. Vasquez in Valparaiso, Chile, and reported by K. Gayner in *J. Brit. Astr. Ass'n, 83*, 357-361 (1973). SAO 186575 has not been resolved during an occultation, although that should be easy, but it is included in the special list because it is a spectrum binary. The interferometer results were reported on the I.A.U.'s Double Star Commission's Information Circular No. 73 (Nov. 1977).

Frank Fekel obtained spectra of SAO 95166 = Z.C. 913, at the University of Texas at Austin. His data indicate a period for the spectroscopic binary of only 14ᵈ6. This means that the component discovered during occultations must be a third star relatively far from the tight spectroscopic pair; this is indicated in the table. It would seem that the distant star would be bright enough to appear in the spectra, but Fekel can't see it there. In this respect, the star seems to be like two bright stars in Virgo resolved by speckle interferometry, where there is a similar discrepancy with spectroscopic binary data, noted in a previous issue.

The occultation of SAO 118599 was seen as a fade by Ferreira. This could have been due to diffraction rather than duplicity, at a cusp angle of only 27°.

Listed below are K-catalog numbers of non-SAO stars discovered to be double during occultation. The double star codes (column N) will be included in the K-catalog predictions for 1979, but not 1978.

USNO K-No.	B.D. No.	AGK3 No.	N	*O. N.* Ref.
K01879	+19°544A	+19° 275	Y	#8, p. 73
K03058	+23 1147	+23 586	K	#10, p 110*
K03283	+23 1311	+23 650	X	#10, p. 110
K03509	+21 1317	+21 707	X	#10, p. 110
K04689	+13 1961	+12 1060	X	#13, p. 140
K04800	+12 1926	+11 1044	V	#10, p. 110

*Called Anonymous-1 in *O.N.* #10 (1950 $\alpha = 5^h 57^m 52^s$, $\delta = +23° 54'$)

NEW ZODIACAL DOUBLE STARS, 1977 DECEMBER 23

SAO/BD	ZC	M	N	MG1	MAG2	SEP	PA	MAG3	SEP3	PA3	DATE, DISCOVERER, NOTES
78571*	1018	I	V	6.2	6.2	ʺ075	106°				1976.860, H. McAlister, KPNO, AZ
93022	0384	P	V	6.4	6.5	.021	266				1977 Sep 30, J. Africano, McDonald Observatory, TX
95166*	0913	S	L	6.3	6.3	.0014		6.5	ʺ060	76°	Spectroscopic binary data added for close pair
97094		T	K	10.0	10.0	0.2	93				1977 Mar 29, J. Van Nuland, San Jose, CA
118599		T	K	9.5	9.5	0.04	177				1977 June 23, J. Ferreira, Fremont, CA
158293		T	V	9.2	9.6	0.08	172				1977 Aug 20, R. Nolthenius, San Diego, CA
158296		T	V	9.4	9.7	0.04	222				1977 Aug 20, R. Nolthenius, San Diego, CA
159085	2170	P	X	6.9	9.5	.054	339				1977 July 24, J. Africano, McDonald Observatory, TX
159683*	2303	I	V	5.17	7.6	.129	257				1976.450, H. McAlister, KPNO, AZ
159786		P	X	8.4	10.9	.103	238				1977 July 26, G. Kern, McDonald Observatory, TX
159795		T	V	9.5	10.1	0.35	253				1977 July 26, R. Nolthenius, San Diego, CA
159807	2331	T	V	7.0	7.3	0.03	324				1977 July 26, R. Nolthenius, San Diego, CA
160399		P	V	9.2	10.5	.030	302				1977 July 27, G. Kern, McDonald Observatory, TX
160474	2497	T	X	7.8	7.8	1.3	105				1977 Sep 19, R. Laureys, Diepenbeek, Belgium
160757		T	K	10.1	10.1	0.1	90				1977 Oct 17, D. Herald, Canberra, Australia
160940		T	V	9.6	9.6	0.33	122				1977 Aug 24, R. Nolthenius, Alpine, CA
160947		T	V	9.4	9.4	0.11	84				1977 Aug 24, R. Nolthenius, Alpine, CA
161033		T	Y	9.8	9.8	0.4	87	10.8	10.0	288	1977 Oct 17, J. Bourgeois, Montigny le Tilleul, Belgium (close pair)
162183		T	V	9.2	9.2	0.1	94				1977 Oct 18, J. Bourgeois, Montigny le Tilleul, Belgium
162512*	2826	P	X	4.2	6.7	.036	326				1977 Oct 19, S. Welch, Boulder, CO (Observation, not discovery)
162584		P	X	9.6	10.5	.022	234				1977 July 29, G. Kern, McDonald Observatory, TX
165359*	3356	I	V	6.4	6.9	.076	109				1976.859, H. McAlister, KPNO, AZ
186575*	2642	I	V	7.5	8.0	.260	131				1976.454, H. McAlister, KPNO, AZ
+13°1961		G	X	9.3	10.0	0.1	194				1977 Oct 7, R. Nolthenius, Ocean Beach, CA
-12°4008		P	V	9.6	10.2	.022	135				1977 July 24, G. Kern, McDonald Observatory, TX
-17°4581		T	V	10.1	10.1	0.04	102				1977 July 26, R. Nolthenius, San Diego, CA
-18°4305		P	X	9.9	10.4	.020	257				1977 Sep 19, B. Smith, McDonald Observatory, TX
-19°4790		T	V	9.1	9.7	0.41	117				1977 Aug 24, R. Nolthenius, Alpine, CA