Occultation Newsletter

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FROM THE PUBLISHER

For subscription purposes, this is the second issue of 1980.

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. Back issues also are priced at $1/issue. Please see the masthead for the correct ordering address.

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 12.-- to Hans J. Bode, Bartold-Knaust Str. 8, 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, Coyoacán, Mexico, D.F., Mexico.

ERRATA

Noted by Don Stockbauer: *O.N. 2* (7) 69, graze table; the graze on 1979 September 10 was of Z.C. 401, not Z.C. 410; and the graze of SAO 164030 on 1979 October 29 was at Algoa, not Algota.

Noted by David Dunham: *O.N. 2* (7) 61, 2nd column, 7th line of text, name should read Sofia, not Sofio; p. 68, graze table, the Z.C. 3019 graze on 1979 April 20 at Gum Tree should show 9 (#Sta), 54 (#Tm), 8 (CC), 13 (Ap cm), and C5S188-33; p. 71, double star table, method code for SAO 95728 is X; p. 76, column 2, lines 53-4, Kaleakala should read Haleakala.

IOTA NEWS

David W. Dunham

Thomas O'Toole, staff writer for the *Washington Post*, published an article about solar variations, entitled "As the Sun Slowly Shrinks in the West, on page 8 of the March 1st edition of the newspaper. My eclipse work was given prominent coverage and was properly credited, although, unfortunately, IOTA's and USNO's roles for the 1979 eclipse were not mentioned. O'Toole wrote the article largely from telephone conversations with several solar physicists, especially Sabatino Sofia at Goddard Space Flight Center, with whom I am now working part-time on eclipse analysis. The article was distributed via Associated Press by the Los Angeles Times - Washington Post Syndicate, and has appeared in many newspapers across the U.S.A. In Sarasota, FL, it was put at the top of the first page! We have submitted an article to *Science* describing solar radius changes derived from solar eclipses observed from both limits in 1715, 1976, and 1979; it is now being revised to answer questions raised by the referees.

The situation regarding occultation work at the Royal Greenwich Observatory is clarified in Leslie Morrison's article on p. 84. I have received several offers of help, mainly in the form of regional coordinators, which might be utilized by the new institution which eventually assumes the work.

This issue is being published later than anticipated (but within *O.N.'s* long-term schedule) since astrometry by Klemola at Lick Observatory in January indicated that the April 6th occultation by neither Pluto nor perhaps Charon, would be visible from anywhere on the earth's surface, decreasing that event's urgency. In early March, I sent a note about the event to several observers in the nighttime area facing Pluto at the time of the appulse, suggesting astrometric observations or monitoring for secondary events. In my note, I erroneously said that Charon would be south of Pluto, whereas it actually will be north.

Tony Mallama, Greenbelt, MD, used a novel technique to time the December 30th occultation of Aldebaran. He observed the star with one eye and watched the flashing seconds of an LED wristwatch with his other eye. It must be called the eye-eye method. I do not know if it would work very well for a star fainter than Aldebaran.

SOLAR ECLIPSE OF 1980 FEBRUARY 16

David W. Dunham

The U.S. National Science Foundation expedition to India to observe the February 16th total solar eclipse was highly successful. Alan Fiala, USNO; Joan Dunham; and I led groups of observers to obtain Baily's bead timings near Shadnagar, 50 km southeast of Hyderabad and just inside the northern limit; and near Gudipadu, 225 km southeast of Hyderabad and just inside the southern limit. David Herald joined our effort with the help of a small grant from an Australian fund which supports certain amateur scientific endeavors. Our predictions, corrected with the offsets which I derived from the 1979 February 26th path-edge observations, proved to be quite accurate.

Fiala led the northern-limit effort, where three stations were established. Jim Luxton, at the northernmost station, saw the corona, but no totality; one bead remained visible at central eclipse. The duration of totality at Fiala's station was 29 seconds. New Delhi shortwave time signals and Baily's bead events called out by Fiala, who watched the sun's image projected onto a piece of white cardboard, were tape recorded. A super-8 movie camera photographed the screen for 200 seconds centered on central eclipse. The movie was timed by banging two empty tape cassette cases together, the sound being tape recorded. At the third station, David and Ann Herald made visual bead timings from a projected image, and took some 35-mm slides with another scope.

At the southern-limit site, the Dunhams made observations similar to Fiala's, and in addition obtained several 35-mm slides using a Celestron-90. Totality lasted 33 seconds. All observations were successful in spite of a slow-moving cloud which blocked the sun six minutes before second contact (it dissipated three minutes later) and approximately two hundred residents of Gudipadu who watched us. Due to the large mountains at the southern edge of the moon, the movie of Baily's beads obtained near Gudipadu is especially striking.

Five students from East Carolina University, including Luxton, helped with the observations, along with Debra Johnson, George Washington University, and two student interpreters from Osmania University, Hyderabad. The trip was a unique experience. We collected much data, which we are just now beginning to reduce. Hans Bode reports that he used a Celestron-8 to obtain 36 photographs of Baily's beads from a southern-limit site in Kenya. He plans to measure the photographs and analyze the measurements by computer.

CLARIFICATION OF THE SITUATION AT R.G.O.

L. V. Morrison

It already has been reported that beginning with 1981, HM Nautical Almanac Office, RGO, will no longer be able to act as the international centre for the receipt and processing of timings of occultations of stars by the moon. It was agreed at the IAU meeting held in Montreal in August 1979 that 'an organisation with the appropriate experience and commitment to the occultation programme be requested to take over this important work.' HMNAO is at present engaged in finding such an organisation. Until suitable arrangements are made for handing over the work, HMNAO will continue to act as the international centre for the processing of timings of occultations. Observers should continue to send their observations to HMNAO until a notice is issued by this Office directing them to send their observations to some other organisation.

Regarding predictions of occultations, HMNAO will continue to provide the basic data for the predictions of total occultations that are published in various national journals, such as the RAS of Canada. However, HMNAO cannot undertake to produce the graze maps after 1981. It is hoped that the organisation which takes over the collection and processing of the observations will also be able to produce the graze maps.

When HMNAO eventually hands over the occultation programme, it will publish all the total observations received since 1971 on microfiche in the same layout as the data for the years 1943-71 published in RGO Bulletin No. 183. All the graze observations will also be published on microfiche. In this way, all the data will be preserved for analyses by future investigators.

ASTEROIDAL OCCULTATIONS

David W. Dunham

According to the British Astronomical Association's Lunar Section *Circular 15*, 19 (1980 March), D. Hall, Leicester, England, observed the January 24th lunar occultation of Vesta visually, noting that the event was gradual. Jari Hoffrén also timed Vesta's disappearance at Kuopio, Finland, but did not report a fade duration. I have not yet heard whether any high-speed photoelectric records, from which a diameter could be derived, were obtained. See *O.N.* 2 (6) 53 for information about 1980 lunar occultations of minor planets.

Observational comparisons of ephemerides of minor planets computed with osculating orbital elements determined by Paul Herget, Cincinnati Observatory, against those computed from Leningrad elements, were discussed on p. 65 of the last issue. Gordon Taylor has used the Herget ephemerides for minor planets 94, 95, and 747 for star catalog comparisons, confirming that the 1980 events of February 13 (747) and November 29 (95) will not occur, as I noted. He found one new event, the data for which, arranged in the same order as the tables on pages 63 and 64 of the last issue, are as follows: First table: 1980 Nov 2, $6^h 45^m$-55^m, Aurora, 12.4, 2.14, 58367, 8.8, A2, $5^h40\overset{m}{.}1$, 33°33', 3.6, 35^s, 54, 17, Argentina, Chile, 133°, 73°, 21-, e71°W. Second table: 1980 Nov 2, 94 Aurora, 188 km, 0".12, 966, 0.082, 315°, 58367, +33°1129, 0.06, 100, 19, 0.3, S, N33°561, -0".08, $-0\overset{m}{.}6$, $5^h42\overset{m}{.}1$, 33°34'.

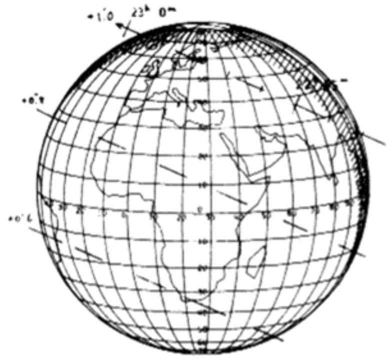
On June 15 U.T. (Saturday night), 11.6-mag. (59) Elpis (mag. 11.6, diam. 170 km) will occult SAO 162018 (V-mag. = 9.3, SP KO, 1950 R.A. $18^h54\overset{m}{.}3$, Declination -10°01') in southern Europe (about 2^h16^m U.T.) and southeast Canada or New England (about 2^h24^m U.T.). A central occultation would last 17^s, with a 2.7-mag. drop. Gordon Taylor plans to have updated predictions on June 13, according to his Bulletin #22.

Derek Wallentinsen's predictions for asteroidal occultations through 1982 are mentioned on p. 64 of the last issue. I stated that they would be published in *Planetary Astronomy*. This is true, but only for the following two months, as published in each issue. The full list probably will be issued as a special publication of the James-Mims Observatory.

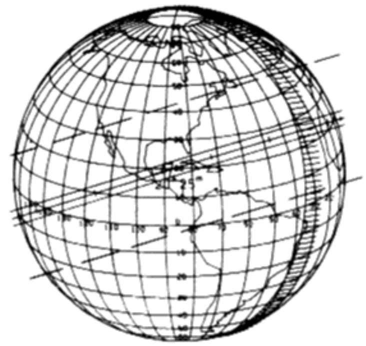
Articles about asteroidal occultations, emphasizing satellites of minor planets and the need for confirmed observations of secondary occultations, have been written by Paul Maley and submitted for publication in various periodicals. The *Griffith Observer* published one of the articles in their March issue, another entitled "Exploring for Satellites of

Minor Planets" recently appeared in *J. Brit. Astron. Assoc.* *90* (1) 30, and *Omni* will publish one in May. → →

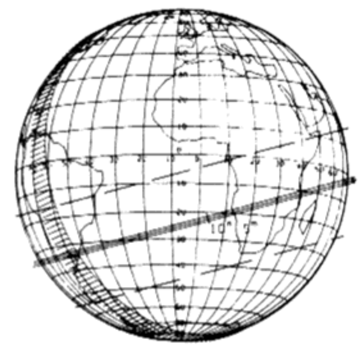
The world maps below were produced by M. Sôma.



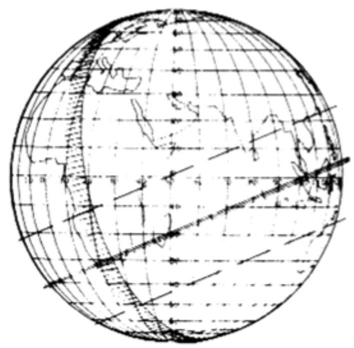
Anonymous by Pluto, 1980 Apr 6



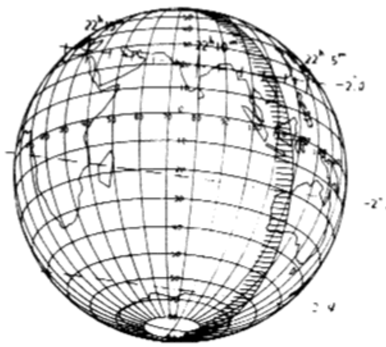
+17°671 by Vesta, 1980 Apr 9



SAO 146599 by Hebe, 1980 Apr 15

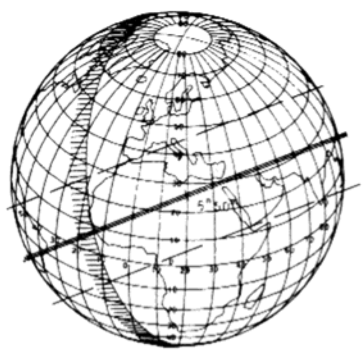


SAO 127441 by Meliboea, '80 Apr 23

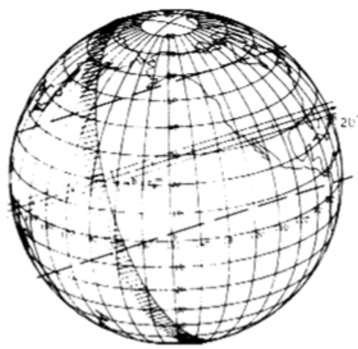


KMU 18 by Neptune, 1980 Apr 24

SAO 75795 by Aurora, 1980 Jun 10

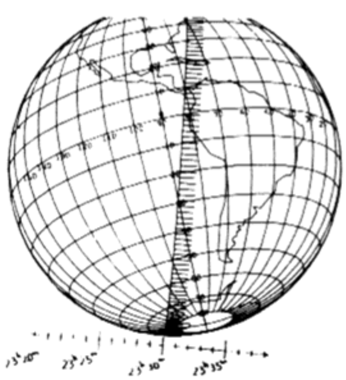


N31°343 by Marianna, 1980 Jul 17

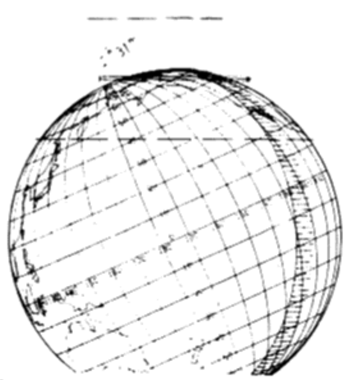


SAO 76043 by Hygiea, 1980 Jul 24

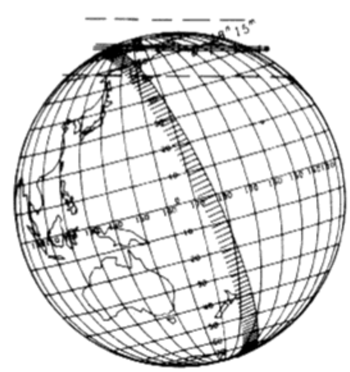
SAO 93855 by Thalia, 1980 Jul 29



KMU 12 by Uranus, 1980 Aug 15



+1°2711 by Parthenope, 1980 Aug 16



SAO 111308 by Hebe, 1980 Aug 27

Paul Maley also is starting to organize for the November 24th occultation by (134) Sophrosyne, which is the most favorable 1980 event for participation by observers throughout North America. He is trying to organize occultation observers and radio hams in cities across the U.S.A. With suitable communication, observational coverage can be optimized during the day before the event, knowing the resources and possible regions which can be covered from each city, and the nationwide weather forecast. Partly because of the large magnitude drops and consequent possibility of large numbers of visual observers, the University of Arizona plans to deploy their mobile photoelectric stations for this occultation and for the one by (78) Diana on September 4th.

In general, the recent observational evidence, some detailed for specific events below, does not favor the idea of satellites of minor planets. Large efforts for the occultations by (3) Juno and by (9) Metis last December 11th have resulted in no satisfactory, let alone confirmed, secondary occultation observations. This is also the case for the smaller efforts which have been made for virtually all of the other recent events. Although I still am convinced of the reality of satellites of minor planets by observations such as those of the (532) Herculina occultation in 1978 June, the evidence seems to be pointing towards the conclusion that asteroidal satellite systems are the exception, rather than the rule. At least, Alan Harris' contention that satellites of asteroids can not be very common, as noted in *Bull. Amer. Astron. Soc. 11*, p. 560 (1979), seems to be confirmed. New information about previously reported events, and observations of recent events, are given below.

(18) Melpomene and SAO 114159, 1978 December 11: I recently learned that D. Haber monitored this appulse with the 36-inch Crossley reflector at Lick Observatory, Mt. Hamilton, CA, using photoelectric recording equipment assembled by John Middleditch. Lick Observatory was directly in line with R. Nolthenius' observing site in Mountainview, CA, where a double dimming was reported; see *O.N. 2* (2) 14. Middleditch examined the Lick record at the time corresponding to Nolthenius' dimmings, and did not confirm them; the counts indicated no drop in the star's light. In the meantime, R. Williamon has published his photoelectric record of a secondary extinction during this appulse in *Astron. J. 85* (2) 174. If the Atlanta extinction were caused by a satellite of Melpomene, the negative observations obtained at the bracketing stations in Monticello, UT and Davis, CA imply that the SAO 114159 component separation is smaller than previously reported, which can only be the case if some of the visual observations of the occultation by the asteroid itself are in error, which is possible.

(51) Nemausa and SAO 144417, 1979 August 17: In his Bulletin 20, Gordon Taylor reports that this occultation was recorded photoelectrically at Dushanbe, Tadzhikstan, USSR, giving a chord length of 120 km, which compares favorably with Nemausa's expected 151-km diameter. No other observations of the occultation of the 8.8-mag. star were obtained. The time for Nemausa's edge to cover SAO 144417 would have been almost ten times less than the corresponding time for the occultation by Cybele on October 17, explaining some of Latifi's remarks on p. 74 of the last issue.

(65) Cybele and B.D. +19°1399, 1979 October 17: A translation of a *Pravda* article about this event appeared on p. 74 of the last issue. More information is given in *I.A.U. Circular* No. 3439, based on a report sent by O. V. Dobrovol'skij, Institute of Astrophysics, Dushanbe. A typographical error in *Pravda* caused the misunderstanding about the distance of the claimed satellite from Cybele in the plane of the sky. The observation was made visually at Ura-Tyube by V. Rakhimov and O. Najmov. The distance of the satellite from Cybele would have been 917 km, if the occultation were central. The observations indicate that Cybele has an irregular shape, with the greatest observed chord being 245 km at the Shakristan Pass. The only photoelectric record was obtained at Gissar Observatory, Dushanbe, by N. N. Kiselev, N. V. Narizhnaya, and G. P. Chernova using a 0.7-m reflector. The partial phase they observed had a mean duration of $0^s\!.32 \pm 0^s\!.2$, implying a stellar angular diameter of $0''\!.0007 \pm 0''\!.0004$.

(27) Euterpe and SAO 77426, 1979 December 8: As noted in the last issue, preliminary astrometry by Penhallow indicated that the occultation path would cross central Finland. In a letter received March 28th, Matti Suhonen reports that he and Juhani Salmi, observing from sites about 15 km apart, near Lahti, Finland, observed a dimming of the star (the expected magnitude drop was 0.9) at times which differ by 7 seconds from what would have been expected had they been caused by an object with Euterpe's motion; the observers' paths were only 4 km apart on the fundamental plane. Some dimmings also were reported by two observers in Turku, but the times are discordant. Other observers at Tampere and in the Helsinki area, including a photoelectric record at Metsähovi Observatory, reported no dimmings.

(9) Metis and SAO 80950, 1979 December 11: Paul Maley's historic photograph of this occultation was published on p. 261 of the March issue of *Sky and Telescope*. Bright moonlight and atmospheric humidity reduced contrast; test exposures taken with a dark sky in Texas several days before the event gave better results. Near the end of the article, a secondary occultation observation at Barquisimeto, Venezuela, is reported. The 13½-second event was timed by Pablo Chiossone, Juana Ines Chiossone, and Nelson Falcon Veloz. Based on this report, I sent a notice to several observatories suggesting direct observations to detect a possible satellite of Metis, noting that Metis would reach opposition on February 5. Cloudy skies and poor seeing prevented such observations from USNO until late January, when a negative observation ("round image") was obtained under good conditions by Charles Worley using the 26-inch refractor. In early February, a letter was received from Jack McConnell at Merida, noting that no occultation was observed at Merida or at Caracas (this would be expected, since Merida and Caracas, the closest stations reporting observations, were 57 and 62 km, respectively, from the Barquisimeto path; the Barquisimeto occultation chord was 64.6 km, so if it was a central chord for a spherical satellite, the radius would be 32 km, much less than the above-noted miss distances). On December 11, he observed with the 26-inch refractor at Merida, using a magnification of 640×, and saw no elongation of Metis' image; the seeing was fair. He further reports, "Due to the partial cloudiness at the Barquisimeto site and to the inexperience of the observers, Stock and I are strongly inclined to discount their obser-

vation. They also took a photograph which purportedly shows the occultation . . . it was of poor quality and showed four or five star trails all of which show the same brightness fluctuation." *Note added March 20:* Paul Maley has recently received a letter from Juana Ines Chiossone, noting that a local postal strike prevented an earlier reply to his letter asking for more information. She was confident that they saw an occultation, noting that the images were steady and that both disappearance and reappearance were instantaneous, while the brightness of other stars in the field of view did not change. They could see Metis before and after it merged with SAO 80950, and during the occultation. Duplicity of the star can not explain the observation, since both the occultation at Barquisimeto and at Georgetown were deep, whereas if Metis were single and the star double, the magnitude drop for one of the events would have been 0.7 or less.

(3) Juno and SAO 115946, 1979 December 11: A good account of the Lowell Observatory's and Massachusetts Institute of Technology's successful efforts to record this occultation with several portable photoelectric telescopes, by Edward Dunham *et al.*, is given on pp. 276-278 of the 1980 April issue of *Sky and Telescope*. However, I take exception to their statement that "timing errors should be much less than 0.1 second." In general, the smallest possible timing error is desired. A $0^s.1$ accuracy was not achieved by some of the other photoelectric observations of the Juno event. We know from Voyager images of Amalthea and from the (18) Melpomene occultation in 1978 December that irregularities on asteroid-sized objects can amount to nearly 10% of the diameter, so a timing accuracy of 2% of the expected central occultation duration is considerably smaller than errors introduced by possible irregularities, and hence, useful. Therefore, good visual timings are quite useful for occultations expected to last 10 seconds or more, and considering the paucity of asteroid occultation observations, visual timings of shorter-duration events also can be of value. This Juno occultation lasted 68^s at central stations, so that even an accuracy of ± $0^s.7$ in timing was ± 1% of the diameter. Also, although it may be true that the relatively large effort needed to deploy portable photoelectric telescopes is not justified for some occultations, this is not the case for visual observers, who can deploy in greater numbers with less effort (in some areas, the density of visual observers is great enough that adequate coverage can be provided by observing from home locations). With only a ½-mag. drop, this Juno occultation was not very well-suited for visual observation, although a few visual timings were obtained by a couple of experienced occultation observers.

The *Sky and Telescope* article did not mention several other groups which observed the occultation; most of them noted on p. 79 of the last issue. Apparently, a copy of galley proofs for the article was received rather late at Lowell Observatory, where several corrections were hurriedly made, but too late to be included in the published article. *Sky and Telescope* plans to publish more about the event in their June issue, which should correct most of the omissions and errors.

(48) Doris and SAO 94441, 1980 January 4: Astrometric observations by Klemola and Taylor indicated a path at about 0".95 north on my maps on p. 78 of the last issue, so that the occultation probably occurred in the vicinity of James Bay, Labrador, Scotland, Denmark, northern Poland, and the northern Ukraine. Most observers were clouded out, but a few who were not, in Montreal, England, and the German Democratic Republic, reported no occultation.

(451) Patientia and SAO 110282, January 14: Astrometry by Penhallow showed that this occultation path shifted 2" west, off the earth's surface.

Enceladus and B.D. +4°2534, January 26: I do not know of any astrometric improvement of this prediction. William Hubbard reports that no events were seen during photoelectric monitoring at Tucson, AZ.

(41) Daphne and B.D. -1°2190, January 28: Astrometry by Penhallow indicated an approximately 1".0 south shift, so that the occultation might have occurred in Hawaii and near Rio de Janeiro, which were notified about a day before the event. Michael Gaffey reports that no occultation occurred in a photoelectric record obtained with the 2.24-m University of Hawaii reflector at Mauna Kea. Jorge Polman reports that it rained in Rio de Janeiro.

(129) Antigone and 7 Leonis, January 29: Astrometry by Penhallow roughly confirmed the AGK3 prediction (path over China and south of Japan) and was relayed to Taylor. No reports have been received.

Neptune and KLM 17, February 10: Astrometry by Klemola showed that no occultation would occur, the minimum separation being 1".5 ± 0".1. James Elliot attempted observation from Mauna Kea, although the possibility was small that an occultation by a distant ring of the planet would occur there.

(11) Parthenope and SAO 118954, February 26: Herald reports that Mike Ashley's Mt. Stromlo Observatory astrometry for this event showed a 2" south shift, off the earth's surface. Most of southern Australia was apparently clouded out at the critical time.

(85) Io and SAO 137555, March 10: Preliminary (separate plate) astrometry by Penhallow on March 4 indicated a 0".9 north path over Florida and South Africa, where observers were alerted. On March 7, Penhallow was able to obtain only one last-minute (one plate with both objects) exposure, which indicated a 0".3 south shift across Colombia and Brazil. No occultation of the 8.8-mag. star occurred in the Washington, DC area. Unfortunately, the faint asteroid, 24° above the horizon, also was not seen, so we could not tell which of Penhallow's astrometric results was correct. I have received no reports from other areas; the weather apparently was less favorable in Florida and Georgia.

(21) Lutetia and SAO 139513, March 26: Astrometry by Penhallow on March 24 indicated that the path would be about 0".7 south, entirely within the Pacific Ocean passing near no islands with observatories.

GRAZES REPORTED TO IOTA

David W. Dunham

The table lists successful, or partly successful, expeditions for grazing occultations, reports of which have been received since the list on pages 68 - 69 of the last issue was prepared. The format of the list was published in *O.N.* 2 (3), 27.

Mo	Dy	Star Number	Mag	% Snl	CA	Location	# Sta	# Tm	C C	Ap cm		St	WA	b
1976														
7	24	095127	7.6	8-	3S	Cocoa, FL	2	12		15	Harold Povenmire		177	55
1977														
3	12	160289	7.8	54-		Pentelli, Greece	1	3		63	Demetrius Elias			
1978														
10	28	1663	5.2	14-		Coimbra, Portugal	6	14		6	Jose Osorio			
1979														
1	04	0004	6.3	39+	N	Tonda, Japan	4	4	8	6	Jiichi Nakamura		3	15
1	19	1818	7.9	66-	S	Yamato, Japan	1	2		15	Hitoshi Ogata		185	-19
2	02	0219	5.1	34+	N	Izumi, Japan	5	25	6	8	Haruhiko Ono		3	42
4	01	0635	3.9	22+	S	Sendai, Japan	8	33	7	5	Haruhiko Ono		184	
4	10	1712	3.8	96+	N	Sendai, Japan	8	13	7	6	Haruhiko Ono		2	-7
4	10	1712	3.8	96+	N	Tsuruoka, Japan	2	3	7	6	Isao Sato		2	-7
4	18	2774	6.3	62-	S	Watari, Japan	7	9	8	6	Haruhiko Ono		188	-51
6	15	3196	6.1	73-		Pentelli, Greece	1	4		63	Demetrius Elias			
9	16	097439	7.9	21-	7N	Lion's Head, Ont.	1		8	15	Douglas Cunningham	S	349	50
10	09	0667	5.3	82-	N	Kanazu, Japan	7	21	8	6	Yasuo Yabu		352	72
10	09	0667	5.3	82-	N	Ohyama, Japan	6	23		6	Sasakura		352	72
10	27	2825	6.4	38+	S	Unoke, Japan	5	16		6	Hidekazu Yokomizo		177	-42
10	27	2825	6.4	38+	S	Furukawa, Japan	8	32			Haruhiko Ono		177	-42
10	28	163175	8.5	45+	2S	Hacienda Hgts.,CA	1	12		15	Richard Nolthenius			-33
11	25	163768	7.1	29+	-2N	Chesley, Ontario	2	3	7	20	Douglas Cunningham		359	-22
12	10	1531	5.9	61-	3N	Plato Center, IL	4	11	8	20	Homer DaBoll	3N	355	1
12	13	1875	6.5	29-	S	Noda, Japan	8	37	6	5	Toshio Hirose		182	-42
12	23	3134	6.9	17+	-3N	Los Alamitos, CA	3	5	4	15	Richard Nolthenius	0	359	-9
12	27	109653	7.0	59+	7S	Aransas Pass, TX	1	5	7	15	Don Stockbauer	1S	174	50
12	30	0692	1.1	93+	N	Bridgeport, MI	1	1		15	David Harrington	S		
12	30	0692	1.1	93+	3N	Wiarton, Ontario	6	34	8	15	Douglas Cunningham	S	353	73
1980														
1	12	158835	7.1	31-	6S	Willow Street, PA	1	1	6	25	David Dunham		190	-51
1	13	2245	6.4	22-	6S	Dammier, TX	1	2	7	25	Don Stockbauer	8S	190	-64
1	22	0036	7.2	26+	S	Kyoto, Japan	4	12	6	15	Fumio Matsui		162	40
1	22	0036	7.2	27+	S	Yokohama, Japan	5	10	7	6	Toshio Hirose		158	40
1	24	110085	8.2	43+	6S	Peculiar, MO	2	17	7	15	Robert Sandy	0	175	61
1	25	0405	4.4	56+	2S	Olancha, CA	2	3		20	Richard Lasher			
1	26	0508	4.3	66+	1S	Halifax, N.S.	1	2		13	Michael Boschat		178	72
2	21	110502	8.3	28+	3S	Cross Roads, TX	1	5	8	25	Don Stockbauer	4N	180	65
2	21	0405	4.4	33+	S	Koza, Japan	3	11	7	8	Noboru Shibuta		182	68
2	22	0479	8.3	39+	2S	Bay City, TX	1	5	7	25	Don Stockbauer	3S	177	69
3	04	1821	2.9	95-	13S	Rion, SC	3	30	7	20	David Dunham	5S	186	-41
3	10	160716	8.5	46-	10S	Largo, MD	2	5	2	20	David Dunham		190	-55
3	21	0692	1.1	33+	N	Slöinge, Sweden	1	4		6	N. P. Wieth-Knudsen	N		

During the graze of Aldebaran (Z.C. 692) at Bridgeport, MI, on 1979 December 30, the star did not disappear, but one 3-second dimming to approximately 2nd magnitude was timed by three observers at the site. Conditions were excellent. Geographical coordinates were not supplied, so we can not see how their observations fit in with two other large expeditions for this graze. Four of the IOTA officers were in the expedition at Lockport, IL, where half of the observers had a miss, including three of the IOTA officers. Jay Gunter published the following report from Douglas Cunningham, Lion's Head, Ontario, in his *Tonight's Asteroids*, Bulletin No. 52: "We set up 18 stations over a distance of 1.5 miles. Can you believe that 13 stations recorded a miss in a cloudless sky?! My station was one of the lucky ones. Aldebaran literally [sic] danced through the northern lunar mountains. [I] recorded 13 events - - - blinks, flashes, ons, offs, and dimmings. It was simply splendid! We are presently preparing a report for *Sky and Telescope*. After over three years of chasing grazes and experiencing cloudy skies most of the time, we were at last rewarded. I still haven't lost my excitement over the incredible spectacle!" The shift amounted to about 0".5 south over what was expected based on the ACLPPP version 78A profile, according to analysis of the Lockport observations. A more careful analysis of last September's Aldebaran graze at China Lake, CA, where the geometry was similar (position angle of graze within one degree) showed a similar-sized south shift, as have other grazes of Hyades stars and nearby stars with good positions. It appears that the +0".08 × latitude libration empirical correction which we have been applying to high-latitude-libration northern-limit grazes is no longer valid. For these events, and especially for grazes of Aldebaran at the north limb, the observing range should be shifted south by 0".5 (usually about 0.7 mile) from what you would expect from the 78A version ACLPPP profiles. Recent comparisons by Robert Sandy show that USNO's version 80B runs a few tenths of an arc second south of version 78A under these conditions.

Michael Boschat, who is restricted to observation from his home location, saw only a ten-second occultation of Z.C. 508 (5 Tauri) on January 26. Both events were gradual, apparently diffraction effects perhaps enhanced by the star's duplicity, known from spectra. A graze of 5 Tauri was the first ever observed with a transported telescope. Lenard Kalish observed it near Castaic Junction, CA, in 1962 September; that graze was on the bright limb.

On March 3, I flew to Columbia, SC, where I met John Safko, Bob Ariail, and other local observers to try to observe a graze of the bright double star Z.C. 1821 = γ Virginis = Porrima about 40 km north of the city. The day before, an unusual storm had coated the area with ice, then about 12 cm of snow. In North Carolina, about 80 cm of snow had fallen, hindering ground transportation from the north. But for the graze, the sky was beautifully clear, the seeing was good, there was no wind, and it wasn't even very cold. We established four stations across the graze path, but timing equipment problems prevented useful data being obtained at the northern station. Safko, at the southern station, had a short occultation of the primary (following) component, but no occultation of the secondary star. At my station, the secondary disappeared twice while there were four occultations of the primary. Since the components were of equal brightness, I thought that it would be difficult to distinguish them, the difference in graze heights being only 0″.2. But with a separation of 3″.9 and the good conditions, it was fairly easy to tell which star was involved for each event. In addition, it appeared that the graze heights of the components differed by more than 0″.2. The difference seemed quite noticeable visually during the graze, but perhaps that was because the graze was on the dark limb of a highly gibbous moon with the nearby terminator increasing its distance from the actual (invisible) edge away from the cusp. If the difference in graze heights was greater than 0″.2, which we will be able to tell from a detailed analysis of the observations, the relative component position angle must have been somewhat smaller than the predicted value of 297°. We had set up our observers about 0″.5 south of the optimum range estimated from the version 78A ACLPPP profile, since it was a southern-limit waning Cassini graze like the ones discussed on p. 69 of the last issue. Our stations turned out to be very well-placed, showing that the expected south shift did occur, and will likely continue to occur for grazes under these conditions. Exactly a month after this graze, on April 4, South Carolinians will have a chance to observe a graze of γ Librae, but on May 4, there is no graze of γ Scorpii.

In late March, a new computer is scheduled to be installed at USNO, and the old machine will be taken away. When that happens, the 78A version, which we have been using for all of our profile calculations, no longer will be available, and it will be necessary to use the current (80B) version. The two versions are known to produce different graze heights, which will affect the profile calculations for graze predictions during the second half of 1980 for most observers. Unfortunately, ACLPPP applies empirical corrections which assume the 78A version. Robert Sandy is studying the version differences for many predicted and observed grazes. In the next issue, we might recommend corrections which should be applied to the ACLPPP profiles when 80B is used, and later the corrections will be built into ACLPPP.

Graze observers are reminded that grazes which occur with latitude librations within 1° of 0° have special value for improving limb correction data for the analysis of total solar eclipse observations used for studying variations in the solar radius. Z.C. 1847 = α Leonis = Regulus is the brightest star in this zone, and it is being occulted currently. Since Baily's beads are observed some distance away from graze areas, timings of total occultations, especially ones relatively close to grazing, are also useful for latitude librations between -1° and +1°.

TIMING SOLAR ECLIPSE CONTACTS - III

William J. Westbrooke

A discussion of mine regarding the timing of solar eclipse contacts published in *O.N. 2* (5) 50 mentions that large errors may have been produced in some way or another by the unsteady solar projection screen I used in October 1977. This suspicion was found to be correct. A simple way to make chord measurements on an unsteady projection screen is to fasten a sheet of millimeter graph paper to it; measurements can then be read with ease. Measurement of the solar diameter both with graph paper and with a ruler laid on the screen showed that the solar diameter was always 2 mm larger when measured with the ruler, probably due to two things: a) it is not possible to hold the screen perfectly steady, nor b) is it possible to concentrate on both ends of the ruler at once.

My results for the 1977 eclipse were reanalyzed with 2 mm being subtracted from all chords. However, perusal of a graph of the new results indicated that an additional 2 mm had to be subtracted from the first twelve chords. When this was done, these results were obtained:

	Predicted	Observed
First Contact	$18^h 49^m 51^s.7$ UT	$18^h 49^m 46^s.7$ UT
Maximum Eclipse	20 01 54.7	20 02 22.1
Last Contact	21 14 45.2 UT	21 15 01.1 UT.

It can be seen that the new results for the two contacts are in good agreement with prediction, though it is not clear why the time for maximum eclipse (mid-eclipse) is so far off.

ON THE ACCURACY OF THE EYE-AND-EAR TIMING METHOD

M. Hammerton and D. D. Stretch

Summary. An experiment is described which simulated the timing of occultations using the method of estimating times within one-second ticks of a clock. It is shown that the accuracy achievable with this method is remarkably good (r.m.s. errors < 100 ms.); and it is suggested that, subject to certain precautions, it is to be preferred to stop-watch methods for human observers.

Introduction. Numerous problems in astronomy require for their solutions the data from the timing of occultations, especially lunar occultations, made over long periods by many observers.[1] Until very recently and even now most of these timings were made using one of two procedures. In one, the observer starts a stopwatch as nearly as he can in time with an accurate clock at some pre-determined instant a few minutes before the occultation is expected, and stops it as promptly as he can as soon as the star disappears. Since the starting of the stopwatch involves a cued reaction time, we would expect it to be liable to errors of ca. 50 ms; and since the stopping is essentially a response to a random event, we would expect a delay of ca. 200-250 ms,[2] giving, for a good observer with quick responses, an overall error of 150-300 ms.

The other procedure is quite different, more interesting, and subject to errors which are not easily predicted.

Knowing to within ± 5 sec. when the occultation is expected, the observer, starting at some pre-determined instant a few seconds before the earliest possible occurrence of the event, counts the 1-second ticks of an accurate clock, whilst watching the star whose disappearance is to be timed. When it duly vanishes, he then estimates the time, within the counted second interval, at which it does so. It is important to realise that what we have here is *not* a question of reaction time at all: it is a question of how precisely a human being can *estimate* the time of a visual stimulus within a stream of auditory stimuli. So far as the writers are aware, this is not a matter whose answer is to be found in the literature of experimental psychology. [Ed: M. Hammerton is a professor in the Dept. of Psychology of the University of Newcastle upon Tyne.]

Astronomers approached by one of the authors (MH) gave estimates of the probable errors of such estimates as 100 ms (L. Morrison, personal communication) and 400 ms (T. Van Flandern, personal communication). The only experimental approach we have found will be used by the authors as a grisly warning to their first-year students of how not to conduct and report a study in human performance. (Charity forbids us to name it here, although scholarship requires that we cite it in the references.) It appeared, then, that the nature, magnitude, and variability of the errors to be expected when using this second procedure are essentially unknown, are of importance, and constituted a suitable subject for an experimental enquiry.

Method. The subjects were 45 second-year psychology students at this university. The apparatus was devised to simulate telescopic observation of a series of occultation events. Subjects looked into the eyepiece at one end of a blackened tube 35 cm long by 18 cm in diameter. The other end of the tube was blanked off and had, mounted in the centre, a small bulb such that, when alight, it appeared to be a starlike point of light.

A tape had been prepared, using a microcomputer, to present a sequence of trials to the subject. On one track were the signals used, with electronoic switching gear, to turn the 'star' on and off; on the other were the sounds which the subjects heard through headphones. These were one-second ticks of a simulated clock, and a warning tone. A single complete trial comprised:

(i) 10 seconds of ticks with no 'star'
(ii) 5 seconds of ticks with the 'star'
(iii) 1 second of warning tone. When this tone ended, the subject was to expect
(iv) 10 seconds of ticks during which the 'star' would vanish after a time determined pseudorandomly from a Gaussian distribution with a mean of 5 seconds, a standard deviation of 2 seconds and arbitrary bounds of 0 and 10 sec.

During the 15 seconds comprising stages (i) and (ii) of the next trial, the subject would state his estimate of the time of 'occultation' to the nearest tenth of a second, from the end of the warning tone.

Each subject received 5 practice trials, after which, when he was ready, the tape was restarted and he carried out 50 experimental trials. Save for the pause between the practice and the experimental trials, there was no break in the ticks. At the start of both the practice trials and of the experimental trials there was an additional block of 20 ticks to help the subject get into the rhythm.

Data presented here are thus based on 50 trials from each of 45 subjects.

Results. It was strikingly apparent from the data that the magnitude and direction of errors were a function of the time between ticks at which the event occurred, but not of the whole number of seconds since the warning. Therefore, results are presented in terms of errors at particular Class Frequency Numbers (CFN's on the figures) thus: if N is an integer between 0 and 9, then any occultation occurring at a time t where N.00 ≤ t < N.10 has the CFN of 0; if N.10 ≤ t < N.20 the corresponding CFN is 1, and so on. If a subject estimated the event to occur later than in fact it did, his error was accounted negative, if earlier, positive.

The overall pattern of means and S.D.'s of errors within the inter-tick 1-second intervals is shown in Figure 1.

The overall pattern of variance of errors is shown in Fig. 2, which presents the mean of individual

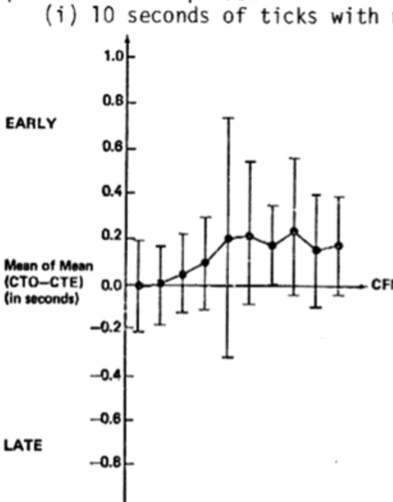


Fig. 1

Graph showing overall relationship between mean (CTO-CTE) and CFN. This gives the mean of the individual subject means with the standard deviation of the 45 means marked in.

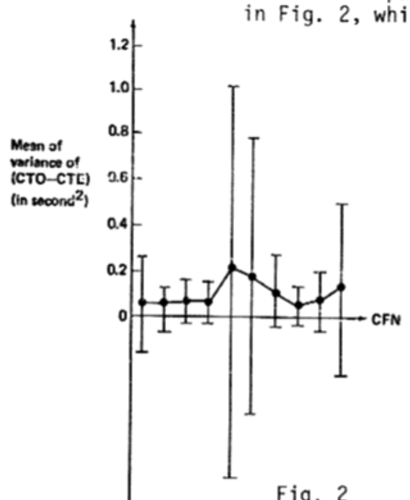


Fig. 2

Graph showing overall relationship between variance of (CTO-CTE) and CFN. This gives the mean of the subject variances with the standard deviation of these marked in.

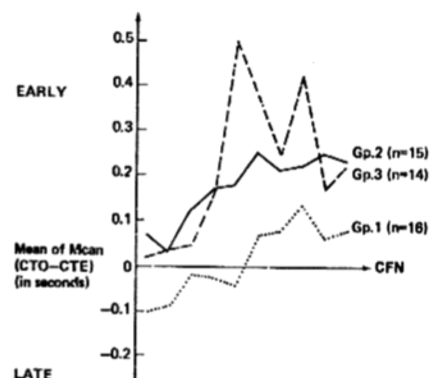


Fig. 3

Graph showing overall relationship between mean (CTO-CTE) and CFN for the three derived groups. The means of individual subject means are plotted.

subject variances and the S.D.'s thereof at each C.F.N.

It is evident upon inspection of these figures that estimates of time become steadily earlier during each inter-tick interval. It also appeared that the relations between mean variance and skew of error were markedly subject-dependent. These findings, together with the fact that the sequence of auditory and visual stimulus was sometimes reversed when they were close together, are of considerable psychological interest; and a detailed analysis is being prepared by the authors. For the present, however, it was of interest to see whether distinct groups of subjects could be isolated; so a dissimilarity matrix was prepared and a single-link nearest-neighbor cluster analysis was carried out.[3]

Two very clear groups emerged, leaving a remainder of 14 subjects who were classed as an artificial group 3. The mean patterns of errors for these three groups are shown in Fig. 3. Standard deviations are not shown in this figure; but they were small for groups 1 and 2.

It is evident that groups 1 and 2 show the same *pattern* of error, but that group 1 (the 'good observers') produced errors of consistently smaller absolute magnitude. The only consistent patterns in the variances are that they are smallest at C.F.N. 9 and largest at C.F.N. 0 for group 1, whilst group 2 reverses these relations, and that both groups have a very small variance at C.F.N. 4 — which may indicate a sort of mid-interval anchor point. Group mean variances and skewness are shown in Table 1.

Table 1

	CFN	Group 1	Group 2	Group 3
	0	0.109	0.023	0.046
	1	0.042	0.056	0.081
	2	0.038	0.052	0.094
	3	0.059	0.069	0.067
Mean	4	0.019	0.016	0.699
	5	0.050	0.094	0.438
	6	0.042	0.054	0.257
Variance	7	0.040	0.034	0.096
	8	0.043	0.070	0.118
	9	0.028	0.115	0.304
	0	-0.059	-0.002	-0.006
	1	-0.007	-0.009	-0.003
	2	0.004	0.003	0.043
	3	0.031	-0.006	-0.005
Mean	4	0	0	0
	5	-0.004	0.003	0.766
	6	0.004	-0.008	0.189
Skew	7	0	0.002	0.018
	8	0.005	0.005	-0.036
	9	0.015	0.061	0.696

Discussion and Conclusions. The experiment described sought to simulate the general aspect and characteristics of an occultation observation by the estimation method. The main difference was that real observations are not massed; and it might be expected that this would make the present subjects somewhat more consistent (not more accurate) than actual observers: both alike had no knowledge of their own accuracy. Accepting this proviso, two strong conclusions emerge: the method is very accurate, given good observers, and a class of genuine 'good observers' emerges from the data.

A glance at Fig. 3 shows that the claim for an accuracy within 100 ms is justified for group 1: the group R.M.S. error = 77 ms, which is very good indeed. Further, the cluster analysis shows that this group is of genuinely superior estimators, who are both more accurate and more consistent than the common run.

Two caveats must be entered at this point. First, it is not evident how to decide in advance whether a given person is in the group of good observers. There is not the slightest reason to suppose that mere reaction time has anything to do with it; and, in order to be sure it might be necessary to set up a repeatable simulation of the kind described here. (The authors are examining possible predictors of performance.) Secondly, the 'star' used in the experiment, though faint, was well above threshold. In the case of very faint stars, on the edge of visibility, signal detection theory[4] becomes central and the quantity β, which is a function of the personality or 'cautiousness' of the individual observer, becomes important. No attempt has been made here to investigate this.

With these provisos in mind, however, the accuracy and consistency of good observers remain impressive. Certainly, they are superior to anything which could be expected using the stop-watch procedure. Therefore we recommend that this old-fashioned method be continued, or resumed where it has been abandoned, as long as reliance has to be made upon human observers.

References.

1. Morrison, L. V., An analysis of lunar occultations in the years 1943-1974 etc., *M. N. Roy. Astron. Soc. 187* (1979), 41-82.
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3. Everitt, B., *Cluster Analysis* (London: Heinemann, 1974).
4. Welford, A. J., *Fundamentals of skill*. (London: Methuen, 1968).
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[Ed: While we do not contest the validity of the final paragraph of the conclusion, we feel that this kind of comparison is unfair unless the Gordon Taylor stopwatch method is used and unless personal equation is applied. A study of Gordon Taylor's stopwatch method similar to this study would be useful for comparison; presumably, use of a stopwatch would be independent of CFN. We would welcome submission of such an article. Gordon Taylor described his method in a chapter of *Practical Amateur Astronomy*, a book published ca. 1963. The description also has appeared in N.A.O. Technical Note No. 5, and in in D. W. Dunham's 1964 paper OGO-III.]

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 columns and general format were described on p. 3 of *O.N. 2* (1).

Two more bright Hyades stars, whose close duplicity was previously known only from spectra, apparently have been resolved during recent visual occultation observations. The observation of SAO 93932 = Z.C. 661 = 71 Tauri was reported in the British Astronomical Association's Lunar *Section Circular 15*, 19 (1980 March). Robert Hays, who was the first to report the occultation resolution of θ^1 Tauri, now has done the same for SAO 93957 = Z.C. 671 = θ^2 Tauri! In each case, near-grazing conditions were needed in order to prolong the duration between component events enough so that they were noticeable visually. On January 27, he did not notice the secondary of θ^1 Tauri, whose occultation was nearly central.

Most of the new stars in our list are non-SAO spectrum binaries included in Paul Schmidtke's article in *P.A.S.P. 91* (543), 674. They are listed simply as "PASP" under the date, discoverer columns of the table. The SAO stars from his article were listed on p. 72 of the last issue, where predictions for three occultations of non-SAO stars were given. The occultation on April 20 is of HDE 257897 = J02784 = B.D. +19° 1363. Four of the stars in Schmidtke's list, the last ones in the table, are in neither the SAO nor B.D. catalog, and are identified only by HD (Henry Draper spectroscopic catalog) numbers. Actually, the HD numbers greater than 200,000 are from the HDE (Henry Draper extension). Most of the non-SAO stars in Schmidtke's article are identified only by HD numbers, so I have given these in my list. The two stars in the B.D. +28° zone are not in the HD. Equinox 1950 coordinates are given for all of these stars in Schmidtke's table.

Orbital elements have been derived by Baize for the first three entries in my list, as reported in the I.A.U. Double Star Commission's *Circulaire d'Information* No. 79 (1979 October) and No. 80 (1980 February). The value given in the separation column is actually the apparent semi-major axis of the visual orbit. An improved orbit, using data through 1977.13, is also given for SAO 98678 = ADS 7460. The two non-SAO stars discovered by Couteau in 1970 were first noted in *O.N.* in the last issue based on photoelectric occultation observations by D. Evans at McDonald Observatory, TX. All of Couteau's visually discovered SAO doubles are included in my lists, but not his non-SAO discoveries.

Paul McBride has supplied information for four of the stars which were listed on p. 71 of the last issue without date and discoverer data, which I had misplaced (and still haven't found) for several of the stars. The complete information for these stars is given in the list below.

NEW DOUBLE STARS, 1980 MARCH 18

SAO/BD	ZC	M	N	MAG1	MAG2	SEP	PA	MAG3	SEP3	PA3	DATE, DISCOVERER, NOTES	
78705*		V	0	8.9	9.4	0″32					Orbit by Baize, last observation 1975.18	ADS 5408
92207*		V	0	8.3	8.8	0.55					Orbit by Baize, last observation 1974.91	ADS 828
93031*		V	0	8.9	8.9	.194					Orbit by Baize, last observation 1969.00	ADS 1993
93932*	0661	T	V	4.8	6.8	0.1	90°				1979, M. Price, Camberley, England	
93957*	0671	T	V	3.8	6.0	0.03	149				1980 Jan 27, R. Hays, Worth, IL	
94424*		T	K	9.7	9.7	0.1	140				1979 Mar 6, P. McBride, Green Forest, AR	
94903*		T	K	9.3	9.3	0.1	70				1979 Apr 3, P. McBride, Green Forest, AR	
97348*	1190	T	Y	7.9	7.9	0.03	158	11.1	15″9	20°	1979 May 2, D. Büttner, Karl-Marx-Stadt, DDR	ADS 6440
99136	1531	G	Y	6.7	6.7	0.02	18	10.9	33.6	132	1979 Dec 10, J. Phelps, Plato Center, IL	ADS 7781
109613		T	X	8.8	8.8	0.03	27				1979 Dec 27, H. Povenmire, Bradenton, FL	
110164		T	X	9.0	9.5	1.0	10				1980 Jan 24, J. Van Nuland, San Jose, CA	
118171*	1497	T	X	8.8	8.8	0.1	80				1979 Mar 12, P. McBride, Green Forest, AR	
128607	0015	T	K	7.8	8.3	0.1	90				1979 Nov 28, D. Hall, Leicester, England	
146344*		T	X	8.6	8.6	0.25	70				1979 Jan 3, P. McBride, Green Forest, AR	
160980		T	K	8.4	8.4	0.05	60				1979 Oct 26, H. Povenmire, Bradenton, FL	
+29°1118		S	V	10.8	10.8	0.05					PASP = HD 251913	
+28°0691		S	V	10.1	10.1	0.05					PASP	
+28°0718		S	V	10.1	10.1	0.05					PASP	
+27°0825		S	V	10.4	10.4	0.05					PASP = HD 245814/5	
+27°1177		S	V	10.7	10.7	0.05					PASP = HD 260710/1	
+25°1039		S	V	10.6	10.6	0.05					PASP = X07914 = HD 249387	
+24°1410		S	V	10.7	10.7	0.05					PASP = HD 264248/9	
+22°1443		S	V	11.7	11.7	0.05					PASP = HD 262204	
+21°1404		S	V	10.2	10.2	0.05					PASP = HD 264997/8	
+20°1470		S	V	11.1	11.1	0.05					PASP = HD 258998	
+19°1363		S	V	11.3	11.3	0.05					PASP = HD 257897 = J02784	
+18°0901*		V	C	9.0	10.8	0.9	188				1970.33, P. Couteau, Nice, France	
+17°1483		S	V	10.7	10.7	0.05					PASP = HD 52830/1	
+17°1619*		V	C	10.2	10.5	0.3	104				1970.58, P. Couteau, Nice, France	
-17°5350		S	V	9.4	9.4	0.05					PASP = HD 174536/7 = J05891	
-18°4574		S	V	11.1	11.1	0.05					PASP = HD 159374	
-18°4799		S	V	8.8	8.8	0.05					PASP = HD 165782 = AX Sgr	
-20°4945		S	V	9.2	9.2	0.05					PASP = HD 164240/1	
HD 243188		S	V	11.2	11.2	0.05					PASP	
HD 244985		S	V	11.3	11.3	0.05					PASP	
HD 259066		S	V	10.9	10.9	0.05					PASP	
HD 267604		S	V	11.1	11.1	0.05					PASP	