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MINOR PLANET ROTATION REPORT

June-December 1976

by Alain C. Porter and Derek Wallentine

The A.L.P.O. Minor Planets Section received fewer light curves of asteroids in the latter half of 1976, a distinct disappointment in view of the better performance in 1975 and early 1976 (cf. MPB 3, 47-50, 4, 14-15, and 4, 36-40). Only 17 observations were submitted, two of which were late reports of observations made in the first half of the year. More disturbing yet is the fact that as of June 1977 only 2 observations have been received by the authors for the calendar year 1977! Observers are asked not to abandon a valuable scientific program which started so successfully. Rotational data are now available for over 100 minor planets, and there are strong reasons why the size of this sample needs to be increased.

Table 1: Observations

Planet	PK	CM	CE	CP	PH	AP	GS	BS	DW
	Observer (initials)								
7 Iris	1								
15 Eunomia		1	1			1			1
22 Kalliope							2		
89 Julia								2	
92 Undina				1					
106 Dione								1	
233 Asterope						1			
354 Eleonora				1		1			
535 Montague							1		
925 Alphonsina	1				1				

Table 2: Observers

PK = Phil Kirby, Springfield, Ohio, USA. 15cm f/8 rfl.
CM = Chris Martin, Ottawa, Ontario, Canada. 41cm f/5 reflector.
CE = Claude McEldery, Dearborn, Michigan, USA. 15cm f/7 reflector.
CP = Chet Patton, Buchanan, Michigan, USA. 15cm f/7 reflector.
PH = Chet Patton and Joe Horvath, Buchanan, Michigan, USA. 25cm f/8 reflector.
AP = Alain Porter, Narragansett, Rhode Island, USA. 15cm f/8 reflector.
GS = Gerard Samolyk, Milwaukee, Wisconsin, USA. 25cm, 30 cm and 32cm reflectors.
BS = Bruce Sumner, Townsville, Queensland, Australia. 15cm f/4 reflector.
DW = Douglas Welch, Ottawa, Canada. 41cm f/5 reflector.

Analysis of Observations

7 IRIS. Iris has been observed at 4 previous oppositions. Its period is $7^{h}08^{m}.1$, and its amplitude can be as much as 0.29 magnitudes. This year's observation is too short ($1^{h}40^{m}$) to give a period, but suggests a variation of at least 0.2 mag. in 1976 July. Its longitude at that time was 303°, which agrees with Caillate's pole of $\lambda_o = 184°$, $\beta_o = 55°$.[1]

15 EUNOMIA. Eunomia has been observed about 7 times in the past, and as a result its period is precisely known: $6^{h}04^{m}50^{s}.304 \pm 1^{s}.728$.[2] Its direction of rotation is retrograde (cf. MPB 4, 8). The 1976 visual observations, corrected for light time difference, agree well with the above period. Two intervals between identical phenomena were observed, covering 51 and 296 rotations, and they give an average sidereal period of $6^{h}04^{m}51^{s}$. (This result is based on the assumption that Eunomia's axis is perpendicular to the ecliptic plane. Its amplitude varies by only 20% with longitude, so this cannot be far from the true orientation.) The precision of this timing cannot be claimed to be better than a few minutes, but it is interesting to note how close to the known period the observations come.

22 KALLIOPE. Samolyk observed 2 shallow minima:

1976 UT Sept 11 $7^{h}58^{m}$
Sept 13 $8^{h}40^{m}$

which satisfy candidate periods of $4^{h}14^{m}$ and $4^{h}04^{m}$. Periods of $4^{h}08^{m}.8$[3] and $4^{h}04^{m}$[4] have been given in the past. The observer reported difficulties with the Moon and a nearby 3.5 magnitude star, so no more than a possible confirmation of the earlier period can be reported. The observed amplitude (0.2-0.3 mag.) was larger than in past years, but one must keep in mind the possibility of error due to the observing conditions.

89 JULIA. Sumner reported 2 light curves and a single estimate on a third night. No orderly variation was detected, only scatter of 0.2 magnitudes. Julia has since been reported to have a period of $11^{h}23^{m}$ and an amplitude of 0.25 mag.[5]

92 UNDINA. Although the single light curve of this object was 6½ hours long, the seeing was bad, and the last quarter Moon aggravated the situation. Two maxima and an intermediate minimum about 0.3 magnitude deep were recorded, but unfortunately the minimum was not symmetrically placed:

1976 UT Sept 15 MAX $5^{h}00^{m}$
min 7 05
MAX 8 05

The last phenomenon was the weakest of the three; if it is discarded, Undina would appear to have a period of about 8^{h} and an amplitude of ¼ mag. or so. Undina would be a good target for observation in future years.

106 DIONE. In $4^{h}44^{m}$ of light curve estimates there was scatter of 0.2 magnitudes, but no periodic variation.

233 ASTEROPE. There was only one short (2^{h}) curve of this object in late 1976, which Section members observed much more extensively in 1975.[6] This short curve showed nothing. Asterope was very close to a star of roughly equal brightness, and difficult to follow. It will next come to opposition in 1978, when there is a good chance of determining the question of its period once and for all.

354 ELEONORA. Patton's light curve showed symmetri-

cally placed phenomena:

1976 Sept 21 (UT) min 5^h45^m MAX 6^h45^m min 7^h45^m MAX 8^h45^m

Two other timings were obtained in December:

1976 Dec 25 (UT) min 4^h48^m MAX 5^h45^m

If Eleonora's rotation had never previously been observed, a period of approximately 4 hours would be proposed. The period is known to be $4^h16^m_{\cdot}6$, however, and a value of $4^h16^m_{\cdot}5$ fits these timings very well. This amounts to almost the same error -- 6½% -- that lay in the visual estimate of 1580 Betulia's rotation period last year. It is a useful reminded that approximate periods are easy to obtain, but a large number of visual observations may be necessary to define the period within a minute.

535 MONTAGUE. Fortunately the only observations of Montague were a series 6½ hours long, and appear to show 3 extrema. The amplitude is uncertain, but appears to be 0.2 magnitudes or more. If the 3 intervals are averaged, one gets a period of roughly 7^h56^m, but clearly the true figure could be anywhere from 6½ to 9 hours. The last maximum observed was broader and less well defined, so the true rotation period is perhaps more likely slightly longer than the value just given.

925 ALPHONSINA. Kirby's observation was made on 1976 Sept. 22, and showed a variation of 0.2-0.3 magnitudes, with a minimum at 5^h10^m UT. Patton and Horvath made a light curve together on 1976 Sept. 20 which was flatter, but showed a maximum at 2^h45^m and a minimum at 5^h00^m. Thus the period appears to be in the neighborhood of 9 hours, but the scatter and relative shortness (about 3½ hours each) of the curves make a more precise estimate risky.

References

1. Vesely, Carl D., in Physical Studies of Minor Planets (1971) edited by T. Gehrels, p. 133.
2. Scaltriti et al. (1974), Astronomy & Astrophysics Supplement Series 19, p. 249.
3. Pilcher, Frederick, and Meeus, Jean, (1973) Tables of Minor Planets, p. 103.
4. Gehrels, T., and Owings, D., (1961) Astrophysical Journal 135, 906.
5. Schober, H.J., and Lustig, G., (1975) Icarus 25, 339.
6. Porter, Alain C., et al., (1976) Minor Planet Bulletin 4, 47.

[Editor's Note: This report by Messrs. Porter and Wallentine is much appreciated, as is the work of the observers reported here. We very much need more and longer light curves of more asteroids in order to make this program a success. If you can participate, please contact Alain C. Porter. If you live in the U.S.A. enclose a large stamped self-addressed envelope and he can send you observing forms. His address is 10 Sea Lea Drive, Narragansett, Rhode Island 02882 USA.]

POSSIBLE OBSERVATION OF A SATELLITE OF A MINOR PLANET

by David W. Dunham and Paul D. Maley

[Note: The following article is reprinted essentially from one of the same title published in the July 1977 issue of Occultation Newsletter, the official publication of the International Occultation Timing Association ("IOTA"). The Editor wishes to thank Dr. Dunham and Mr. Homer DaBoll, the President and Editor respectively for permission to reprint. Mr. DaBoll also sent the original draft of the article which was somewhat longer than that published in order to provide us with as full a story as possible. MPB rarely carries reprints, but because of the nature of this article and the fact that probably many of our readers are not members of IOTA and therefore do not receive Occultation Newsletter, an exception is made in this case.]

With all of the publicity about the rings of Uranus discovered during an occultation of a faint star by the planet during 1977 March 10, we hope that astronomers will not overlook observations of another remarkable occultation which took place five days earlier. This was the occultation of 3.6 magnitude γ Ceti A by 6 Hebe, observed from locations in and near Mexico City (see IAU Circular 3040 and 3047). This is the first time that an occultation of a star by one of the larger minor planets has been observed from more than one station. The preliminary reports, all by visual observers, seem to be consistent with a diameter for Hebe of about 200 km. which is also the value obtained by modern radiometric and polarimetric methods. [Cf. David Morrison in Icarus 31, 204 (June 1977)]. ... The observation described below indicates that double star observation techniques might be used to search for possible satellites of minor planets.

Paul D. Maley, an experienced occultation observer from Houston, Texas, traveled west to avoid widespread cloudiness along the coast. He attempted observation of the occultation by Hebe from a site about 13 km southwest of Victoria, Texas (longitude 97°02'58".7 W., latitude +28°45'00".0, height 91 feet above sea level according to the "Raisin, Texas" 1:24,000-scale U.S. Geological Map), where there was a large clear area. Observation was made with a 13-cm refractor with a sturdy altazimuth mounting. Using a 20x eyepiece, the field of view was 2°4. Maley claims that he saw the star very well during the critical time, with no drops in the star's light of as much as 1/3 due to some cirrus present. But for 0^{s}5 beginning at $2^h35^m00^s_{\cdot}4$ UTC, the star abruptly disappeared from view. The timing was by tape recording voiced calls and WWV shortwave radio time signals. A personal equation of 0^{s}2 was applied to the timings. When we discussed the observation the following morning, we assumed that he had observed a nearly grazing occultation by Hebe since the expected duration of a central event was 5 seconds. We assumed that Maley was near the southern limit since observers south of Austin, Texas, reported a miss (no occultation). Unfortunately, clouds prevented observation by observers in Victoria and Corpus Christi, Texas. Dunham was consequently surprised when Jose de la Herrán telephoned from Mexico City half an hour later to give some information about the successful observations of the occultation made there.

The first inclination is to dismiss Maley's observation as an atmospheric effect (which he feels is not the case), but the fact that his occultation occurred at virtually the same time as the occultation in Mexico City merits further study (the prediction uncertainty was about ±60 seconds in time). This simultaneity makes a terrestrial cause, such as an occultation by a bird seem less probable. A bird might have been noticeable in Maley's telescope due to the nearly full Moon.

Relative to the direction of motion of the occultation shadow across the Earth's surface (approximately east-west in orientation), Maley's site was 900 km (subtends about 0".7 at Hebe's distance) north of the occultation shadow at Mexico City. Hebe cannot have a diameter this large due to albedo considerations, but, more importantly, due to the fact that no occultation was seen from stations between Victoria and Mexico City, such as at Queretaro and Zacatecas, Mexico, and probably at Lynn and Hidalgo, Texas (where there was some interference from clouds).

Duplicity of γ Ceti can also be ruled out as an explanation. The known B component, whose magnitude is estimated to be 6.2 according to recent observations, is 2".9 away and produced a very hard-to-see occultation in an uninhabited part of the southeastern Pacific Ocean. (This event would be very difficult because the primary star was unocculted there). If the A component itself were a close double, the decrease at occultation at either Maley's site or in Mexico would have been 0.75 magnitude or less, whereas observers in both places reported "complete" disappearances. (This probably means a drop of at least two magnitudes, although it is not surprising that they didn't notice the faint B component during the brief occultation. R. Costero, observing from Mexico City, did see the B component when A was occulted by Hebe. He estimated it to be 2 to 3 magnitudes fainter than the A component, which is in accord with the recent observations. During Maley's half-second occultation his eyes did not have time to adjust to notice the B component.

Fresnel diffraction effects were insignificant, with a 300-meter fringe spacing at Hebe's distance. Nor would there be any significant effect from the star's angular diameter.

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

Maley's observation implies a satellite diameter of perhaps 20 km. This would result in a magnitude about 5 fainter than Hebe's, a very difficult object at 0".7 separation. The period of revolution around Hebe might be about two days. The next two oppositions of Hebe occur in early 1978 and 1979. They are relatively unfavorable, with Hebe being only slightly closer to the Earth than it was during the occultation. The 1980 November opposition, being near perihelion, is more favorable, with Hebe's geocentric distance being 1.064 A.U., about 2.3 times closer than during the recently observed occultation. Therefore in late 1980 the satellite might move more than 1".5 away from Hebe. The opposition will be in northern Eridanus, at 1950 R.A. 3^h54^m, Decl. -8°.8. Curiously, at about 3^h UT of 1980 July 25, Hebe will pass only about 11' south of γ Ceti, perhaps a useful astrometric opportunity.

If there is a satellite of Hebe, it is possible, and probably likely, that there are several others, orbiting other large minor planets as well. We will not speculate on the origins of such objects, but feel that it might be worthwhile to apply techniques of observation of close double stars to a few of the larger minor planets. During future occultations of bright stars by minor planets, photoelectric observations and observations by pairs of visual observers about 1 km apart up to a thousand kilometers and more from the predicted occultation path might give confirmation of occultations by satellites of minor planets.

[Editor's Note: In the light of the above article all minor planet occultation observers should be alert for possible secondary occultations caused by satellites when observing the larger minor planets. Observations of these planets with large telescopes at perihelic oppositions are also urged.]

PRECISE POSITIONS OF MINOR PLANETS

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Abstract: Precise and semi-precise photographic and micrometric positions of minor planets by Section members are reported, along with policy for future submissions.

An increasing number of members of the Minor Planet Section are submitting precise positions of minor planets measured off photographic emulsions or by eyepiece micrometer and compared with star positions from standard catalogs. We congratulate these observers on their achievements. In recognition of the value of these measurements and to encourage other observers to initiate observing programs of comparable accuracy, we are establishing a section in the Minor Planet Bulletin devoted to the publication of these minor planet positions. Positions of this accuracy can have value in improving the orbits of the planets.

We are publishing here precise photographic positions by Toshio Kurosaki, Andrew T. Son, and Claude McEldery, and micrometric positions by McEldery. The location of Kurosaki's observatory and summary of his methods appeared in MPB 5, 5, 1977 July-September. Those of Son and McEldery are included along with their observations in this paper.

To be eligible for publication in this section the following requirements must be satisfied. Timings of mid-exposure, or of beginning and end of a trailed exposure, must be accurate to ± 1 minute and accuracy of ± 1 second is preferred using a national time service (WWV in the United States). The longitude, latitude, and altitude of the observatory must be submitted, or at least be on file with us, so that the effects of geocentric parallax can be accounted for. Measurements of reference star positions may be from any standard astrometric catalog.

PRECISE POSITIONS OF MINOR PLANETS

Toshio Kurosaki, Utsunomiya, Japan

Planet	1977 UT	RA (1950.0)	Dec	O-C	
33	Jan 13.54853	$7^h20^m39^s.78$	$+24^\circ52'41''.2$	$0^m.0$	0'
33	Jan 13.60304	7 20 36.41	+24 52 48.4		
37	Feb 22.55661	8 17 58.47	+23 44 03.6	0.0	0
37	Feb 22.62015	8 17 56.20	+23 44 03.0		
45	Jan 13.56045	7 40 58.62	+15 41 47.3	0.0	0
45	Jan 13.60999	7 40 55.78	+15 42 00.2		
54	Feb 22.64671	9 19 25.06	+12 32 49.0	0.0	0
54	Feb 22.59220	9 19 28.07	+12 32 44.3		
67	Mar 12.60479	9 29 43.63	+ 7 37 17.1	0.3+	1+
67	Mar 12.62840	9 29 42.60	+ 7 37 25.3		
76	Jan 28.58552	9 33 37.03	+11 24 22.7	0.0	0
76	Jan 28.65087	9 33 34.19	+11 24 36.4		
103	Jan 28.59351	9 36 27.93	+14 26 34.9	0.1-	0
103	Jan 28.66539	9 36 24.34	+14 26 59.9		
117	Jan 28.58274	9 33 00.51	+28 09 30.3	0.1+	1-
117	Jan 28.64769	9 32 56.67	+28 09 35.9		
124	Feb 22.56216	8 29 48.44	+15 21 00.5	0.2-	0
124	Feb 22.62605	8 29 45.82	+15 21 15.1		
130	Jan 13.53534	7 09 30.86	+ 1 53 10.1	0.0	0
130	Jan 13.59679	7 09 27.70	+ 1 53 40.9		
130	Jan 28.54385	6 58 08.83	+ 4 10 07.3	0.0	0
130	Jan 28.60115	6 58 06.47	+ 4 10 41.6		

137	Jan 28.54212	6 57 51.05	+ 4 55 15.8	0.1+	1-
144	Feb 22.55939	8 30 38.58	+25 01 04.9	0.0	0
144	Feb 22.62275	8 30 35.89	+25 01 30.9		
146	Feb 22.56639	8 37 12.98	+34 03 51.0	0.1-	0
146	Feb 22.63230	8 37 09.82	+34 03 59.5		
152	Jan 28.56781	8 42 02.63	+36 57 47.5	0.2-	1+
152	Jan 28.61956	8 41 59.48	+36 57 56.4		
187	Feb 22.58265	9 52 20.24	+28 40 35.5	0.1-	1+
187	Feb 22.63959	9 52 16.41	+28 40 39.4		
187	Mar 12.60792	9 35 07.43	+28 21 33.9	0.0	1+
187	Mar 12.63153	9 35 06.41	+28 21 29.3		
197	Jan 19.52031	6 32 58.43	+28 11 25.1	0.0	0
197	Jan 19.56476	6 32 55.95	+28 11 30.3		
216	Jan 13.55686	7 34 05.99	+ 0 23 46.0	0.6-	1-
216	Jan 13.60652	7 34 03.16	+ 0 23 51.0		
264	Mar 12.61104	9 53 34.78	+28 23 26.3	0.0	0
264	Mar 12.63396	9 53 33.82	+28 23 25.6		
288	Feb 22.58855	9 03 42.30	+19 27 37.8	0.0	0
288	Feb 22.64272	9 03 39.58	+19 27 54.3		
298	Jan 28.59628	10^{h}02^{m}47^s.88	+21°46'39".5	0^m.6-	5+
298	Jan 28.66817	10 02 43.69	+21 46 57.1		
371	Jan 28.55740	8 28 04.64	+14 29 50.4	0.0	1+
371	Jan 28.61065	8 28 01.38	+14 29 54.7		
371	Feb 22.54758	8 07 07.54	+15 01 56.5		
371	Feb 22.61112	8 07 05.04	+15 01 59.8		
383	Jan 13.59124	6 52 23.82	+23 50 01.6	0.2+	0
383	Jan 13.59297	6 52 23.55	+23 50 01.7		
383	Jan 19.53733	6 47 27.54	+24 00 48.4	0.2+	0
383	Jan 19.57727	6 47 25.63	+24 00 52.5		
388	Jan 28.57337	9 07 20.42	+23 13 58.5	0.0	0
388	Jan 28.62407	9 07 17.54	+23 14 08.2		
405	Jan 13.54089	7 16 34.60	+10 28 27.3	0.0	0
405	Jan 13.59992	7 16 30.62	+10 28 19.5		
410	Jan 13.52179	6 48 40.53	+25 03 55.3	0.0	0
410	Jan 13.58574	6 48 36.72	+25 04 08.3		
480	Jan 13.51728	6 36 13.03	- 2 42 28.7	0.0	0
480	Jan 13.58013	6 36 09.45	- 2 42 35.3		
480	Jan 19.52847	6 30 56.79	- 2 49 29.9	0.0	0
480	Jan 19.57292	6 30 54.50	- 2 49 31.2		
498	Jan 28.54733	7 52 02.20	+26 18 17.2	0.0	1+
498	Jan 28.60462	7 51 58.91	+26 18 31.6		
509	Jan 28.63359	9 46 23.73	- 8 21 00.6	0.1+	3+
626	Jan 28.57927	9 24 54.29	+38 50 16.3	0.0	0
626	Jan 28.64491	9 24 48.08	+38 50 08.2		
626	Feb 22.57206	8 49 01.60	+36 29 36.9	0.0	0
626	Feb 22.63606	8 48 57.18	+36 29 02.7		
648	Feb 22.60522	9 14 23.44	+ 7 14 38.9	0.1-	0
648	Feb 22.65591	9 14 21.00	+ 7 14 42.0		
705	Mar 12.59229	9 12 03.37	+40 33 54.8	0.4-	2+
705	Mar 12.62146	9 12 02.25	+40 33 38.9		
751	Jan 13.50617	5 47 14.42	+31 49 34.3	0.1-	0
751	Jan 13.56936	5 47 10.90	+31 49 50.7		
751	Jan 19.50851	5 42 30.28	+32 12 38.1		
751	Jan 19.55434	5 42 28.34	+32 12 46.9		
762	Jan 28.55115	7 14 04.64	+26 31 53.6	0.1-	0
762	Jan 28.60741	7 14 01.73	+26 31 41.9		
865	Jan 19.59080	7 37 35.02	- 1 32 31.5	0.7+	1+
865	Jan 19.62760	7 37 33.06	- 1 32 13.0		
943	Jan 19.61927	9 55 43.46	+19 48 56.7	1.2+	7-
943	Jan 19.64670	9 55 42.65	+19 49 12.0		
1252	Jan 19.59983	8 14 41.13	+ 0 54 15.8	0.0	0
1252	Jan 19.63258	8 14 39.12	+ 0 54 43.5		

PRECISE POSITIONS OF MINOR PLANETS

Andrew T. Son, Nyenheim, Holland

Planet	UT	RA (1950.0)	Dec
25	1976 Jul 28.91389	18^{h}30^{m}01^s.2	+19°52'50"
25	1976 Aug 14.89583	18 28 44.2	+17 11 12
40	1975 Feb 9.85938	8 49 41	+22 35 59
198	1976 Oct 16.86667	0 46 38	+23 59 33
258	1976 Oct 16.88889	1 02 14.6	+10 17 37
324	1975 Feb 9.83889	7 36 38.8	+29 19 57

Longitude 5°13'22".5 E
Latitude 52 05 07.1 N
Altitude 15 meters above sea level

Ilford HP-3 plates, measured according to the method of Rinia, comparison stars from SAO catalogue, accuracy ± 1^s, ± 2".

Photographs by Claude McEldery, Dearborn, Michigan, USA

Planet	UT	RA (1950.0)	Dec
944	1976 Oct 23.271	1^{h}23^{m}08^s.4	+21°08'37"
1580	1976 May 20.229	16 20 23.3	+ 6 46 57
1580	1976 May 23.167	15 39 20.6	-10 59 41

Longitude 82°55'25".4 W
Latitude 42 45 42.4 N
Altitude 203 meters above sea level

44	1977 Mar 16.059	8^{h}36^{m}13^s.0	+20°18'04"
44	1977 Mar 17.052	8 36 19.8	+20 19 09
44	1977 Mar 20.124	8 36 55.1	+20 21 03
44	1977 Mar 21.170	8 37 11.9	+20 21 22

15 cm f/4 reflector at prime focus
Longitude 83°09'34".5 W
Latitude 42 21 00.0 N
Photographs measurable to 0.12 mm
SAO Star Catalogue

PRECISE POSITIONS OF MINOR PLANETS

Micrometer visual measurements by Claude McEldery, Dearborn, Michigan, USA

Planet	UT	RA (1950.0)	Dec
1	1977 Apr 9.125	12^{h}27^{m}24^s.6	+14°36'04"
1	1977 Apr 30.111	12 14 02.5	+14 14 40
2	1977 Feb 16.184	8 45 12.7	-17 08 49
2	1977 Mar 1.194	8 38 57.0	-11 36 35
4	1977 Feb 16.104	6 47 47.7	+25 30 17
4	1977 Mar 1.101	6 46 10.4	+25 51 46
6	1976 Oct 30.146	23 59 22.0	-22 51 36
6	1976 Nov 1.146	23 59 33.7	-22 46 01
6	1976 Dec 3.083	0 16 46.7	-18 35 16
6	1976 Dec 9.066	0 22 52.9	-17 23 58
10	1977 Mar 8.288	10 52 49.0	+01 41 33
10	1977 Mar 17.132	10 46 08.7	+02 19 35
16	1977 Mar 2.239	10 45 58.6	+08 40 09
16	1977 Mar 8.239	10 41 20.6	+09 12 22
20	1977 Feb 9.106	7 05 26.4	+21 22 08
20	1977 Feb 11.128	7 04 39.9	+21 23 25
22	1976 Dec 3.163	3 56 34.1	+19 56 25
22	1976 Dec 9.122	3 50 48.5	+20 12 02
23	1977 Mar 2.167	9 59 01.6	+32 12 58
23	1977 Mar 8.197	9 54 36.8	+32 10 17
32	1977 Mar 27.170	12 35 12.1	-09 06 14
32	1977 Mar 30.146	12 32 49.1	-08 44 49
37	1977 Feb 9.128	8 27 56.5	+23 36 10
37	1977 Feb 11.163	8 26 08.8	+23 39 01
41	1976 Jun 4.163	16 23 36.5	+07 00 02
41	1976 Jun 5.146	16 22 59.0	+07 02 00
41	1976 Jun 6.139	16 22 17.9	+07 04 28
41	1976 Jun 7.149	16 21 38.5	+07 04 07

44	1977 Feb 11.160	8 50 31.7	+18 16 25
44	1977 Mar 1.257	8 38 25.9	+19 44 31
44	1977 Mar 2.097	8 38 07.0	+19 47 20
44	1977 Mar 8.127	8 36 27.4	+20 04 26
129	1976 Jul 5.198	16 41 18.9	-05 51 34
216	1977 Feb 17.153	7 10 32.9	+03 00 07
216	1977 Feb 18.114	7 10 17.1	+03 05 58
471	1976 Dec 3.222	4 18 52.4	+13 44 46
471	1976 Dec 9.170	4 12 52.9	+14 25 08
1580	1976 May 19.354	16 31 25.8	+11 30 05
1580	1976 May 21.228	16 06 59.4	+00 57 55
1580	1976 May 24.179	15 24 11.2	-17 10 07

Longitude 83°09'34".5 W
Latitude 42 21 00.0 N
Telescopes used: all planets except 216, 1580
15 cm, f/4
Planet 216: 20 cm, f/16
Planet 1580: 32 cm, f/7.2
Measured visually by micrometer using drift method and stop watch, positional accuracy about ± 0.s3, ± 30", reference stars from SAO Catalogue.

MINOR PLANET NEWS

MINOR PLANET TYPES. David Morrison has published an excellent paper entitled "Asteroid Sizes and Albedos" in Icarus 31, 185-220 (1977 June) which presents a more technical discussion of the conclusions set forth in Sky and Telescope 53, 181-183 (1977 March). Section members should try to read these if they can. Perhaps fully as interesting as Morrison's conclusions regarding diameters are the differences between surface compositions of various minor planets which are now fairly well established. It might be of interest to summarize for our readers the basic types, something not previously done in these pages:

C-type. Carbonaceous chondrite. By far the most common type, found particularly in the middle and outer parts of the asteroid belt. Perhaps 80% of all minor planets are of this type (although our present sample is still small to be certain of this). Examples: 1 Ceres, 10 Hygiea, 19 Fortuna, 511 Davida. The albedos of these planets are all very low, 0.02 to 0.06.

S-type. Silicaceous. The second most common group, although only about one seventh as common as C-type. Silicaceous planets predominate on the inner edge of the minor planet belt, and among those whose orbits approach the Earth. Examples include 15 Eunomia, the only S-type with a diameter of more than 250 km, and 3 Juno, 6 Hebe, 7 Iris, 8 Flora. Albedos are distinctly higher than C-type -- 0.08 to 0.18.

M-type. Metallic. Probably the third most common group (about 4%). Examples include 16 Psyche, 21 Lutetia, 22 Kalliope, 97 Klotho and 216 Kliopatra. Albedos are about 0.08 to 0.15.

O-type. Ordinary chondrite. A rare type with only two examples on Morrison's list: 349 Dembowska and 1566 Icarus. Albedos about 0.25, which is fairly high.

E-type. Enstatite achondrite. A moderately rare type. Examples include 44 Nysa, 64 Angelina, and 434 Hungaria. Albedos are high -- 0.25 to 0.40 and perhaps even higher.

Basaltic type. Planet 4 Vesta is the only example of this type presently known. Albedo 0.229.

-- RGH

1960 UA RECOVERED. The near-Apollo-type minor planet 1960 UA, unobserved in recent years, has been recovered by G. Schwartz and C.-Y. Shao on two exposures taken with the 155-cm reflector at Harvard College Observatory's Agassiz Station. This recovery fulfills the hope of Dr. Brian G. Marsden that this planet would be recovered this year (cf. MPB 4, 36). At the time of recovery the photographic magnitude of 1960 UA was 19. (Cf. IAU Circular 3084)

1975 YA ORBITAL ELEMENTS IMPROVED. Brian G. Marsden published the following improved orbital elements for this Apollo-type planet in July:

T = 1977 Aug. 3.1628 ET   Epoch = 1977 Aug. 5.0 ET
ω = 61°.6509 } 1950.0   e = 0.298214
Ω = 93.7387   a = 1.290069 AU
i = 64.0167   n° = 0.6726431
q = 0.905353 AU   P = 1.465 years

These elements are based on 33 observations from 1975 December 27 through 1976 July 3. (Cf. IAU Circular 3089)

1977 RA DISCOVERED. This Amor-type planet was discovered by Dr. Paul Wild, Astronomisches Institut der Universität Bern, at Zimmerwald on 1977 Sept. 4, at which time its photographic magnitude was 14.5. Improved orbital elements by Brian G. Marsden were published in IAU Circular 3111 as follows:

T = 1977 Aug. 18.5410 ET
ω = 41°.6994 } 1950.0   e = 0.411586
Ω = 287.3317   a = 2.104511 AU
i = 5.2617   n° = 0.3228324
q = 1.238325 AU   P = 3.053 years

Its diameter is probably about 2 km. An ephemeris for the remainder of 1977 indicates that it is growing fainter, requiring moderately large telescopes.

1977 HA ORBITAL ELEMENTS IMPROVED. The orbital elements of this fast-moving Apollo-type planet discovered earlier this year by E. Helin and B. Bus (cf. MPB 5,11) have been improved by Brian G. Marsden, as reported in IAU Circular 3106:

T = 1977 Feb. 13.3471 ET   Epoch = 1977 Feb. 26.0 ET
ω = 290°.4182 } 1950.0   e = 0.503665
Ω = 190.8990   a = 1.599742 AU
i = 23.0513   n° = 0.4871123
q = 0.794008 AU   P = 2.023 years

The planet 1977 HA came closest to the Earth on April 1.8 ET early this year, when its distance was 0.032 AU.

69 HESPERIA AT EXTREMELY SMALL PHASE ANGLE. On 1977 September 28 (UT) the minor planet 69 Hesperia attained the extremely small phase angle of 0.03. This event is rare for a planet as bright as Hesperia, and should have offered an opportunity to observe a surge in brightness, and provide photometric data helpful in the study of its surface porosity. Dr. Edward Bowell of Lowell Observatory worked hard to enlist observations of this event. As this issue of MPB is published the results have not been made known.

APOLLO-TYPE PLANET 1976AA. Readers with a special interest in Apollo-type minor planets will want to read several papers on planet 1976 AA,(the only asteroid with a semi-major axis smaller than that of the Earth), published in Icarus 31, 415-438 (1977 August). Photometry of 1976 AA indicates it is probably a silicaceous planet -- it is certainly not C-type. Its radiometric diameter is 940 (+200, -100) meters, and its geometric albedo is 0.18 ± 0.06.

MINOR PLANETS SECTION NEWS

ABOUT THIS ISSUE OF MPB. This particular issue of MPB is distinctly shorter than preceding issues. Our readers will doubtless wonder why this is the case. There are three reasons:

(1) The number of papers of suitable quality submitted to the Editor has declined at the moment. Probably this is a temporary lull. Some of the longer reports tend to come at the end of the year or at mid-year, thus appearing in the January or July issues. The fact remains, however, that more quality papers on minor planets are welcome, particularly if they are not too long. These might involve results of research observations, or historical studies, or observing techniques. While most of our papers are directed toward the serious amateur and professional researcher, some papers for the benefit of the beginning or intermediate level amateur observer would also be helpful since a number of our subscribers would appreciate them.

(2) The Editor has been somewhat pressed for time, and a shorter issue eases the burden upon him. The October issue is probably the most difficult for him to produce since there is no academic holiday of any length in which to put it together. (Christmas, Spring and Summer vacations come at the right time and make the other issues easier since the work must be done on his own free time). The Editor this year has felt the burden more than other years: his introductory astronomy class enrollment is 95 students this semester, up 44% from last year's record enrollment. The teaching is a joy, but seeing that every student gets a chance to observe on the telescopes consumes a lot of evenings. The Editor also has an article in mind he would like to write for MPB, but of course there has not been time to write it.

(3) Financially a shorter issue from time to time is certainly helpful in cutting back production and postal costs. Our last issue (14 pages) was very expensive. If such large issues became a habit, given the present number of subscribers, MPB would face a financial crisis, particularly since costs are rising. The Editor would therefore indicate that readers should expect issues to average eight or ten pages in length, and that longer issues than this will probably have to be balanced by shorter issues at another occasion.

MEMBERSHIP LIST. A list of members of the A.L.P.O. Minor Planets Section is in the process of preparation and should be available near the end of 1977.

SUBSCRIPTION INCREASE. Due to increased postal costs for overseas air mail delivery, the overseas air mail subscription price for MPB must hereafter be $ 6.00 US funds per volume instead of the $ 5.50 previously charged. This change is effective immediately, except for institutional orders already billed. We regret any increase, but an analysis of air mail costs requires this adjustment. The regular $ 4.00 fee for subscribers in Canada, Mexico, and the United States, and the $ 4.50 US rate for overseas surface delivery is not affected, and are unlikely to be changed for some time to come. We are dedicated to keeping MPB rates as low as possible consistent with maintaining a quality publication.

THE CONVENTION AT BOULDER. The Recorder enjoyed very much having the opportunity to meet a number of our A.L.P.O. Minor Planets Section members at the August NAA Convention at Boulder, Colorado (cf. MPB 5, 12). Among them, for the first time, were Dr. and Mrs. J.U. Gunter, Alain C. Porter, Ray Bryant, H.J. Stelzer, Homer DaBoll -- to name a few. It was also encouraging to hear several challenging papers on minor planets.

GENERAL INFORMATION

POSITIONAL OBSERVATIONS of minor planets should be submitted to Prof. Frederick Pilcher, Assistant Minor Planets Section Recorder, Illinois College, Jacksonville, Illinois 62650 U.S.A. Please note that effective for 1977 and following single observations of a given planet will no longer be received to avoid any cases of misidentification.

OBSERVATIONAL REPORT FORMS may be obtained from the Section Recorder Richard G. Hodgson (address given below) at a rate of $ 1.00 US for 20 forms, postpaid, or $ 3.00 US for 100 forms, postpaid. Ephemerides for particular numbered planets can also be supplied by the Recorder at a rate of $ 0.25 ($ 0.50 if an overseas order) for the first planet, and $ 0.10 for each additional planet requested at the same time, payable in U.S. funds.

PHOTOMETRY OBSERVATIONS should be sent to Alain C. Porter, 10 Sea Lea Drive, Narragansett, Rhode Island 02882 U.S.A., who is one of our Photometry Co-ordinators. Photometry Report Forms may be obtained free from him (U.S. residentd should send a large, stamped, self-addressed envelope to defray costs).

THE A.L.P.O. MINOR PLANETS SECTION is directed by its Recorder, Prof. Richard G. Hodgson, who is also editor of MPB. Items for publication, subscriptions, and reports of unusual observations should be communicated to him. (He would also appreciate receiving reprints of articles and papers on minor planets published by subscribers in other journals: it is becoming impossibly expensive to subscribe to all the journals)! Address him either at his home, 316 South Main Avenue, Sioux Center, Iowa 51250 USA (faster during holiday periods) or at Dordt College, Sioux Center, Iowa 51250 USA. His home telephone is (712)-722-4081.

MPB SUBSCRIPTION RATES: Individual: $ 4.00 US a year in Canada, Mexico and the United States of America. Elsewhere on Earth $ 6.00 US a year delivered Air Mail (highly recommended) or $ 4.50 US delivered by surface mail. Group rates: For Canada, Mexico and U.S.A., for groups of 5 through 9 (multiple copies with order entered at one time and mailed to one address) $ 3.00 US a copy; for groups of 10 or more (on the same basis) $ 2.50 a copy a year. For group rates elsewhere please consult the Editor. Checks in payment of subscriptions may be made payable to "The Minor Planet Bulletin."

If checked your subscription ( ) expires with this issue; ( ) expires with the next issue. Your prompt renewal is appreciated!

Note: Your subscription expired at the end of volume 4. I hope you will renew!