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GENERAL REPORT OF POSITION OBSERVATIONS BY THE A. L. P. O. MINOR PLANETS SECTION FOR THE YEAR 1979

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Abstract. Observations of positions of minor planets by members of the Minor Planets Section are summarized.

Two classes of position observations are accepted by the Minor Planet Section. The first is approximate positions, either visual or photographic, which clearly and unequivocally show that the suspected object is moving in the manner predicted. From these positions it should be possible to calculate residuals from the ephemeris positions accurate to $\pm 0^m.1$, $\pm 1'$, and especially to note whether the residual is appreciable. With some experience observers should be able to estimate, especially for fainter planets near the limits of their equipment, magnitudes within $\pm 0^m.5$ by comparison with other asteroids even if no standard comparison stars are in the field. Occasionally discrepancies of this magnitude or greater occur, and reports of these permit the correction of a few gross errors still existing in the catalogs. A minimum of two observations, with the planet confirmed to be absent from the position of the first observation at the time of the second, are required to qualify for acceptance in this category. Unconfirmed single observations, especially of fainter planets, carry too high a chance of misidentification.

The second class of observation is precise photographic or visual micrometric positions. It is strongly recommended that at least two observations be made of each asteroid to confirm the expected motion, but in some cases single photographic positions can be published when the photograph is permanently retained in the observer's archives and can be remeasured if the observation should be called into question later. The time of a precise position should be recorded to the nearest 0.00001 day, and the longitude, latitude, and altitude of the observatory must be supplied so that geocentric corrections can be made.

Measuring engines to precisely measure astrometric positions on photographs are located in general only at major observatories and often are not conveniently available. Alain Porter, 10 Sea Lea Drive, Narragansett, RI 02882, USA, offers to measure photographs by Section members on the Smithsonian measuring engine to which he now has access. Any members who now have or in the future obtain photographs of minor planets are encouraged to send their original negatives to Mr. Porter for precise measurement if they have no other means to measure their photographs.

During the year 1979 a total of 2642 observations of 313 different planets were reported. The 11 contributing observers are praised for their achievements, and we hope that others will be encouraged to initiate their own observing programs of comparable quality.

It is noteworthy that not a single planet with opposition in 1979 was observed by Section members farther than $\pm 0^m.5$ from its ephemeris location. One decade ago a survey by Dr. Brian G. Marsden, Smithsonian Astrophysical Observatory, of observations of numbered minor planets reported to the Minor Planet Center showed that 10% of all planets had residuals larger than this amount. The Minor Planet Bulletin congratulates the computational centers, particularly at the Smithsonian Astrophysical Observatory, Cambridge Massachusetts, USA, the Institute for Theoretical Astronomy, Leningrad, USSR, and the University of Cincinnati Observatory for this improvement in orbital theory and resulting ephemerides. All observers may be grateful that virtually all ephemerides are now very nearly correct and that the need to search the line of variation is a burden of the past.

The summary lists planets in numerical order, the observer and telescope aperture (in cm), dates of the observing period (in Universal Time), and total number of observations in that period. Dates are assumed to be 1979 unless some other year is explicitly stated. Photographic positions are denoted by P following the number of observations, all others are visual observations. All of the precise positions for photographs listed in the summary have been published previously.[1] Planets appreciably brighter than predicted are denoted B in the NOTES column.

Two planets were observed by Frederick Pilcher, Jacksonville, Illinois, USA, to be significantly brighter than listed in the 1979 ephemeris volume.

99 Dike. On the basis of observations in 1976 and 1978[2, 3] Pilcher predicted this planet to be near B = 14.6 rather than 15.6 as listed. A large number of observations confirmed this prediction closely.

267 Tirza. Pilcher observed this planet to be near B = 14.7 rather than 15.3 as listed. This suggests that B(1,0) should be adjusted from its published value of 12.1 downward to 11.5.

For both of these planets Pilcher made a large number of observations and obtained constant magnitudes. No rotational variation above a detectability limit of $\pm 0^m.3$ could be found.

Positional observations were contributed by the observers listed below.

Observer, Instrument	Location	Planets	Total Positions
Birtwhistle, Peter 300 mm f. l. f/4.5 photographic lens	Cheam, Surrey England	1	2
Cunningham, Clifford 36 cm, f/5 reflector	Kitchener, Ontario, Canada	7	30
Embrey, Bryan R. 15 cm f/8 Newtonian	Sacramento, California, USA	12	70
Fabré, R. E. 20 cm f/8 Newtonian 20 cm f/4 Newtonian	Aiea, Hawaii, USA	198	1237

Garrett, Lawrence 20 cm Celestron 8 15 cm Newtonian	Burlington, Vermont, USA	14	46
Manning, Brian 26.5 cm f/7 reflector	Stakenbridge, England	1	4
Pilcher, Frederick 35 cm Celestron 14	Jacksonville, Illinois, USA	175	1063
Ridley, K. 500 mm f. l. astro-camera	Godalming, England	1	1
Scott, Nigel W. 500 mm f/4 lens	Hale, England	1	1
Van Looy, F. 300 mm f/4.5 tele-photo lens	Raleigh, England	1	2
Watson, William W. 20 cm Celestron 8	Tonawanda, New York, USA	46	186

REFERENCES

1. Birtwhistle, P., Minor Planet Bulletin, Vol. 7, No. 2, 9 (1979 Oct-Dec).
2. Pilcher, F., Minor Planet Bulletin, Vol. 3, No. 4 Part 1, 51 (1976 Apr-Jun).
3. Pilcher, F., Minor Planet Bulletin, Vol. 7, No. 1, 1 (1979 Jul-Sep).

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD	NO. OBS.	NOTES
1 Ceres	Fabré, 20 Pilcher, 35 Watson, 20	Oct 15-24 Sep 11-25 Nov 13-25	7 10 2	
2 Pallas	Fabré, 20 Pilcher, 35 Watson, 20	Jul 25-28 Aug 24-Sep 4 Aug 28-Sep 1	3 8 3	
3 Juno	Fabré, 20 Pilcher, 35	Dec 11-Jan 13'80 Nov 11-30	4 9	
4 Vesta	Fabré, 20 Garrett, 20 Pilcher, 35 Watson, 20	Nov 9-21 Nov 28-29 Oct 10-20 Nov 13-21	7 2 6 2	
5 Astraea	Embrey, 15 Fabré, 20 Garrett, 15 Pilcher, 35 Watson, 20	May 28-Jun 12 Mar 27-30 Mar 20-May 1 Feb 19-Apr 3 Apr 18-May 1	7 4 4 10 5	
6 Hebe	Fabré, 20, 15 Garrett, 15 Watson, 20	May 17-Jul 2 Jun 20-Jul 4 Jun 16-27	10 5 5	
7 Iris	Embrey, 15 Fabré, 20 Garrett, 15 Watson, 20	Jun 19-23 May 17-30 Jun 20-Jul 4 Jun 16-27	5 9 5 6	
8 Flora	Fabré, 20 Garrett, 15 Pilcher, 35 Watson, 20	Feb 22-24 Feb 15-17 Jan 18-Feb 1 Feb 6-28	3 2 5 5	
10 Hygiea	Fabré, 20 Pilcher, 35	Sep 14-19 Sep 11-17	6 9	
12 Victoria	Fabré, 20 Pilcher, 35	Dec 12-20 Nov 17-Dec 11	7 8	
15 Eunomia	Fabré, 20	Mar 26-30	3	
16 Psyche	Fabré, 20 Garrett, 15 Watson, 20	Jul 18-27 Jul 28-31 Sep 9-25	6 2 10	
20 Massalia	Fabré, 20	Sep 13-19	7	
21 Lutetia	Fabré, 20	Jan 3-7	2	
22 Kalliope	Embrey, 15 Fabré, 20 Pilcher, 35	May 20-29 May 18-30 May 16-18	7 5 4	
23 Thalia	Fabré, 20	Aug 20-30	9	
24 Themis	Fabré, 20 Garrett, 20 Watson, 20	Dec 12-20 Dec 22-Jan 5'80 Dec 16-21	7 3 3	
25 Phocaea	Fabré, 20 Pilcher, 35	Feb 22- Mar 4 Feb 19-28	5 7	
26 Proserpina	Fabré, 20	Jul 15-18	3	
27 Euterpe	Cunningham, 36 Fabré, 20 Garrett, 20 Pilcher, 35	Dec 30-Jan 13'80 Dec 12-20 Dec 9-22 Nov 17-Dec 11	2 7 5 8	
28 Bellona	Embrey, 15 Fabré, 20 Pilcher, 35 Watson, 20	Apr 12-27 Mar 20-30 Mar 26-Apr 6 Apr 18-21	5 8 4 4	
31 Euphrosyne	Garrett, 15 Pilcher, 35 Watson, 20	Jan 7-19 Feb 19-27 Jan 24-Feb 18	2 6 7	
32 Pomona	Fabré, 20	Nov 10-22	4	
33 Polyhymnia	Pilcher, 35	Apr 3-May 5	9	
35 Leukothea	Fabré, 20 Pilcher, 35	Jan 19-28 Jan 18-Feb 1	6 6	
37 Fides	Fabré, 20	Jul 19-28	6	
38 Leda	Fabré, 20	Mar 20-Apr 3	8	
40 Harmonia	Embrey, 15 Fabré, 20 Watson, 20	May 20-29 Apr 16-28 Apr 18-21	7 10 4	
42 Isis	Fabré, 20	Dec 11-20	8	
43 Ariadne	Fabré, 20 Pilcher, 35	Nov 10-15 Oct 21-30	4 5	
44 Nysa	Fabré, 20	Sep 18-22	5	
45 Eugenia	Fabré, 20 Watson, 20	Sep 13-16 Sep 20-25	4 4	
47 Aglaja	Fabré, 20 Watson, 20	Aug 13-30 Aug 21-Sep 1	14 3	
48 Doris	Fabré, 20 Garrett, 20	Dec 12-20 Dec 22-Jan 5'80	7 3	
49 Pales	Fabré, 20	Feb 22-Mar 4	7	
51 Nemausa	Embrey, 15 Fabré, 20 Watson, 20	Jul 7-17 Jul 15-27 Aug 17-22	6 7 3	
52 Europa	Fabré, 20 Pilcher, 35	May 23-30 May 17-26	6 7	
53 Kalypso	Fabré, 20 Pilcher, 35	Oct 12-24 Sep 12-17	10 5	
54 Alexandra	Fabré, 20 Pilcher, 35	Oct 13-24 Sep 11-16	8 6	
55 Pandora	Fabré, 20	Jan 3-7	3	
56 Melete	Fabré, 20	Nov 13-26	7	
57 Mnemosyne	Fabré, 20	Jan 19-Feb 1	8	
59 Elpis	Fabré, 20	Mar 22-30	4	
60 Echo	Fabré, 20 Garrett, 20 Watson, 20	Dec 11-20 Dec 9-22 Nov 25-Dec 21	8 5 4	

61 Danaë	Fabré, 20	Oct 12-17	5
	Pilcher, 35	Sep 11-16	7
65 Cybele	Fabré, 20	Dec 18-20	3
66 Maja	Fabré, 20	Aug 20-30	10
	Pilcher, 35	Aug 24-Sep 4	6
67 Asia	Fabré, 20	Dec 12-20	7
68 Leto	Pilcher, 35	Nov 11-30	9
69 Hesperia	Fabré, 20	Jan 23-26	4
	Pilcher, 35	Jan 18-Feb 1	5
	Watson, 20	Feb 3-7	4
70 Panopaea	Fabré, 20	Mar 20-Apr 3	9
	Watson, 20	Mar 21-23	3
73 Klytia	Fabré, 20	Jan 31-Feb 1	2
77 Frigga	Fabré, 20	Jul 15-20	6
80 Sappho	Cunningham, 36	Jun 20-Jul 6	6
	Embrey, 15	Jun 18-22	5
	Fabré, 20	Jun 13-Jul 2	6
	Watson, 20	Jun 26-27	2
82 Alkmene	Cunningham, 36	Dec 29-Jan 24'80	6
	Fabré, 20	Dec 18-20	3
83 Beatrix	Fabré, 20	May 23-30	4
	Watson, 20	May 19-20	2
87 Sylvia	Fabré, 20	Nov 21-26	5
89 Julia	Fabré, 20	Mar 20-29	5
92 Undina	Fabré, 20	Feb 22-Mar 1	4
93 Minerva	Fabré, 20	Jan 3-7	2
94 Aurora	Fabré, 20	Sep 13-19	7
	Pilcher, 35	Sep 11-15	6
	Watson, 20	Sep 20-25	4
95 Arethusa	Fabré, 20	Jul 19-28	5
97 Klotho	Fabré, 20	Jul 24-27	3
99 Dike	Pilcher, 35	Dec 8-19	16 B
101 Helena	Fabré, 20	Mar 22-30	5
103 Hera	Fabré, 20	Sep 14-22	8
107 Camilla	Fabré, 20	Nov 13-26	6
110 Lydia	Embrey, 15	May 28-Jun 12	7
	Fabré, 20	May 16-28	7
	Watson, 20	May 19-Jun 26	5
111 Ate	Cunningham,36,32	Sep 26-28	3
	Fabré, 20	Sep 14-19	6
113 Amalthea	Fabré, 20	Nov 10-26	8
	Pilcher, 35	Nov 10-14	6
114 Kassandra	Fabré, 20	Feb 22-Mar 4	7
	Pilcher, 35	Feb 19-27	5
	Watson, 20	Feb 18-Mar 23	10
115 Thyra	Birtwhistle, 7	Feb 28	2P
	Manning, 26	Jan 27-Feb 23	4P
	Ridley, 500 mm f.l.	Feb 25	1P
	Scott, 12.5	Jan 30	1P
	Van Looy, 7	Jan 2	2P
117 Lomia	Fabré, 20	Jul 19-27	5
118 Peitho	Fabré, 20	Apr 20-May 3	10
119 Althaea	Fabré, 20	Jan 23-26	4
120 Lachesis	Pilcher, 35	Sep 26-Oct 1	6
122 Gerda	Fabré, 20	Jan 23-31	6
123 Brunhild	Fabré, 20	Nov 21-26	5
	Pilcher, 35	Nov 10-14	6
125 Liberatrix	Fabré, 20	Jan 23-Feb 1	5
126 Velleda	Fabré, 20	Dec 12-20	6
127 Johanna	Fabré, 20	Jan 19-31	7
	Pilcher, 35	Jan 18-Feb 1	5
128 Nemesis	Fabré, 20	Mar 20-30	8
	Pilcher, 35	Feb 19-28	6
130 Elektra	Fabré, 20	May 16-23	5
131 Vala	Fabré, 20	Apr 19-30	9
	Pilcher, 35	Apr 28-May 2	6
133 Cyrene	Fabré, 20	Apr 16-26	8
136 Austria	Fabré, 20	Oct 16-26	7
137 Meliboea	Fabré, 20	Apr 20-May 5	12
139 Juewa	Fabré, 20	May 17-25	4
141 Lumen	Fabré, 20	Jan 3-7	4
144 Vibilia	Fabré, 20	Jul 15-17	2
145 Adeona	Embrey, 15	Apr 12-20	5
	Fabré, 20	Mar 20-28	7
	Watson, 20	Feb 28-Mar 23	8
146 Lucina	Fabré, 20	Sep 14-22	8
148 Gallia	Fabré, 20	Mar 20-28	7
159 Aemilia	Fabré, 20	Nov 10-24	7
161 Athor	Fabré, 20	May 17-30	6
162 Laurentia	Pilcher, 35	Dec 8-11	5
165 Loreley	Fabré, 20	Jan 24-Feb 1	6
170 Maria	Fabré, 20	Jan 23-26	4
173 Ino	Fabré, 20	Jan 23-Feb 1	7
174 Phaedra	Pilcher, 35	Sep 26-Oct 1	6
176 Iduna	Fabré, 20	Oct 23-27	4
	Pilcher, 35	Oct 10-20	6
179 Klytaemnestra	Fabré, 20	Oct 12-17	5
	Pilcher, 35	Sep 11-16	6
183 Istria	Fabré, 20	Sep 13-16	5
	Pilcher, 35	Aug 24-Sep 4	7
185 Eunike	Cunningham, 36	Jun 20-Jul 6	6
	Fabré, 20	Jun 29-Jul 2	2
188 Menippe	Fabré, 20	May 18-Jun 2	5
	Pilcher, 35	May 16-18	5
192 Nausikaa	Fabré, 20	Jan 3-7	2
	Garrett, 15	Jan 4-19	3
	Watson, 20	Jan 24-Feb 7	5
195 Eurykleia	Pilcher, 35	Oct 14-22	5
196 Philomela	Fabré, 20	July 15-18	2
198 Ampella	Fabré, 20	Apr 24-May 2	4
200 Dynamene	Fabré, 20	Sep 15-22	7
	Pilcher, 35	Sep 15-17	5
	Watson, 20	Sep 24-25	2
201 Penelope	Fabré, 20	Apr 19-30	8
	Pilcher, 35	Apr 28-May 2	5
202 Chryseïs	Fabré, 20	Mar 20-Apr 3	9
203 Pompeja	Fabré, 20	Nov 10-24	7
204 Kallisto	Fabré, 20	Sep 13-18	6
205 Martha	Pilcher, 35	Apr 3-May 2	10
206 Hersilia	Fabré, 20	Oct 16-26	7
209 Dido	Fabré, 20	Sep 13-19	7
211 Isolda	Fabré, 20	Aug 13-30	14

214 Aschera	Pilcher, 35	Sep 19-24	5
216 Kleopatra	Fabré, 20	May 23-30	6
218 Bianca	Fabré, 20	Mar 22-Apr 3	5
	Watson, 20	Mar 22-23	2
221 Eos	Fabré, 20	Nov 9-21	7
	Pilcher, 35	Oct 21-30	6
224 Oceana	Fabré, 20	Dec 19-20	2
234 Barbara	Fabré, 20	Oct 15-24	7
	Pilcher, 35	Sep 11-25	10
235 Carolina	Fabré, 20	May 2-16	5
236 Honoria	Fabré, 20	Aug 13-23	8
	Pilcher, 35	Aug 24-30	5
	Watson, 20	Aug 16-22	4
238 Hypatia	Fabré, 20	Nov 21-25	5
	Pilcher, 35	Nov 11-15	6
241 Germania	Fabré, 20	Jun 29-Jul 4	4
246 Asporina	Fabré, 20	Jul 24-28	4
253 Mathilde	Pilcher, 35	May 17-26	6
255 Oppavia	Pilcher, 35	Oct 21-29	8
256 Walpurga	Pilcher, 35	Feb 26-27	4
259 Aletheia	Pilcher, 35	Jan 18-Feb 1	7
261 Prymno	Fabré, 20	Dec 12-20	7
263 Dresda	Pilcher, 35	Sep 16-24	8
264 Libussa	Fabré, 20	Jul 25-28	3
267 Tirza	Pilcher, 35	Apr 3-May 1	8 B
268 Adorea	Fabré, 20	Mar 22-Apr 3	5
	Watson, 20	Apr 18-21	4
272 Antonia	Pilcher, 35	Dec 14-17	7
276 Adelheid	Fabré, 20	Dec 11-20	8
278 Paulina	Pilcher, 35	Mar 26-Apr 3	5
287 Nephthys	Embrey, 15	Jun 17-22	5
	Fabré, 20	Jul 18-25	5
	Watson, 20	Jul 20-21	2
295 Theresia	Pilcher, 35	Sep 14-19	8
303 Josephina	Pilcher, 35	Jan 18-Feb 1	6
306 Unitas	Fabré, 20	Aug 13-30	14
	Watson, 20	Aug 31-Sep 10	4
308 Polyxo	Fabré, 20	Aug 13-30	16
	Watson, 20	Aug 21-Sep 1	4
311 Claudia	Pilcher, 35	Mar 26-Apr 6	4
312 Pierretta	Fabré, 20	Sep 13-18	6
313 Chaldaea	Fabré, 20	Sep 14-19	6
	Pilcher, 35	Sep 14-17	7
319 Leona	Pilcher, 35	Oct 14-26	7
322 Phaeo	Fabré, 20	Oct 12-24	9
	Pilcher, 35	Sep 26-Oct 1	6
323 Brucia	Fabré, 20	Nov 9-15	5
	Pilcher, 35	Oct 25-Nov 14	8
336 Lacadiera	Fabré, 20	Apr 16-27	8
	Watson, 20	Apr 19-21	3
338 Budrosa	Pilcher, 35	Feb 19-Mar 29	8
340 Eduarda	Pilcher, 35	Dec 8-11	5
344 Desiderata	Fabré, 20	May 16-30	8
	Pilcher, 35	Apr 28-May 7	7
	Watson, 20	Apr 18-21	4
345 Tercidina	Fabré, 20	Mar 20-Apr 3	8
	Watson, 20	Mar 21-22	2

346 Hermentaria	Fabré, 20	Apr 20-May 5	10
348 May	Pilcher, 35	Nov 11-15	6
349 Dembowska	Fabré, 20	Feb 22-Mar 5	7
	Pilcher, 35	Feb 19-27	6
	Watson, 20	Feb 18-Mar 21	7
352 Gisela	Fabré, 20	Jul 19-27	5
353 Ruperto-Carola	Pilcher, 35	Jan 25-Feb 5	6
354 Eleonora	Embrey, 15	Jul 14-18	5
	Fabré, 20	Jul 15-27	8
	Garrett, 15	Aug 18-21	2
358 Apollonia	Fabré, 20	Nov 10-26	8
	Pilcher, 35	Nov 10-14	6
360 Carlova	Fabré, 20	Oct 12-17	6
361 Bononia	Pilcher, 35	Feb 26-28	5
369 Aëria	Fabré, 20	May 23-30	6
	Pilcher, 35	May 17-26	9
371 Bohemia	Fabré, 20	Sep 11-18	7
372 Palma	Fabré, 20	Jan 3-7	2
	Watson, 20	Jan 24-Feb 6	4
374 Burgundia	Pilcher, 35	Feb 27-28	3
375 Ursula	Fabré, 20	Feb 22-Mar 4	7
376 Geometria	Fabré, 20	Jul 2-4	3
377 Campania	Fabré, 20	Feb 22-24	3
384 Burdigala	Fabré, 20	Dec 12-20	6
	Watson, 20	Dec 16-21	3
386 Siegena	Fabré, 20	May 17-30	4
388 Charybdis	Fabré, 20	Jul 15-27	9
389 Industria	Fabré, 20	May 23-30	6
390 Alma	Pilcher, 35	Dec 15-17	6
391 Ingeborg	Pilcher, 35	Dec 14-17	7
397 Vienna	Fabré, 20	Aug 13-23	10
	Watson, 20	Aug 22-Sep 1	3
402 Chloë	Fabré, 20	Nov 9-20	6
403 Cyane	Fabré, 20	Feb 22-24	3
	Pilcher, 35	Feb 19-27	5
404 Arsinoë	Fabré, 20	Aug 20-30	8
405 Thia	Pilcher, 35	Sep 26-Oct 1	6
408 Fama	Pilcher, 35	Sep 22-30	7
410 Chloris	Fabré, 20	Sep 14-22	8
414 Liriope	Pilcher, 35	Oct 13-22	5
419 Aurelia	Embrey, 15	Apr 8-18	6
	Fabré, 20	Apr 19-28	9
	Pilcher, 35	Apr 3-May 7	10
	Watson, 20	Apr 18-21	4
420 Bertholda	Pilcher, 35	Oct 14-22	5
422 Berolina	Fabré, 20	Aug 20-30	10
	Pilcher, 35	Sep 11-15	6
423 Diotima	Fabré, 20	Feb 22-Mar 5	7
431 Nephele	Fabré, 20	Aug 13-19	8
	Pilcher, 35	Aug 24-Sep 12	7
432 Pythia	Fabré, 20	Feb 22-Mar 4	7
433 Eros	Fabré, 20	Aug 13-24	15
	Pilcher, 35	Aug 24-30	6
434 Hungaria	Pilcher, 35	May 25-26	4
444 Gyptis	Fabré, 20	Oct 14-24	8
	Pilcher, 35	Oct 10-20	5
451 Patientia	Fabré, 20	Oct 16-26	7

453 Tea	Pilcher, 35	Nov 18-Dec 11	8
454 Mathesis	Pilcher, 35	Dec 8-11	6
455 Bruchsalia	Fabré, 20	Dec 12-20	7
456 Abnoba	Fabré, 20	May 18-30	6
	Pilcher, 35	May 18-26	6
461 Saskia	Pilcher, 35	Feb 1-27	8
464 Megaira	Fabré, 20	Oct 16-26	7
	Pilcher, 35	Oct 10-20	6
470 Kilia	Pilcher, 35	Feb 19-26	6
471 Papagena	Fabré, 20	May 15-23	6
472 Roma	Fabré, 20	Nov 21-25	5
474 Prudentia	Fabré, 20	Jul 15-25	7
	Watson, 20	Jul 20-21	2
476 Hedwig	Fabré, 20	Oct 14-24	6
	Pilcher, 35	Sep 17-22	6
478 Tergeste	Fabré, 20	Aug 13-23	7
481 Emita	Fabré, 20	Jan 3-19	6
483 Seppina	Pilcher, 35	Apr 28-May 2	5
485 Genua	Fabré, 20	Feb 22-Mar 8	10
	Watson, 20	Mar 18-23	6
487 Venetia	Fabré, 20	Feb 22-Mar 5	7
492 Gismonda	Pilcher, 35	Sep 14-17	6
497 Iva	Fabré, 20	Nov 10-24	8
	Pilcher, 35	Oct 21-30	5
	Watson, 20	Nov 13-21	3
498 Tokio	Fabré, 20	Jul 14-25	9
501 Urhixidur	Fabré, 20	Sep 14-19	5
	Pilcher, 35	Aug 24-Sep 4	7
504 Cora	Pilcher, 35	Oct 13-25	7
505 Cava	Fabré, 20	Jan 3-19	6
507 Laodica	Pilcher, 35	Sep 28-Oct 14	9
510 Mabella	Cunningham, 36	Jun 20-Jul 5	5
	Fabré, 20	Jul 2-4	3
	Pilcher, 35	May 16-26	6
	Watson, 20	Jun 25-27	3
511 Davida	Fabré, 20	Nov 21-26	5
	Garrett, 20	Nov 21-29	3
	Pilcher, 35	Nov 11-15	6
	Watson, 20	Nov 25-Dec 21	4
518 Halawe	Pilcher, 35	May 16-26	9
523 Ada	Pilcher, 35	Oct 22-29	7
524 Fidelio	Pilcher, 35	Sep 26-Oct 1	6
525 Adelaide	Pilcher, 35	Dec 14-18	6
532 Herculina	Fabré, 20	Aug 13-26	9
537 Pauly	Cunningham, 36	Jun 12-13	2
	Fabré, 20	May 23-30	6
	Pilcher, 35	May 16-26	6
541 Deborah	Pilcher, 35	May 25-Jun 23	8
543 Charlotte	Pilcher, 35	Sep 19-Oct 1	12
550 Senta	Pilcher, 35	Dec 8-11	4
552 Sigelinde	Pilcher, 35	Feb 26-27	4
554 Peraga	Fabré, 20	Apr 19-28	9
568 Cheruskia	Fabré, 20	Oct 24-27	3
569 Misa	Pilcher, 35	Oct 10-14	5
580 Selene	Pilcher, 35	Sep 16-19	5
584 Semiramis	Fabré, 20	Jan 3-7	2
601 Nerthus	Pilcher, 35	Oct 13-21	6
602 Marianna	Fabré, 20	Jul 16-27	8
623 Chimaera	Pilcher, 35	Dec 8-11	5
627 Charis	Pilcher, 35	Oct 25-29	5
628 Christine	Fabré, 20	Aug 13-17	4
629 Bernardina	Pilcher, 35	Feb 19-27	6
636 Erika	Pilcher, 35	Oct 10-14	5
640 Brambilla	Pilcher, 35	May 5-18	7
673 Edda	Pilcher, 35	Sep 16-24	8
675 Ludmilla	Fabré, 20	Jan 23-Feb 1	7
694 Ekard	Fabré, 20	Dec 12-20	7
702 Alauda	Fabré, 20	Sep 11-16	5
	Pilcher, 35	Aug 24-30	6
704 Interamnia	Fabré, 20	Jul 24-28	4
714 Ulula	Fabré, 20	Jan 23-31	6
734 Benda	Pilcher, 35	Oct 21-24	5
742 Edisona	Pilcher, 35	Nov 28-Dec 10	6
751 Faïna	Fabré, 20	Jul 2-4	2
758 Mancunia	Fabré, 20	Jan 23-31	6
767 Bondia	Pilcher, 35	Aug 30-Sep 16	6
771 Libera	Pilcher, 35	Jan 18-25	4
776 Berbericia	Fabré, 20	Jan 3-7	4
783 Nora	Fabré, 20	Jul 2-4	2
	Pilcher, 35	Jun 21-23	5
804 Hispania	Fabré, 20	Sep 15-22	7
	Watson, 20	Sep 23-25	3
805 Hormuthia	Pilcher, 35	Apr 28-May 2	6
811 Nauheima	Pilcher, 35	Aug 30	2
825 Tanina	Pilcher, 35	Apr 3	2
832 Karin	Pilcher, 35	Sep 19-24	4
850 Altona	Pilcher, 35	May 17-26	7
851 Zeissia	Pilcher, 35	Feb 26-27	4
859 Bouzareah	Pilcher, 35	Sep 14-17	6
875 Nymphe	Pilcher, 35	Sep 15-17	6
886 Washingtonia	Pilcher, 35	Dec 8-11	6
888 Parysatis	Fabré, 20	Oct 16-26	7
	Pilcher, 35	Oct 10-14	4
889 Erynia	Pilcher, 35	Jan 18-Feb 6	8
892 Seeligeria	Pilcher, 35	Dec 14-16	5
894 Erda	Pilcher, 35	Jun 21-23	4
897 Lysistrata	Pilcher, 35	Aug 30-Sep 3	4
907 Rhoda	Pilcher, 35	Nov 11-14	6
912 Maritima	Fabré, 20	Jan 19-31	7
925 Alphonsina	Fabré, 20	Jul 15-17	2
951 Gaspra	Pilcher, 35	Dec 15-17	5
969 Leocadia	Pilcher, 35	Nov 12-18	6
979 Ilsewa	Pilcher, 35	Oct 14-22	4
984 Gretia	Pilcher, 35	Dec 11-15	6
995 Sternberga	Pilcher, 35	Nov 11-15	6
1002 Olbersia	Pilcher, 35	Aug 30-Sep 15	6

1004 Belopolskya	Pilcher, 35	Aug 30-Sep 16	5
1005 Arago	Pilcher, 35	Aug 30-Sep 16	8
1015 Christa	Pilcher, 35	Oct 10-14	6
1028 Lydina	Pilcher, 35	Sep 17-22	6
1031 Arctica	Pilcher, 35	Oct 22-26	5
1042 Amazone	Pilcher, 35	Oct 13-21	4
1062 Ljuba	Pilcher, 35	Jan 18-25	5
1064 Aethusa	Pilcher, 35	Sep 14-17	7
1074 Beljawskya	Pilcher, 35	Sep 19-24	6
1078 Mentha	Pilcher, 35	May 1-17	6
1086 Nata	Pilcher, 35	Dec 14-16	5
1104 Syringa	Pilcher, 35	Oct 13-22	6
1130 Skuld	Pilcher, 35	Sep 19-24	6
1140 Crimea	Pilcher, 35	Sep 16-22	6
1149 Volga	Pilcher, 35	Oct 14-21	4
1177 Gonnessia	Pilcher, 35	Nov 28-Dec 15	6
1214 Richilde	Pilcher, 35	Aug 30-Sep 15	6
1241 Dysona	Pilcher, 35	Aug 24-30	4
1242 Zambesia	Pilcher, 35	Nov 11-15	6
1263 Varsavia	Pilcher, 35	Oct 13-14	3
1269 Rollandia	Pilcher, 35	Dec 18-19	4
1304 Arosa	Pilcher, 35	Mar 26-Apr 3	6
1305 Pongola	Pilcher, 35	Feb 26-27	4
1323 Tugela	Pilcher, 35	Mar 26-Apr 3	6
1353 Maartje	Pilcher, 35	Sep 15-17	6
1409 Isko	Pilcher, 35	Nov 14-17	6
1458 Mineura	Pilcher, 35	May 25-26	4
1473 Ounas	Pilcher, 35	Aug 30-Sep 3	4
1567 Alikoski	Pilcher, 35	Dec 17-19	6
1734 Zhongolovich	Pilcher, 35	Nov 12-18	6

THE FUTURE OF POSITIONAL OBSERVATIONS

by R.G. Hodgson, Recorder

As Prof. Pilcher reported (above), Minor Planets Section observations of 313 different planets in 1979 failed to show any with large ephemeris errors. Are we to conclude positional observations are no longer needed?

Indeed not! There will always be need for precise positions based on photography to update and improve planet orbits, and even semi-accurate positions determined visually can serve to check ephemeris accuracy, something which will be needed for the next few years at least. Observers are urged to check carefully for significant magnitude errors and/or large amplitudes (say 0.5 magnitude or more) and telephone the Recorder (712-722-1513) if any are found. Pilcher's discoveries concerning 99 Dike, 267 Tirza, and 657 Gunlöd (next article) demonstrate what an alert observer can do. Remember also that large amplitudes may be observed only when their orientations are favorable, so several oppositions must be observed in order to settle the question with respect to a particular planet.

657 GUNLÖD - A MAIN BELT ASTEROID WITH A LARGE AMPLITUDE LIGHTCURVE

by Prof. Frederick Pilcher
Illinois College, Jacksonville, Illinois 62650 USA

Abstract. The minor planet 657 Gunlöd was found by visual observation in February and March, 1980, to have a large amplitude lightcurve near $1^{m}.0$. The rotation period could not be uniquely determined but may be near 15^{h} or near 11^{h}.

In February and March, 1980, I included planet 657 Gunlöd in my continuing visual survey of minor planets with the Celestron 14 at the Walter H. Balcke Observatory, Illinois College, Jacksonville, Illinois, USA. All times given in this report are in UT and refer to the year 1980. All magnitudes were obtained visually by comparison with other asteroids with well-established magnitudes and reduced to the B photoelectric system. Errors are believed to be of order $\pm 0^{m}.3$, but changes of $\pm 0^{m}.2$ could be detected readily. At no time during the investigation was Gunlöd much above the $\sim 15^{m}$ limit of the telescope. Due to poorer sky transparency at low altitude observations could be obtained on any one night only during a time interval of about 4 hours centered on transit.

After an initial failure to find the object Feb. 13.26, I observed minor planet 657 Gunlöd Feb. 17.27 near $14^{m}.6$, about the value listed in the ephemeris volume. As is my usual practice, I looked for Gunlöd again later in the same night to check for motion and thereby confirm my identification. But at Feb. 17.35 the object had disappeared, evidently fainter than $15^{m}.0$. The possibility of large lightcurve amplitude was immediately suggested. The following night I again found Gunlöd at Feb. 18.18, $\sim 14^{m}.7$, the motion since Feb. 17.27 being consistent with that predicted and rendering the identification highly probable. At Feb. 18.22 I possibly barely glimpsed Gunlöd near $15^{m}.1$. Repeated attempts to find Gunlöd every 20 to 30 minutes, alternating with observations of other asteroids in my program, from Feb. 18.24 to Feb. 18.32 all resulted in failure. Bad weather and increasing moonlight prevented additional observation in February.

On March 6.12 I again found Gunlöd, $14^{m}.8$. There was some hint of brightening to $14^{m}.7$ by Mar. 6.14; then Gunlöd faded, disappearing at $15^{m}.0$ about Mar. 6.21 and not seen again by Mar. 6.26 when increasing moonlight terminated observation. On this occasion motion between Mar. 6.12 and 6.21 was unmistakable and there could be no doubt about the correctness of the identification.

March 18 featured excellent weather and I again found Gunlöd Mar. 18.09, $\sim 15^{m}.0$. Thereafter it faded, last glimpsed $\sim 15^{m}.2$ Mar. 18.13, and remained invisible until Mar. 18.29 when it was again barely glimpsed $\sim 15^{m}.1$, its motion since Mar. 18.09 unmistakable and consistent with that predicted. On Mar. 18.31 I barely glimpsed Gunlöd for the last time as decreasing altitude in the southwest prevented further observation.

Negative efforts to observe Gunlöd were also recorded at 20 to 40 minute time intervals Mar. 15.14-15.29 and Mar. 19.10-19.23. It is not evident whether these failures were due to inferior sky conditions or to Gunlöd being near lightcurve minimum throughout the interval.

From the observations of Feb. 17 and 18 we can see that the rapidly fading part of the light curve was repeated at an interval of 22 $\pm$ 1 hours. With the usual assumption that the lightcurve variation is due to rotation of an elongated object, we can derive a rotation period which is an integer divisor of 44 $\pm$ 2 hours, that is near 44, 22, 15, 11, ... hours. Of the four nights on which positive observations were obtained, only Mar. 18 revealed both the rising and falling parts of the light curve, but as these were recorded 4 hours apart very long (22 or 44 hours) and very short (less than 11 hours) periods are both ruled out. Thus we conclude that the period of rotation is either 15 or 11 hours, with an uncertainty of 5%, but the available data are insufficient to distinguish between these two possibilities.

Variation of $0^m.4$ was positively measured. A consideration of light curve properties for highly elongated objects shows that the actual amplitude is probably much larger than this. Planets 433 Eros, 624 Hektor, and 1620 Geographos show broad maxima and deep but narrow minima as the cross sectional area of an elongated object presented to Earth only briefly lies at near its smallest value. Only near maximum was Gunlod within reach of the C14; this was followed by at least 3 hours of invisibility. Thus it appears that minimum was far below the $15^m.0$ to $15^m.1$ limit, probably $15^m.5$ or fainter, and the amplitude is near $1^m.0$ or possibly even larger.

In observations of over 900 main-belt asteroids I have never before encountered a rotational variation anywhere nearly this large. Only for Earth-approachers 433 Eros, 1620 Geographos, and 1978 CA have I seen such large variation. The most recent tabulation of lightcurve parameters[1] shows no main belt asteroids with rotational amplitudes exceeding $0^m.8$ and very few exceeding $0^m.5$. Only non main-belt objects Eros, Geographos, and the Trojan 624 Hektor among asteroids with known lightcurves have amplitudes of 1^m or greater.

Planet 657 Gunlod is thus seen to have a larger amplitude lightcurve than known for any other main belt asteroid. The rotation period is much longer than that of any of the large amplitude non main belt asteroids mentioned above. Gunlöd has a unique lightcurve and deserves further study. So large an amplitude makes Gunlod an excellent candidate for photographic or visual photometry, unlike most small-amplitude asteroids for which quality light curves can be obtained only photoelectrically. If the orbital and rotational poles are nearly 90° apart, as for some other large amplitude asteroids, then the amplitude might be much smaller at some future apparitions. David Bender, Jet Propulsion Laboratory, has privately distributed a tabulation of opposition circumstances 1980-1990 for over 2100 asteroids. His list shows that Gunlod will have another near-perihelion opposition 1984 Jan. 26 at aspect not too different from that in the 1980 opposition. A large amplitude light curve can be predicted again for early 1984, and observers able to reach B = 15 or fainter are strongly urged to plan a massive observational assault over several weeks to determine an accurate and definitive rotation period and amplitude.

REFERENCES

1. Tedesco, E. F., in Asteroids, ed. by T. Gehrels, U. of Ariz. Press, 1979, pp 1098-1107.

OBSERVER OF THE YEAR

In view of the fact that Ramon E. Fabré secured 1,237 positional observations of 198 different minor planets during the year 1978, the Recorder is happy to name him "Observer of the Year." The fact that his observations were made with telescopes of 20 cm aperture is an indication of what can be accomplished with that size instrument when it is in the hands of a dedicated person.

The Recorder would also like to commend Prof. Pilcher for his extensive observing work in 1978, and for his excellent positional observations report.

MINOR PLANET ROTATIONS 1978-1979

by Alain C. Porter and Derek Wallentinsen

The Photometry Division of the A.L.P.O. Minor Planets Section has received 25 observations in the past year. This is almost exactly the same number as was received in the year 1977-1978, but there is an encouraging difference: three of this year's light curves are photoelectric. We feel this is a sign of serious, long-term interest in the photometry program, and hope it will encourage other amateurs and college/university student groups to make contributions which can prove valuable, whether they are visual, photographic, or photoelectric.

This report covers observations made between January 13, 1978 and January 30, 1979, not discussed in the preceding report (cf. MPB 6, 19-20, 1978).

Table: The Observations

Planet Number	RB	DH	GH	PK	TM	AP	BS	Planet Total
4						6		6
9						2		2
12		2		2				4
21		1						1
42	1*							1
69							1	1
79			1					1
270						5		5
324					1*			1
354	1*							1
377							1	1
405		1						1
Observer Total	2	4	1	2	1	13	2	25

Observers

RB = Richard Binzel, St. Paul, Minnesota, U.S.A.

DH = David Hough, South Plainfield, New Jersey, U.S.A. (15 cm reflector)

GH = Guy Hurst, Northampton, England (26 cm reflector)

PK = Phillip Kirby, Springfield, Ohio, U.S.A. (15 cm reflector)

TM = Thomas McFaul, Hopewell Junction, New York, U.S.A.

AP = Alain C. Porter, Narragansett, Rhode Island, U.S.A. (15 cm reflector, 7x35mm binoculars (for Vesta only))

BS = Bruce Sumner, Perth, Australia (20 cm Celestron)

* denotes photoelectric observation

PRIMARY RESULTS

4 Vesta

Porter made a series of observations of this object primarily to test his magnitude resolution. Vesta has a well known period of $5^h20^m31^s.7$ with an amplitude of 0.1 to 0.13 magnitudes (eg, Gehrels 1967). Such a tiny variation would be only marginally detectable to the naked eye. In fact, on only 2 of the nights were the light curves long enough, and the variation appreciable enough, to merit comment. These were 1978 June 7, 5^h00^m to 6^h51^m UT, and June 10, 2^h33^m to 6^h42^m UT. The comparison stars used were SAO 160046 and SAO 160052. Their magnitudes are given in the SAO Star Catalog as 5.0 and 5.6, respectively. These figures seem doubtful, for if they are accepted, the conclusion is that Vesta was varying between magnitudes 5.1 and 5.4, whereas its predicted magnitude was 5.5.

On June 7 Vesta appeared fairly steady at 5.2 (provisional magnitude). On June 10 it rose from a minimum, peaked at mag. 5.1 at 4^h40^m and then began a slow decline. These data, as far as they go, are consistent with previous ones. Groeneveld and Kuiper's (1954) light curves show maxima which are broad and flat, so there seems to be no difficulty with the apparent constancy on the first night's run: it would have been around the time of maximum.

The remaining observations are not discussed, since they are short, scattered, and were made with different comparison sequences, which have not been calibrated to the one above. The authors' hope is that photoelectric observations were made last year, and will soon be available for a firm evaluation of these observations.

9 Metis

This object has been observed extensively before, both professionally and by non-professional members of the A.L.P.O. This year the data are insufficient to derive a period. A minimum was suspected at 5^h37^m UT on 1978 September 5, but an observation made the next night showed no variation of the type expected; only slow fading. Metis has a highly inclined pole in Aquarius, and was in Capricornus at the time of the observations. At such times, its observed amplitude has been only about 0.1 magnitudes, so it is not surprising that nothing definite has come of this opposition.

12 Victoria

The only light curve that showed a coherent variation was Kirby's of June 15. Between 2^h41^m and 4^h37^m it showed Victoria brightening from m_v 9.4 to 8.9, with an apparent maximum toward the end of that period. This is at least consistent with Tempesti and Burchi's (1973) period of $8^h39^m.2$ and amplitude of $0^m.33$. Hough, however, observing for 2 hours -- supposedly an entire branch of the light curve -- on both June 11 and 12 saw no variation. This is more consistent with Tempesti and Burchi's pole, which they place at λ_o=242° in Scorpius. Victoria was in Ophiuchus at the time.

42 Isis

Binzel's 1^h46^m photoelectric light curve was made with a 1P21 photomultiplier and the 30.5 cm Cassegrain reflector at Macalester College, St. Paul, Minnesota. The light curve clearly is not a simple sine curve; it more nearly resembles that of an object like 29 Amphitrite or 471 Papagena. These objects have 3 maxima and minima due to highly irregular shape and varying albedo. The light curve was halted by clouds. Isis has not been observed before, so nothing further can be said at this point. Further observations are important to determine whether or not Isis is really like the asteroids mentioned; these objects are rare.

69 Hesperia

Sumner observed from 1979 January 12^h40^m to 17^h10^m producing a light curve with an apparent amplitude of at least 0.3 magnitudes, perhaps 0.5 to 0.6. The high maximum could be error, but cannot be ruled out, given the rapidity of the variation in the whole curve and the isolation of the two points of which it consists. Based on the one observing session, the period seems to be short, but more work is necessary.

270 Anahita

Three timings were obtained, as follows:

U.T. 1978	July 29	4^h40^m	min
	Sept 2	3 33	MAX
	Sept 6	3 00	min

In the 1975 Photometry Report (Porter and Wallentinsen 1975), it was concluded that Anahita had a synodic period of 17^h37^m. Later Zappala (1977; Scaltriti and Zappala 1978) confirmed that the period was longer than 12 hours. Now Harris and Young (1979, in preparation) have determined a precise and accurate period of $15^h03^m.6$. They have kindly furnished their 5 nights of observations in advance of publication. Porter's light curve of July 29 partly overlaps one of their runs, and agrees with it to within a few minutes. With a knowledge of their period, the September features can be identified, and a period of $15^h03^m.7$ derived, in excellent agreement with the photoelectric results.

In the 1975 report, it was also mentioned that Anahita's maxima seemed broader than its minima. Both the visual observations in 1978 and Harris and Young's photoelectric work confirm this phenomenon.

324 Bamberga

McFaul made a 2.5 hour photoelectric observation using a 20 cm Schmidt Cassegrain and a OOAA Model SSP photometer. An amplitude of 0.4 magnitudes, and a minimum at around 1978 October 3, 7^h00^m UT is indicated. The data points are sparse, so no more can be said. Bamberga has been observed previously, by Gehrels and Owings (1962), and seemed then to have a period of some 8 hours with an amplitude of 0.07 magnitudes. McFaul's observation could be fitted to a period of this length. The different amplitude could be the sign of a highly inclined axis. Bamberga was in Perseus in 1978, and in Leo in 1958. The pole could be near the latter position.

354 Eleonora

Binzel's photoelectric light curve agrees with previous ones. Eleonora has always shown unequal maxima and minima, and its light curve changes shape with phase angle. Binzel's timings,

UT 1978	May 10	$5^h41^m.3$	min
		7 12.0	MAX,

with a hump on the intermediate rising branch, suggest that the maximum observed is the primary maximum M_1 of Zappala et al.(1979). It should be noted that Eleonora's period, $4^h16^m.6$ is much less than four times this interval.

An Exhortation

This report brings the Photometry Division's light curve total to 170. Unfortunately, only about 50 of these have been made within the last 2 years, and as of this writing (late 1979), no further observations have been received for the year 1979! We thank our regular contributors, ask old observers to renew their commitments if they can, and invite others to get involved. So often our discussions have concluded "...further observations are necessary." As this report shows, enough time has passed so that some of those further observations are being made. But many remain to be done, and more are being added to the list all the time. Now that even serious amateurs are making photoelectric observations, there is all the more need for visual photometry to supplement and guide them. Coordinated, though independent, observing runs on a particular planet would be quite valuable, especially if three or more observers can participate.

Interested people should contact the Photometry Division Coordinators for further information:

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Predictions of passes of asteroids through AAVSO variable star fields during the current year are available from Mr. Wallentinsen free of charge. Observing forms are available for a self-addressed stamped envelope (from U.S. observers) from Mr. Porter. Completed observations should be sent to Mr. Porter as soon as the observing apparition is ended.

References

1. Gehrels, Thomas (1967) Astronomical Journal 72, 929.
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METHOD FOR CALCULATING AN OBJECT'S POSITION USING TWO REFERENCE STARS

by Claude McEldery

Introduction

Whenever data is submitted for analysis it will always be presented this way:

(1) The object will always be north or south of reference stars. S_1 shall always be nearest object in declination.

(2) Or the object will always be east or west of reference stars; in which case S_1 shall always be nearest object in right ascension.

There are eight possible combinations. These are illustrated at the bottom of this page.

I. Determine arc separation between reference stars.

Let Arc Separation = r_3 Let $A = \frac{a_1 - a_2}{4}$

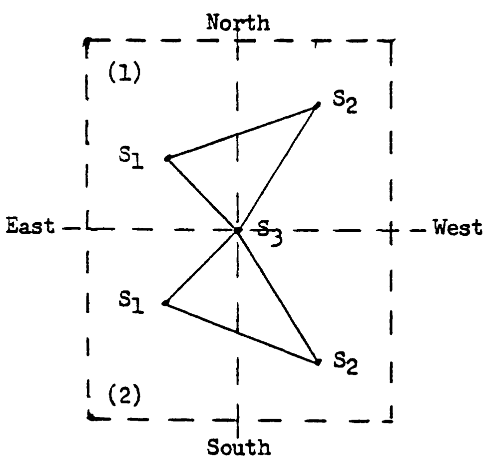
Then:

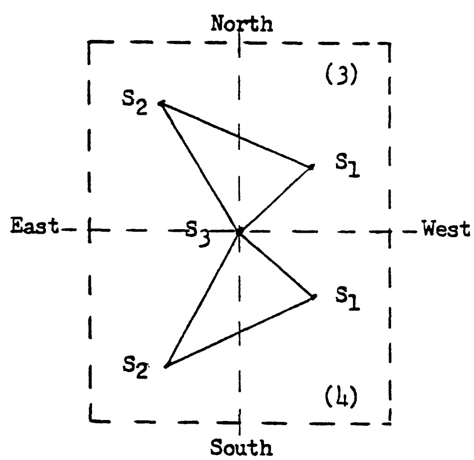
$$r_3 = \text{arc cos } (\sin \delta_2 \sin \delta_1 + \cos \delta_2 \cos \delta_1 \cos A)$$

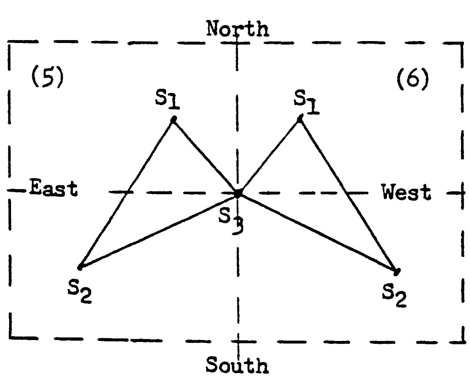
Notes - a_1 and a_2 expressed in minutes of R.A., and δ_1 and δ_2 expressed in degrees.

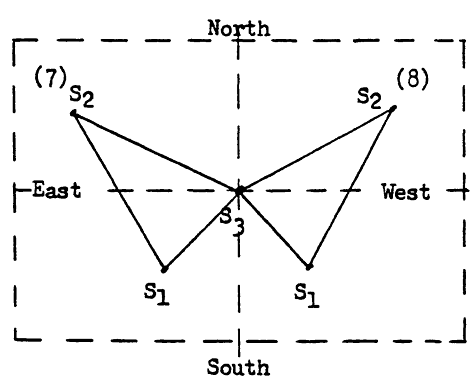
II. Determine arc separation between reference stars and the object.

Let m_1, m_2, and m_3 represent measured distances between the first reference star and the object, second reference star and the object, and between reference stars respectively. This to be measured directly on the photograph.









Also let S_1 = first reference star

S_2 = second reference star

S_3 = the object

In step I

S_1 to $S_2 = r_3$

then

$r_3 = m_3$ (by direct measurement of picture)

Calculating further

S_1 to $S_2 = r_1 = \frac{r_3 m_1}{m_3}$ $\quad$ S_2 to $S_3 = r_2 = \frac{r_3 m_2}{m_3}$

Notes - measurements of m_1, m_2, and m_3 can be in inches, millimeters, or any units that are convenient for you. Measure carefully. The higher accuracy you achieve, the better your answer will be.

III. Determine the angles in the three corners of the triangle formed by the object and two reference stars.

Let the angle at: S_1 = A, S_2 = B, S_3 = D, and sides opposite equal r_2, r_1, and r_3 respectively.

Then

$$A = \text{arc cos}\left[\frac{\cos r_2 - \cos r_1 \cos r_3}{\sin r_1 \sin r_3}\right]$$

$$B = \text{arc cos}\left[\frac{\cos r_1 - \cos r_2 \cos r_3}{\sin r_2 \sin r_3}\right]$$

$$D = \text{arc cos}\left[\frac{\cos r_3 - \cos r_1 \cos r_2}{\sin r_1 \sin r_2}\right]$$

Checking:

$A + B + D = 180°$ (approximately - there can be more than 180° in a spherical triangle)

Notes - Angle B is the only necessary number needed for further calculations.

IV. Determine the Position Angle of S_1 from S_2

$$P.A._1 = \text{arc cos}\left[\frac{\sin \delta_1 - \cos r_3 \sin \delta_2}{\sin r_3 \cos \delta_2}\right]$$

V. Now Calculate the declination (δ_3) of the Object (S_3)

(1) From steps III and IV we can determine the position angle of the object (S_3) from S_2.

Calculating - If S_3 is north of the reference stars

or,

If S_3 is east or west of the reference stars

And S_1 is south of S_2 then:

$P.A._2 = P.A._1 - B$ (Cases 2,4,7,8)

If S_3 is south of the reference stars

or,

If S_3 is east or west of the reference stars

And S_1 is north of S_2 then:

$P.A._2 = P.A._1 + B$ (Cases 1,3,5,6)

(2) From step II we know r_2, then:

$$\delta_3 = \text{arc sin}(\sin \delta_2 \cos r_2 + \cos \delta_2 \sin r_2 \cos P.A._2)$$

VI. Now Calculate the R.A. (a_3) of the Object (S_3).

(1) First determine the Δa from S_2.

$$a = 4\left\{\text{arc cos}\left[\frac{\cos r_2 - \sin \delta_3 \sin \delta_2}{\cos \delta_3 \cos \delta_2}\right]\right\}$$

(2) If the object is east of S_2 (Cases 1,2,6,8)

then: $a_3 = a_2 + \Delta a$

(3) If the object is west of S_2 (Cases 3,4,5,7)

then $a_3 = a_2 - \Delta a$

[Editor's Note: Claude McEldery's paper concludes with a work sheet which is reproduced without photoreduction for the convenience of possible users on page 31 of this issue. Readers may feel free to Xerox or otherwise reproduce this form.

The Editor has been given to understand that Mr. McEldery will no longer be able to make positional observations as he has in the past due to personal misfortunes, and that the above paper is his final contribution to the Minor Planets Section. The above paper is a fine monument to a capable and diligent positional observer. We shall miss him, and only hope that others will step forward to continue the work in which he has been engaged.]

LETTER

To the Editor:

Although Apollo-Amor objects (abbreviated A-A objects in this letter) have been regarded as plausible candidates for extinct comets, A-A objects' aphelia are well inside Jupiter's orbit unlike those of short-period comets. This aphelion reduction seems to be difficult to explain by Whipple's jet effect. Hence the author hypothesized that Earth's or Venus' gravitational attraction had reduced comets' aphelion distances when the comets had passed close to Earth or Venus.

It has been found that there exists a remarkable agreement between the Jacobi constants* of A-A objects and those of hypothetical short-period comets that enter shallowly inside or graze the orbit of Earth or Venus. This fact appears to support the above hypothesis, because Jacobi constants approximately remain unchanged in the Sun-planet-comet (A-A object) system, according to the restricted circular three-body problem.

Also, the computer simulation of the close encounter events shows that a close approach of several ten thousand kilometers can turn a short-period comet into an A-A type orbit.

* Jacobi constant $C = 1/a + 2\sqrt{a(1-e^2)}\cos i$ the unit of length is the Sun-planet distance (viz. Sun-Earth or Sun-Venus distance), and i refers to the planet's orbital plane.

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(Work Sheet)

POSITIONAL ANALYSIS OF PHOTOGRAPH

OBJECT ______________ OBSERVER ______________

DATE ________ TIME ________ LOCATION ______________

TELESCOPE ______________ DATE OF OPPOSITION ______________

FILM ______________ SUBJECT: Calculate objects R.A. & DEC. using two reference stars and spherical trigonometry.

CAMERA ______________ CASE # ________

* *

REFERENCE STARS: S_1 = SAO# ______________ Mv _____ Spectral Type _____

R.A. ______________ DEC. ______________

S_2 = SAO# ______________ Mv _____ Spectral Type _____

R.A. ______________ DEC. ______________

ASTROMETRIC MEASURES:
(From Photograph)

m_1 = ______________

m_2 = ______________

m_3 = ______________

DECIMAL EQUIVALENT OF DECLINATIONS:

DEC_1 = ______________

DEC_2 = ______________

* * * * * * * * * * * * * *

IV. $P.A._1$ = ______________

V. $DEC._3$ = ______________

VI. $R.A._3$ = ______________

* * * * * * * * * * * * * *

I. r_3 = ______________

II. r_2 = ______________

r_1 = ______________

III. B = ______________

* *

TABLE OF DIFFERENCES

R.A. DEC.

t = ______________ T ________

Third Order Interpolations:

R.A. ______________

DEC. ______________

ANALYSIS:

Predicted Position R.A. ______________ DEC. ______________

Observed Position R.A. ______________ DEC. ______________

Residuals R.A. ______________ DEC. ______________

ERRATUM

Prof. Frederick Pilcher very kindly has called attention to a typographical error in the alphabetical list of minor planet names in MPB 7, 14: the name of planet 1910 should be spelled Mikhailov. Subscribers should please note this correction.

NEWS NOTES

216 KLEOPATRA. D.J. Tholen of the Department of Planetary Sciences, University of Arizona, reports that his recent photometry of 216 Kleopatra suggests the planet has an M or E type surface chemistry, and is therefore of higher albedo and smaller diameter than previously thought. Older diameter estimates suggested 219 km; Tholen estimates the maximum diameter range from 126 to 59 km. Kleopatra also has a large-amplitude light variation indicating that it is very elongated. He estimates the minimum diameter in the range of 68 to 31 km. This information will be of interest to occultation observers.

Occultations of stars by 216 Kleopatra occur in 1980 on October 10, November 6, and November 21. Hopefully one or more of these events will be well enough observed to permit an improved knowledge of the dimensions of this unusual planet.

1980 PA. H.-E. Schuster of the European Southern Observatory discovered a fast-moving asteroidal object, now designated 1980 PA, on August 6. The object was then seventeenth magnitude. Subsequent observations by several observers through September 7 have permitted C.M. Bardwell of the Harvard-Smithsonian Center for Astrophysics to calculate the following improved orbital elements for planet 1980 PA:

T = 1980 Oct. 10.755 ET	
ω = 124°.721	e = 0.45841
Ω = 261.933 1950.0	a = 1.92484 AU
i = 2.155	n° = 0.369074
q = 1.04248 AU	P = 2.67 years

From the above data it is evident that 1980 PA is an Amor-type planet that can approach within 7 million km of Earth under favorable conditions. This year's separation was somewhat more than 22 million km. (Cf. IAU Circular 3512)

118 PEITHO. R. Stanzel and H.J. Schober report a rotation period (synodic) for this planet of $7^h.78 \pm 0^h.05$ and an amplitude of $0^m.33$ based on photoelectric observations made on December 2/3 and December 3/4, 1977. (Cf. Astronomy & Astrophysics Suppl. Ser. 39,3-5 (1980))

952 CAIA. R. Stanzel and H.J. Schober also report a rotation period (synodic) for Caia of $7^h.51 \pm 0^h.03$ and a maximum amplitude of $0^m.13$ based on five nights of photoelectric observation during the 1978 October opposition. (Cf. Astronomy & Astrophysics Suppl. Ser. 39, 3-5 (1980))

LONG-LOST PLANET 1370 HELLA RECOVERED. A letter from Dr. Lutz D. Schmadel of the Astronomisches Rechen-Institut, Heidelberg, West Germany, to the Editor reports recovery of long lost 1370 Hella by Hans-Emil Schuster, European Southern Observatory, La Silla, Chile, as a result of Dr. Schmadel's reexamination of the old 1935 Heidelberg Königstuhl observations. This is indeed welcome news, and represents Dr. Schmadel's second success in recovering long-lost minor planets -- his work was responsible for the recovery of 1206 Numerowia several years ago. Details have been submitted to the Astronomische Nachrichten for publication.

RD-TYPE MINOR PLANET SURFACES. Studies of the more remote minor planets reveal the fact that many have very low albedos (like the C-type that are the overwhelmingly predominant type in the outer portion of the Minor Planet Belt), yet are distinctly red in color. These are now designated RD (red - black) type. The RD type are particularly found among the Trojan asteroids, which orbit the Sun at the mean distance of Jupiter, and may also be characteristic of cometary nuclei remote from the Sun. According to J. Gradie and J. Veverka of Cornell University the surface material contains tar-like organic substances called kerogen. Small amounts of this complex organic molecule have been found in some carbon-rich meteorites. Gradie and Veverka obtained their sample from the residue remaining after soluble substances were removed from coal tar. The residue's spectral characteristics were then very much like that of the RD minor planets.

ARE ASTEROIDS GROOVY? According to P. Thomas and J. Veverka of Cornell University, perhaps as many as one fourth of all minor planets smaller than 100 km diameter may have grooved surfaces like that found on the surface of Phobos, the inner satellite of Mars. They are of the opinion that Phobos' grooves, first dramatically revealed by the Mariner 9 photographs in 1972, are not the result of tidal forces caused by Mars' proximity to the small satellite, but rather chiefly the result of the extremely violent impact that formed Stickney, Phobos' largest crater. That impact came close to shattering Phobos.

Presumably many of the smaller minor planets have had occasional encounters with large meteoroids or very small asteroids during the course of their history, and may be similarly grooved as a result. Many astronomers regard Phobos and Deimos, the two Martian satellites, as former minor planets that were captured by Mars early in their history. If so (and one should understand that the hypothesis is far from proven), the grooves might stem from Phobos' days as a minor planet.

SECTION NEWS

The Recorder-Editor of the Minor Planets Section is happy to report his safe return to Sioux Center, Iowa, after a year's leave from teaching. The year in the West Indies living on a sailboat was quite an adventure, but not exactly conducive to keeping abreast of all developments in the asteroid field, nor for keeping the MPB on time. Your patience during the past year is very much appreciated. The next issue of MPB should appear at the end of 1980, and we hope thereafter to be on time...

We are delighted to learn that Dr. J.U. Gunter, a charter member of the Minor Planets Section, has been honored in the naming of planet 2136 JUGTA (his initials + initials of Tonight's Asteroids which he edits). It is an honor well deserved, for he has done much to promote amateur observations of minor planets.

* * * *

NEW ADDRESS AND TELEPHONE NUMBER. Please note that all correspondence for Prof. Richard G. Hodgson, the Section Recorder and Editor of MPB, should now be sent to him at Dordt College, Sioux Center, Iowa 51250, U.S.A. (He no longer lives at the address used in past years). His new home telephone number (for this academic year only) is 712-722-1513. The best time to call is in the evenings.

THE MINOR PLANET BULLETIN

BULLETIN OF THE MINOR PLANETS SECTION OF THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS

VOLUME 7, NUMBER 4, PART II: SPECIAL OBSERVER'S SUPPLEMENT

SPECIAL OBSERVER'S SUPPLEMENT

This special observer's supplement is intended as an aid for serious amateur observers and for college and university undergraduate students who would like to get involved in minor planet observations, but who do not (at the moment at least) have access to the necessary ephemerides, occultation predictions, and/or photometry opportunity predictions. Such information is available (see below), but given the speed of mails today it might be several weeks before such materials might come to hand, and the expense might be a deterent to those who at this point are unsure of just how deeply they might wish to become involved. In any event, valuable observing opportunities would be lost.

This supplement is intended to bring together enough information to get some useful observations started. There are (1) ephemerides for selected minor planets for late 1980 and early 1981. Some of these are fairly bright, and should be easily located; others are objects of special interest. Next (2) predictions of selected planets passing through American Association of Variable Star Observers' (AAVSO) variable star chart fields in November and December, 1980. With appropriate charts one can monitor the brightness variations of these planets (at, say, 10 minute intervals) and within a few night's observation determine possibly their rotation periods. The planets given all have unknown rotation periods. Experience in observing variable stars is helpful in this work. Finally (3) there are a few occultation predictions for late 1980 and early 1981 that will be favorably visible from current subscriber locations.

SELECT EPHEMERIDES. Positions given for 10 day intervals in most cases. α (= Right Ascension) and δ (= Declination) are for epoch 1950.0. "B" stands for the predicted magnitude in blue light of the UBV system; visual observers will find most planets about 0.7 or 0.8 magnitude brighter than these values; in some cases there may be errors of ½ magnitude or more in predicted values, in which case these objects should be monitored carefully to determine amplitude (if measurable), period (if possible), and mean brightness.

712 Boliviana

1980/81		α 1950.0	δ
IX	18	$1^h40^m.5$	+23°59'
	28	1 36.7	+23 08
X	8	1 30.6	+21 45
	18	1 23.3	+19 53
	28	1 16.8	+11 36
XI	7	1 10.6	+15 29

Notes: Highly favorable opposition this year; opposition on Oct. 16. Blue magnitude at opposition 11.5.

75 Eurydike

1980/81		α 1950.0	δ
IX	28	2 15.2	+17 18
X	8	2 07.9	+17 25
	18	1 58.6	+17 16
	28	1 48.8	+16 53
XI	7	1 40.1	+16 25
	17	1 33.8	+16 00

Notes: Opposition on 1980 Oct. 24, highly favorable; blue magnitude then 11.6.

78 Diana

1980/81		α 1950.0	δ
IX	28	$2^h20^m.6$	+25°18'
X	8	2 13.7	+25 35
	18	2 04.6	+25 32
	28	1 54.2	+25 10
XI	7	1 44.0	+24 30
	17	1 35.1	+23 41

Notes: Opposition on 1980 Oct. 25, somewhat more favorable than average; blue magnitude then 12.1.

354 Eleonora

1980/81		α 1950.0	δ
IX	28	2 18.9	-10 58
X	8	2 13.0	-12 29
	18	2 05.7	-13 48
	28	1 57.8	-14 48
XI	7	1 50.2	-15 22
	17	1 43.6	-15 30

Notes: Opposition on 1980 Oct. 26, somewhat less favorable than average; blue magnitude then 11.4.

1627 Ivar

1980/81		α 1950.0	δ
X	18	3 34.4	- 1 14
	28	3 19.9	- 2 18
XI	7	3 04.6	- 2 49
	17	2 50.9	- 2 42
	27	2 40.5	- 2 02
XII	7	2 34.1	- 0 56

Notes: Opposition 1980 Nov. 10, blue magnitude 14.8. Well-known Amor type planet, this opposition more favorable than average, but not really close; a challenge for the better equipped.

198 Ampella

1980/81		α 1950.0	δ
X	18	3 42.8	+31 47
	28	3 36.0	+31 06
XI	7	3 26.7	+29 58
	17	3 16.5	+28 27
	27	3 07.4	+26 45
XII	7	3 00.7	+25 02

Notes: Opposition 1980 Nov. 15, blue magnitude 11.4. Opposition quite favorable this year.

1862 Apollo: readers are reminded this famous planet will make a close approach to Earth in mid-November, and is expected to be 13.7 blue magnitude Nov. 17-20. See ephemeris published in MPB 7, 20.

6 Hebe

1980/81		α 1950.0	δ
X	28	4 02.3	- 7 45
XI	7	3 55.0	- 8 46
	17	3 46.0	- 9 12
	27	3 36.8	- 8 56
XII	7	3 29.1	- 8 02
	17	3 23.8	- 6 34
	27	3 21.6	- 4 43

Notes: Hebe is at highly favorable opposition on 1980 Nov. 21, and around this date will be blue magnitude 8.4 (about 7.6 visual), and can be easily followed, even with binoculars.

10 Hygiea

1980/81		α 1950.0	δ
X	28	4 00.8	+24 32
XI	7	3 53.7	+24 12
	17	3 45.5	+23 44
	27	3 37.2	+23 11
XII	7	3 29.4	+22 36

Notes: Hygiea, a large minor planet which is fairly remote, at opposition 1980 Nov. 21, $magnitude_{blue}$ = 11.3. Relatively unfavorable opposition in 1980.

704 Interamnia

1980/81		α 1950.0	δ
XI	7	4 58.4	+37 33
	17	4 50.2	+36 58
	27	4 40.3	+36 04
XII	7	4 30.0	+34 51
	17	4 20.7	+33 26
	27	4 13.4	+31 56
I	6	4 08.8	+30 27

Notes: This planet is at highly favorable opposition on 1980 Dec. 3; blue magnitude then 11.1.

1980/81		α 1950.0	δ
111 Ate			
XII	27	$8^h58.7$	+18°20'
I	6	8 52.7	+18 22
	16	8 44.1	+18 32
	26	8 34.0	+18 43
II	5	8 23.8	+18 53
	15	8 15.1	+18 57
	25	8 08.7	+18 56

Notes: Ate is at highly favorable opposition on 1981 January 26, when it is expected to be blue magnitude 11.6.

For well equipped observers planet 1865 Cerberus will make a highly favorable approach to the Earth:

XI	1	2 58.57	+ 7 33.1	15.6mB
	3	2 52.77	+ 5 24.1	15.5
	5	2 46.51	+ 3 06.0	15.4
	7	2 39.80	+ 0 39.1	15.4
	9	2 32.65	- 1 55.5	15.4
	11	2 25.11	- 4 36.5	15.4
	13	2 17.21	- 7 22.6	15.4
	15	2 09.00	-10 11.8	15.4
	17	2 00.52	-13 02.1	15.5
	19	1 51.83	-15 51.5	15.5
	21	1 42.98	-18 38.1	15.6
	23	1 34.02	-21 20.1	15.7
	25	1 24.98	-23 56.2	15.7
	27	1 15.92	-26 25.4	15.8
	29	1 06.87	-28 46.9	15.9
XII	1	0 57.86	-31 00.2	16.0

Notes: 1865 Cerberus is an Apollo planet; closest approach to Earth occurs about 1980 Nov. 22, but will be brighter and better placed for northern observers during the period Nov. 3-15. Photometry is much desired. Because of the glare of the Moon, the early part of the month of November is much to be preferred.

For those who would like to try some visual (or photometric) photometry observations, planets 47 Aglaja and 751 Faina will be well placed in the dark of the Moon in early December. Their light curves are unknown. Both have C-type surfaces; their estimated diameters are 135 km and 105 km respectively; their approximate visual magnitudes at the time are expected to be 12.4 for Aglaja and 11.7 for Faina. Under each listing below are given the Harvard designation of the variable star at the center of the chart field, the variable star name, the AAVSO star charts involved, the 1950.0 position of the variable star, and the polar coordinates (ρ, θ) of the minor planet relative to the variable star for 0^h UT of the dates indicated.

47 Aglaja

0501+30 RW Aur	Dec. 06	32'	129°
D, E	07	24	152
$05^h04^m.6$ +30°20'	08	22	185
	09	28	214
	10	38	230

751 Faina

0529+24 CQ Tau	Dec. 08	30	182
D	09	28	217
$05^h32^m.9$ +24°43'	10	36	245

To order the necessary charts to observe the above planets, give the Harvard designation and variable star name, followed by the chart letter(s). Charts are available from AAVSO, 187 Concord Avenue, Cambridge, Massachusetts 02138, U.S.A. for $ 0.25 each; a self-addressed stamped envelope should be included with each order. Report results to Alain C. Porter (address given in next column) without delay.

For those who wish to participate in observing the occultation of stars by adequately large minor planets there will be opportunities in the next few months for those living in relatively out-of-the-way places. Favorable opportunities for European and North American observers (who constitute the large majority of our subscribers) appear nil until the 1981 March 19 event involving 48 Doris, visible in the north-central U.S.A. and western Canada. Doris has an estimated diameter of 148 km, which should make an adequately wide shadow-path on the Earth. Another possible event is that of 1981 January 8 involving 44 Nysa, expected to be visible in northern Spain, southern Italy, Asia Minor, and the Middle East in darkness, but its diameter is only estimated to be 72 km, yielding a rather narrow path to intercept. If the predicted path of this event should be revised in a northerly direction it would come near a number of MPB subscribers, and should then be observed.

In the data given below the predicted times and latitude/longitude positions are given, together with data on the star's position, and notes.

1980 Nov. 21 216 Kleopatra - SAO 128184

00^h57^mUT	151.°0W	+19.°9
59	129.6W	+17.2
01 01	115.4W	+14.1
03	103.6W	+10.9
05	93.0W	+07.7
07	82.9W	+04.4
09	72.7W	+01.0
11	62.1W	-02.5
13	50.1W	-06.1
15	35.1W	-10.0
17	02.8W	-14.7

216 Kleopatra: diameter estimate 219 km; duration 21^s; $mag._v$ = 10.4

SAO 128184 ($mag._v$ = 6.8) spect. K0; 1950.0 position $23^h24^m.2$, + 02°12'

Notes: visible Hawaii, central Pacific (daylight-twilight); Colombia, northern Brazil, S. Atlantic (darkness).

1981 Jan. 8 44 Nysa - SAO 119165

02^h08^mUT	23.°1W	+44.°0
10	00.3E	+41.9
12	16.1E	+39.7
14	29.1E	+37.3
16	40.8E	+35.0
18	51.9E	+32.6
20	63.0E	+30.2
22	74.7E	+27.7

44 Nysa: diameter est. 72 km; duration 8^s; $mag._v$= 10.3

SAO 119165 ($mag._v$ = 8.9) G0 1950 position $11^h58^m.4$,+02°09'

Notes: Visible n. Spain, s. Italy, Asia Minor, Middle East in darkness.

1981 Mar. 19 48 Doris - SAO 118832

UT$11^h40^m00^s$	93.°9W	+45.°4
20	100.9W	+47.4
40	104.8W	+49.4
41 00	107.8W	+51.4
20	110.1W	+53.5
40	111.8W	+55.6
42 00	113.0W	+57.9
20	113.5W	+60.2
40	113.2W	+62.8

48 Doris diameter est. 148 km; duration 11^s; $mag._v$ = 11.3

SAO 118832 ($mag._v$ = 9.0) K2 1950.0 position $11^h21^m.9$, +02°12'

Notes: Darkness visibility in north-central U.S.A., western Canada.

Occultation observers should always be alert for last minute changes in event coordinates. Often these appear in the IAU Circulars. Occultation results should be communicated to Dr. David W. Dunham, P.O. Box 488, Silver Spring, Maryland 20907 (tel. 301-585-0989) promptly.

For those amateurs and students who intend to make extensive positional observations, a copy of the yearbook Ephemerides of Minor Planets is a necessity, and may be ordered via V/O "Mezhdunarodnaja kniga" Moscow, U.S.S.R. through national booksellers maintaining business contacts therewith. Cost in 1979 was $ 6.00 US; current price is not known to this writer.

For more data on future photometry opportunities, write Derek Wallentinsen, 3131 Quincy NE, Albuquerque, New Mexico 87110, U.S.A. His excellent Occultations by Minor Planets 1979-1982 is available for $ 3.00 US from James-Mims Observatory, Inc., P.O. Box 15854, Baton Rouge, Louisiana 70895, U.S.A., and is recommended to all serious occultation observers.

Positional observations of minor planets should be sent to Prof. Frederick Pilcher, Illinois College, Jacksonville, Illinois 62650 U.S.A. Note that single observations of a given planet will not be received to avoid any cases of misidentification. Photometry observations should be sent to Alain C. Porter at his new address: 132 Sherman St., Apt. 6, Cambridge, Mass. 02138, U.S.A.

-- R.G. Hodgson

THE MINOR PLANET BULLETIN

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OF THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS

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LETTER

OBITUARY NOTICE

INDEX TO PLANETS DISCUSSED (Note: Does not include major lists such as the Positional Report or Pilcher's list of names, or planets at highly favorable opposition)