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ASTEROID LIGHTCURVE ANALYSIS AT THE OAKLEY SOUTHERN SKY OBSERVATORY: 2009 APRIL – MAY

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Photometric data for 30 asteroids were collected over 23 nights of observing during 2009 April and May at the Oakley Southern Sky Observatory. The asteroids were: 255 Oppavia, 957 Camelia, 1097 Vicia, 1454 Kalevala, 2009 Voloshina, 2217 Eltigen, 2610 Tuva, 2665 Schrutka, 2670 Chuvashia, 2869 Nepryadva, 3219 Komaki, 3432 Kobuchizawa, 3909 Gladys, 3999 Aristarchus, 4147 Lennon, 4154 Rumsey, 4358 Lynn, 4417 Lecar, 4654 Gor'kavyj, 5350 Epetersen, 5567 Durisen, (5773) 1989 NO, (5787) 1992 FA1, 5839 GOI, (6073) 1939 UB, (7255) 1993 VY1, 8151 Andranada, 13018 Geoffjames, (14720) 2000 CQ85, and (29665) 1998 WD24.

Thirty asteroids were observed from the Oakley Southern Sky Observatory in New South Wales, Australia, on the nights of 2009 April 14–23, 26–28, 30, and May 2–5, 13–15, 17, 23. From the data, we were able to find lightcurves for 17 asteroids. Out of those 17, 16 were previously unrecorded results. We were unable to determine periods for the remaining 13 asteroids.

Asteroids were selected based on their sky position about one hour after sunset. Asteroids without previously published lightcurves were given higher priority than asteroids with known periods, but asteroids with uncertain periods were also selected with the hopes that we would be able to improve previous results. A 0.5-m Ritchey-Chretien optical tube assembly mounted on a Paramount ME was used with a Santa Barbara Instrument Group STL-1001E CCD camera and a clear filter. The image scale was 1.2 arcseconds/pixel. Exposure times varied between 60 and 180 seconds. Calibration of the images was done using master twilight flats, darks, and bias frames. All calibration frames were created using *CCDSoft*. *MPO Canopus* was used to measure the processed images.

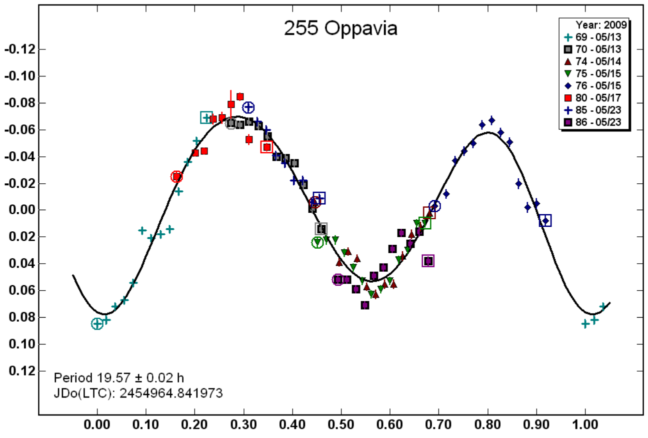
As far as we are aware, these are the first reported observations for the period of the following asteroids: 2009 Voloshina, 2217 Eltigen, 2610 Tuva, 2665 Schrutka, 3219 Komaki, 3999 Aristarchus, 4154 Rumsey, 4358 Lynn, 4417 Lecar, 5350 Epetersen, 5567 Durisen, (5787) 1992 FA1, 5839 GOI, (6073) 1939 UB, (7255) 1993 VY1, and 13018 Geoffjames. One asteroid, 255 Oppavia, had a published period of 14.3 ± 0.4 h found by Behrend (2009). Our data for 255 Oppavia could not be made to fit this period. Six of the asteroids appear to have long periods, but we did not get enough data to determine a rotational period. These were 1097 Vicia, 1454 Kalevala, 4147 Lennon, (5773) 1989 NO, (14720) 2000 CQ85, and (29665) WD24. For seven of the asteroids the lightcurve amplitude was smaller than random variation in our data, so no period could be found. This list includes 957 Camelia, 2670 Chuvashia, 2869 Nepryadva, 3432 Kobuchizawa, 3909 Gladys, 4654 Gor'kavyj, and 8151 Andranada. Results from all of the asteroids are listed in the table below.

Acknowledgement

Construction of the Oakley Southern Sky Observatory was funded with a grant from the Oakley Foundation and by a generous donation from Niles Noblitt.

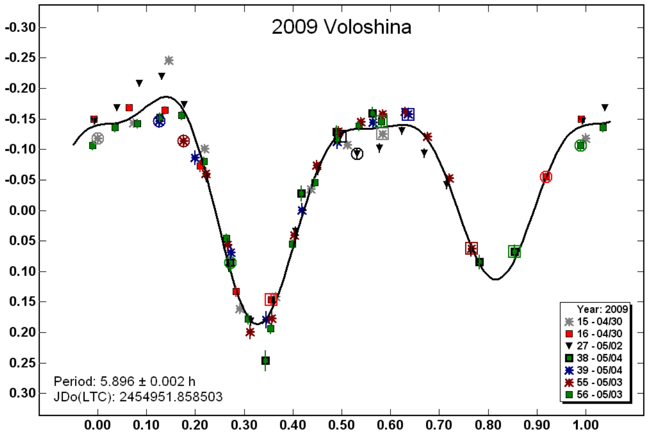
References

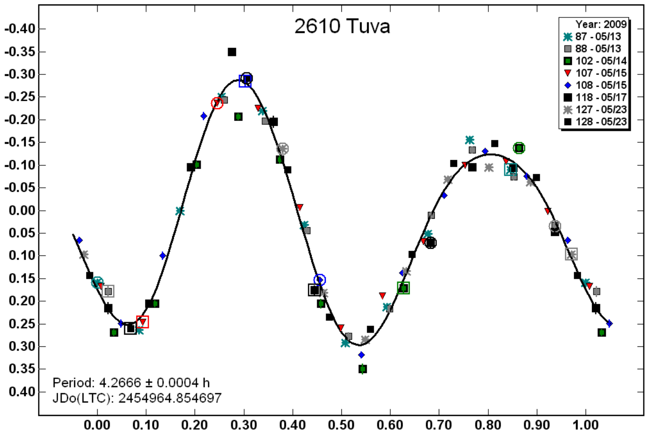
Behrend, R. (2009) Observatoire de Geneve web site, *http://obswww.unige.ch/~behrend/page_cou.html*

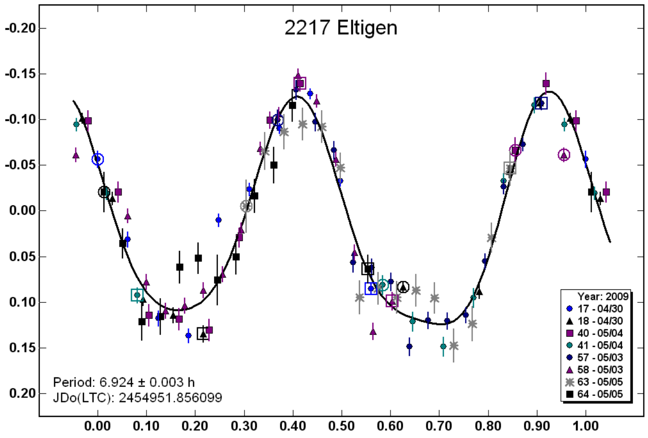


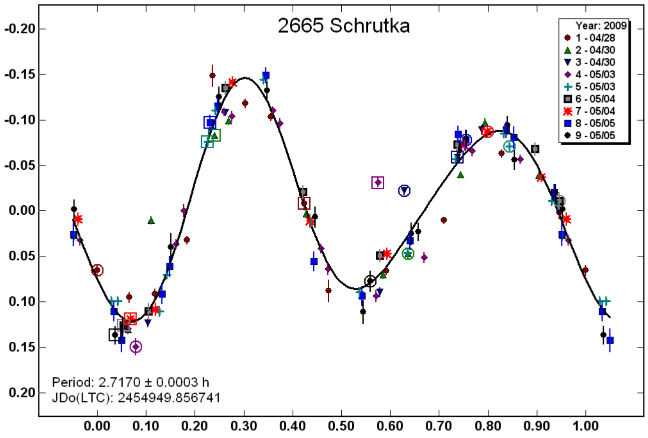
Number	Name	Dates 2009 (mm/dd)	Data Points	Period (h)	P. E. (h)	Amp (mag)	A.E. (mag)
255	Oppavia	5/13-15, 17, 23	91	19.57	0.02	0.15	0.02
957	Camelia	5/13- 15, 17, 23	87			0.1	
1097	Vicia	4/30, 5/3-5	84			0.1	
1454	Kalevala	4/20-23, 26	75			0.15	
2009	Voloshina	4/30, 5/2-4	77	5.896	0.002	0.40	0.05
2217	Eltigen	4/30, 5/3-5	96	6.924	0.003	0.24	0.03
2610	Tuva	5/13-15, 17, 23	81	4.2666	0.0004	0.60	0.05
2665	Schrutka	4/28, 30, 5/3-5	112	2.7170	0.0003	0.25	0.03
2670	Chuvashia	4/20-23, 26-27	90			0.14	
2869	Nepryadva	4/20-23, 26	73			0.1	
3219	Komaki	4/27-28, 30, 5/2, 4-5	112	3.8110	0.0006	0.16	0.02
3432	Kobuchizawa	4/14-19	75			0.04	
3909	Gladys	4/20-23, 26	74			0.04	
3999	Aristarchus	5/13-15, 17, 23	82	12.58	0.02	0.30	0.03
4147	Lennon	4/14-19	95			0.25	
4154	Rumsey	5/13-15, 17, 23	89	3.2569	0.0002	0.38	0.04
4358	Lynn	4/14-19	86	3.8377	0.0006	0.60	0.04
4417	Lecar	4/14-19	87	3.001	0.002	0.20	0.04
4654	Gor'kavyj	4/30, 5/2-4	81			0.1	
5350	Epetersen	4/20-23, 26	68	5.025	0.002	0.28	0.02
5567	Durisen	4/27-28, 30, 5/2, 4	84	7.001	0.003	0.22	0.02
5773	1989 NO	5/13-15, 17, 23	73			0.3	
5787	1992 FA1	5/13-15, 17, 23	87	4.0176	0.0004	0.20	0.02
5839	GOI	4/20-23, 26	75	6.303	0.003	0.35	0.03
6073	1939 UB	4/15-23, 26	133	5.897	0.002	0.20	0.03
7255	1993 VY1	5/13-15, 17, 23	83	9.022	0.003	0.18	0.03
8151	Andranada	4/14-19	88			0.04	
13018	Geoffjames	4/28, 30, 5/2, 4-5	104	4.3337	0.0004	0.56	0.03
14720	2000 CQ85	4/14-19	103			0.35	
29665	1998 WD24	4/14-19	88			0.16	

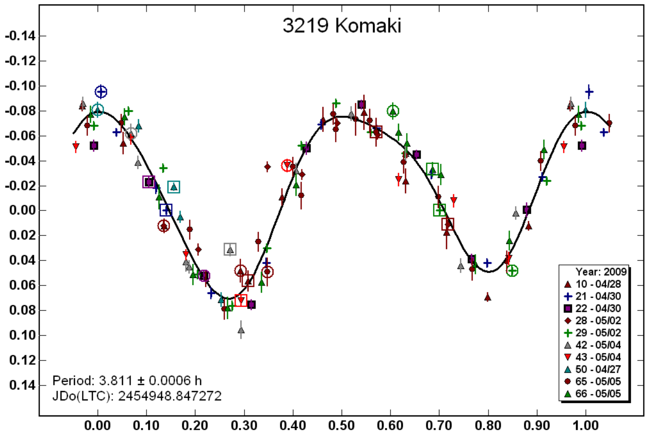
Table I. Circumstances for asteroids observed at Oakley Southern Sky Observatory between 2009 April and May.

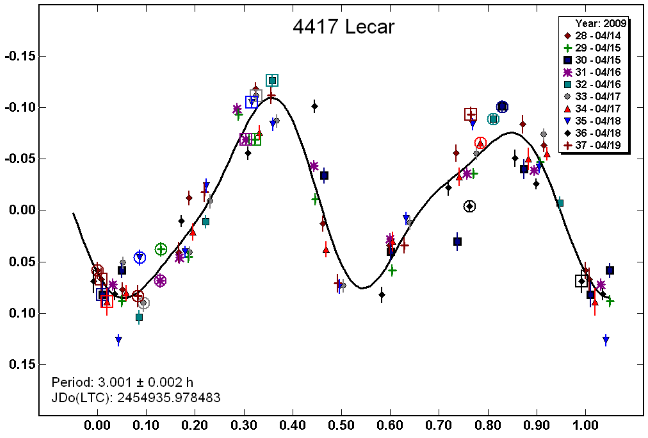


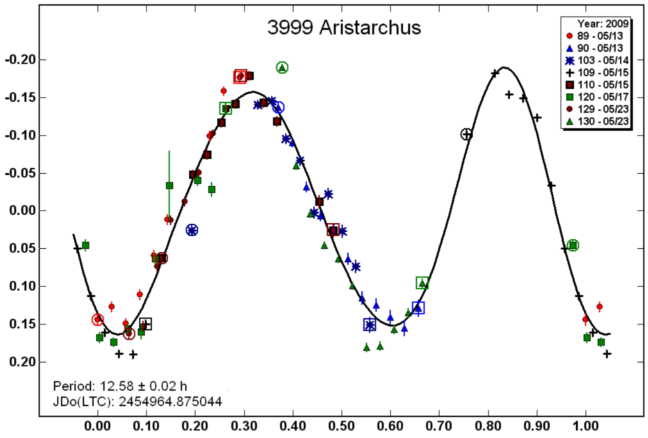


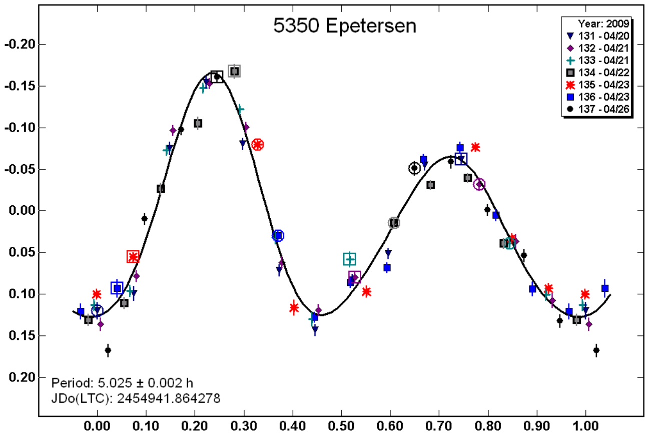





3219 Komaki
Year: 2009
10 - 04/28
21 - 04/30
22 - 04/30
28 - 05/02
29 - 05/02
42 - 05/04
43 - 05/04
50 - 04/27
65 - 05/05
66 - 05/05
Period: 3.811 ± 0.0006 h
JDo(LTC): 2454948.847272
-0.14 -0.12 -0.10 -0.08 -0.06 -0.04 -0.02 0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


4417 Lecar
Year: 2009
28 - 04/14
29 - 04/15
30 - 04/15
31 - 04/16
32 - 04/16
33 - 04/17
34 - 04/17
35 - 04/18
36 - 04/18
37 - 04/19
Period: 3.001 ± 0.002 h
JDo(LTC): 2454935.978483
-0.15 -0.10 -0.05 0.00 0.05 0.10 0.15
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


3999 Aristarchus
Year: 2009
89 - 05/13
90 - 05/13
103 - 05/14
109 - 05/15
110 - 05/15
120 - 05/17
129 - 05/23
130 - 05/23
Period: 12.58 ± 0.02 h
JDo(LTC): 2454964.875044
-0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


5350 Epetersen
Year: 2009
131 - 04/20
132 - 04/21
133 - 04/21
134 - 04/22
135 - 04/23
136 - 04/23
137 - 04/26
Period: 5.025 ± 0.002 h
JDo(LTC): 2454941.864278
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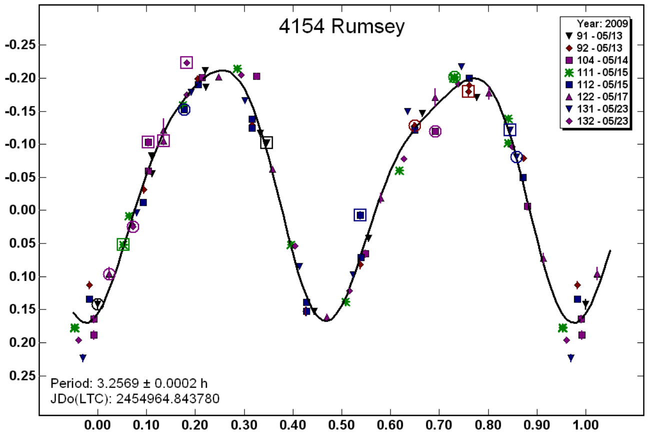
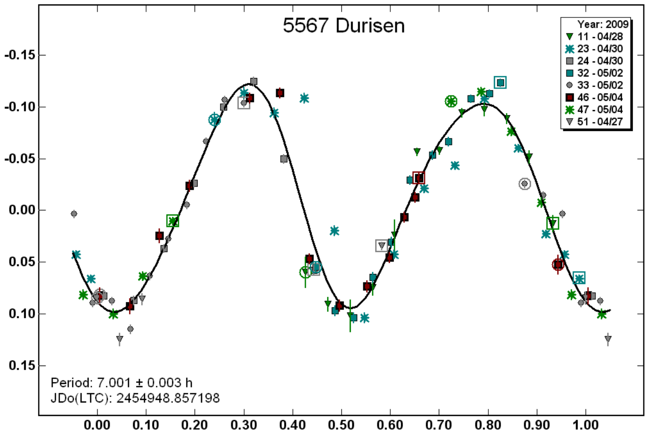
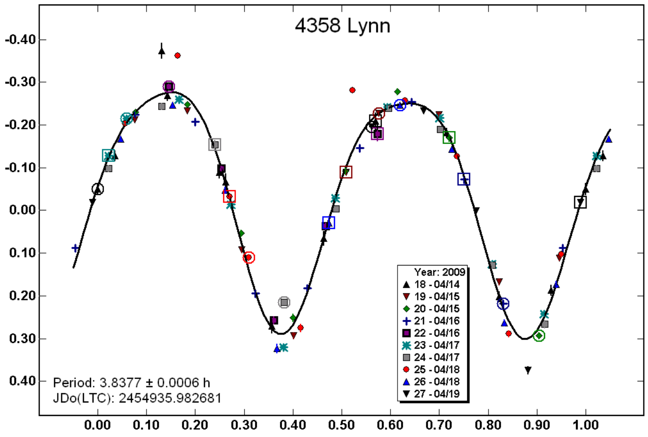
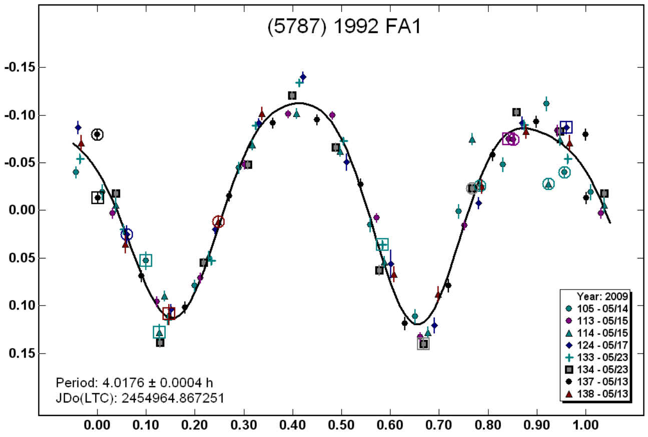
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


4154 Rumsey
Year: 2009
91 - 05/13
92 - 05/13
104 - 05/14
111 - 05/15
112 - 05/15
122 - 05/17
131 - 05/23
132 - 05/23
Period: 3.2569 ± 0.0002 h
JDo(LTC): 2454964.843780
-0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


5567 Durisen
Year: 2009
11 - 04/28
23 - 04/30
24 - 04/30
32 - 05/02
33 - 05/02
46 - 05/04
47 - 05/04
51 - 04/27
Period: 7.001 ± 0.003 h
JDo(LTC): 2454948.857198
-0.15 -0.10 -0.05 0.00 0.05 0.10 0.15
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


4358 Lynn
Year: 2009
18 - 04/14
19 - 04/15
20 - 04/15
21 - 04/16
22 - 04/16
23 - 04/17
24 - 04/17
25 - 04/18
26 - 04/18
27 - 04/19
Period: 3.8377 ± 0.0006 h
JDo(LTC): 2454935.982681
-0.40 -0.30 -0.20 -0.10 0.00 0.10 0.20 0.30 0.40
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


(5787) 1992 FA1
Year: 2009
105 - 05/14
113 - 05/15
114 - 05/15
124 - 05/17
133 - 05/23
134 - 05/23
137 - 05/13
138 - 05/13
Period: 4.0176 ± 0.0004 h
JDo(LTC): 2454964.867251
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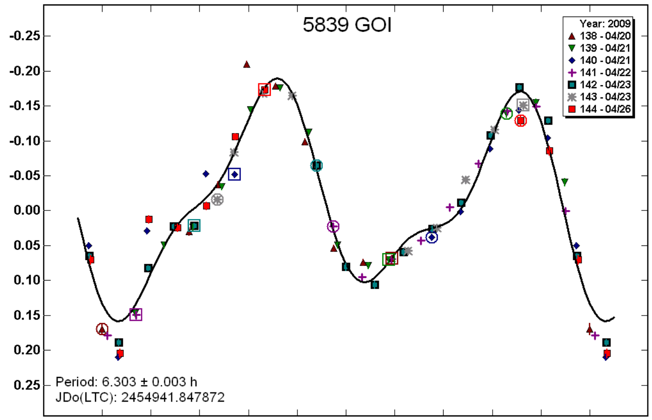
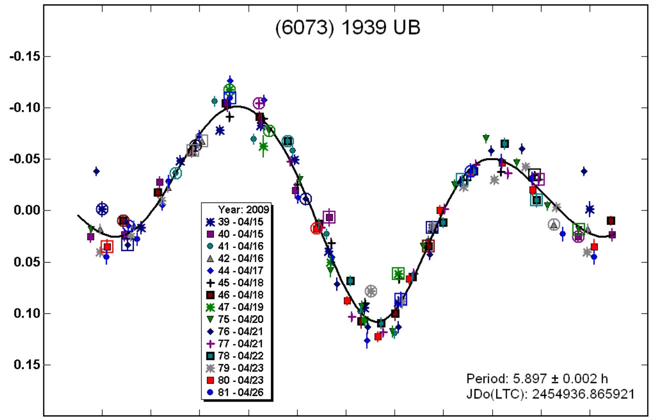
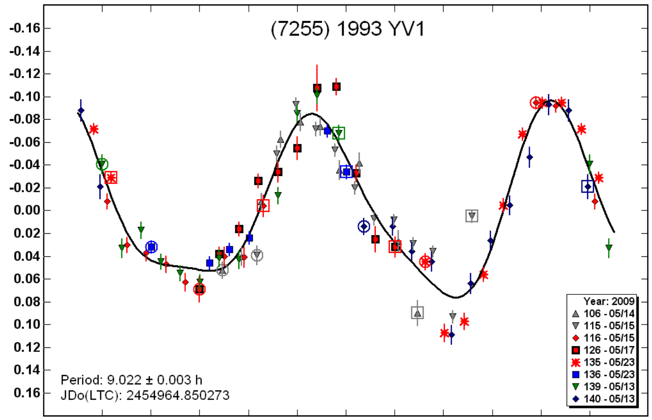
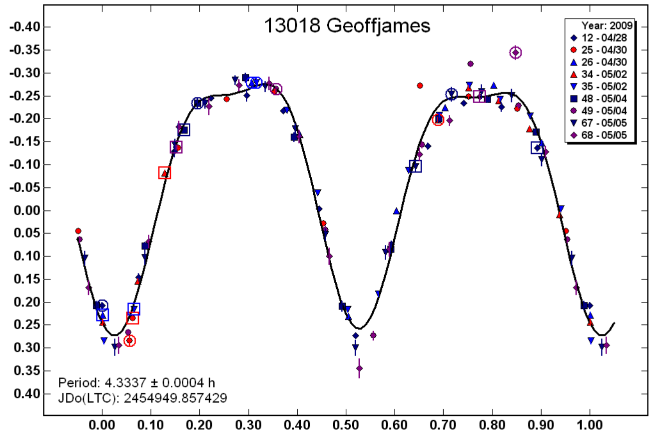
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00









CLOSE APPROACHES OF MINOR PLANETS TO NAKED EYE STARS IN 2010

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A list is presented of approaches of minor planets brighter than magnitude 14 to naked eye stars. This may be helpful in finding some faint minor planets.

The accompanying table lists close approaches of minor planets to stars during 2010 where:

- The event takes place more than 30° from the Sun.
- The minor planet is brighter than visual magnitude 14.
- The star is brighter than magnitude 6.
- The minimum angular separation is smaller than 120".

This list can be helpful in locating some otherwise faint minor planets. By carefully drawing the star field around the predicted position down to the magnitude of the minor planet and comparing it to the situation some time later, one can visually detect the intruder by its apparent motion.

The information contained in the list is divided into 5 groups:

1. Date: gives the date and time in U.T. of the closest geocentric approach. All subsequent data pertain to this instant.

2. Closest approach: the two columns give the position of the minor planet with respect to the star:
    - the minimum geocentric distance in seconds of arc
    - the position angle in degrees, measured from north over east

3. Minor planet: gives information about the minor planet:
    - number and name
    - visual magnitude
    - apparent motion in seconds of arc per hour
    - parallax in seconds of arc

4. Star: the following data of the star are given:
    - Hipparcos star number
    - visual magnitude
    - right ascension for the equinox 2000.0
    - declination (2000.0)

5. Sun and Moon:
    - elongation of the Sun in degrees
    - elongation of the Moon (degrees)
    - illuminated fraction of the Moon in %

The *observed* minimum distance depends on the location of the observer on the Earth's surface but is always comprised between the minimum *geocentric* distance plus and minus the parallax. An occultation will be visible somewhere on the Earth when the parallax is greater than the geocentric separation.

The close approaches in this article were computed at the Computer Center of Agfa-Gevaert N.V., Mortsel, Belgium.

Close approaches of minor planets to stars

(Dist. < 120" ; El. Sun > 52°
Star < 6.0 ; Min. pl. < 14.0)

	Date (U.T.)		Minim. dist.	Pos. ang.	Minor planet Name	Minor planet Vis. mag.	Minor planet App. mot.	Minor planet Hor. par.	Star Designation	Star Vis. mag.	Right ascens. (2000.0)	Declination (2000.0)	Elongation Sun	Elongation Moon	Ill. frac Moon
		h m	"	°			"/h	"			h m	° '	°	°	%
	2009 dec 27	10 7.0	71.32	348	747 Winchester	12.8	65.37	2.91	HIP 105928	5.9	21 27.25	-21 11.8	42	81	76
	dec 28	17 34.6	99.14	192	27 Euterpe	12.4	60.67	2.64	HIP 77939	5.9	15 55.01	-19 23.0	36	172	87
	dec 31	20 24.2	24.17	153	116 Sirona	13.8	39.54	2.62	HIP 114939	4.9	23 16.85	- 7 43.6	66	114	100
	2010 jan 2	23 56.0	24.61	194	410 Chloris	13.3	69.97	3.19	FK6 564	2.6	15 17.01	- 9 23.0	53	96	93
	jan 5	20 10.4	34.32	15	68 Leto	12.8	53.04	2.44	HIP 78168	5.8	15 57.67	-20 59.0	43	67	67
	jan 6	7 12.1	75.62	167	393 Lampetia	13.0	87.75	3.40	HIP 108102	5.9	21 54.17	- 4 16.6	44	148	63
	jan 8	1 22.2	33.30	336	126 Velleda	13.8	46.23	4.31	FK6 36	4.3	1 2.94	+ 7 53.4	90	171	43
	jan 14	9 12.8	33.72	359	105 Artemis	13.1	77.86	3.86	FK6 3214	5.7	15 23.87	-12 22.2	62	53	1
	jan 14	17 54.0	9.41	183	133 Cyrene	12.6	31.67	3.73	HIP 37704	5.4	7 44.12	+25 47.0	175	173	0
	jan 17	9 13.3	45.44	165	599 Luisa	13.4	20.58	4.20	HIP 24902	5.5	5 20.24	+41 5.2	141	120	4
	jan 20	20 42.0	22.20	355	626 Notburga	12.6	44.53	5.59	FK6 346	5.3	9 13.80	+43 13.1	153	120	25
	jan 24	18 20.1	97.98	178	568 Cheruskia	12.9	34.98	5.28	FK6 304	4.9	7 59.74	- 3 40.8	156	76	64
	jan 27	3 22.3	98.73	145	163 Erigone	12.9	24.51	7.18	HIP 20732	4.8	4 26.61	+14 42.8	120	19	86
	jan 28	20 53.3	68.52	203	172 Baucis	13.9	54.48	3.36	HIP 76470	3.8	15 37.02	-28 8.1	70	129	97
	feb 1	4 20.4	16.76	218	86 Semele	14.0	16.24	3.36	HIP 57328	4.9	11 45.28	+ 8 15.5	138	17	94
	feb 7	5 51.4	31.28	197	94 Aurora	12.2	27.16	4.02	FK6 2860	5.5	10 46.42	+14 11.7	159	86	37
	feb 7	13 55.6	75.67	205	796 Sarita	14.0	33.67	3.87	HIP 53377	5.9	10 54.97	+34 2.1	152	97	34
	feb 13	11 1.1	19.30	16	231 Vindobona	13.3	32.47	4.35	FK6 2824	5.4	10 16.68	+13 43.7	172	165	0
	feb 13	16 17.2	89.53	197	188 Menippe	14.0	32.99	3.88	HIP 46509	4.7	9 29.15	- 2 46.1	163	165	0
	feb 19	16 34.3	86.75	169	31 Euphrosyne	13.5	45.00	1.93	HIP 103127	5.5	20 53.67	-39 48.6	33	90	27
	feb 20	5 47.9	79.86	13	198 Ampella	13.7	36.14	3.31	HIP 79404	4.5	16 12.30	-27 55.6	85	154	32
	feb 22	10 3.8	15.07	18	13 Egeria	12.1	46.88	3.14	HIP 85084	5.4	17 23.36	-28 8.6	71	166	54
	feb 28	5 57.7	77.11	204	50 Virginia	13.6	34.23	4.13	HIP 49637	4.5	10 7.90	+ 9 59.8	170	3	100
	mar 3	19 30.9	4.17	346	67 Asia	13.6	35.13	3.35	HIP 20885	4.0	4 28.58	+15 57.7	85	137	86
	mar 7	19 38.1	71.93	338	202 ChryseÔs	13.2	44.37	2.77	HIP 16322	5.1	3 30.41	+11 20.2	66	152	48
	mar 24	22 32.6	12.91	338	70 Panopaea	12.9	79.61	2.92	HIP 113136	3.3	22 54.65	-15 49.3	26	134	66
	mar 30	6 36.2	45.69	358	117 Lomia	13.8	39.09	2.79	HIP 98421	5.4	19 59.86	-34 41.9	74	102	100
	mar 30	8 26.7	16.36	346	51 Nemausa	12.5	60.37	3.24	FK6 2330	5.0	4 28.84	+13 2.9	58	124	100
	mar 31	10 55.1	115.43	356	11 Parthenope	11.8	37.50	3.38	HIP 29655	3.3	6 14.88	+22 30.4	82	115	97
	mar 31	20 43.7	13.09	34	236 Honoria	13.3	26.27	3.68	HIP 53807	5.0	11 0.56	+ 3 37.0	153	50	96
	apr 1	18 32.8	65.28	165	18 Melpomene	11.0	78.17	3.59	HIP 20400	5.8	4 22.06	+14 4.6	54	158	91
	apr 2	11 16.2	101.70	351	345 Tercidina	13.6	68.45	3.39	HIP 20732	4.8	4 26.61	+14 42.8	55	165	86
	apr 5	21 47.3	12.91	350	287 Nephthys	13.1	48.48	3.66	HIP 29650	5.3	6 14.85	+19 9.4	77	172	55
	apr 9	23 3.9	30.50	348	14 Irene	11.9	50.18	2.80	HIP 107188	4.9	21 42.66	-18 52.0	58	11	19
	apr 10	21 20.9	37.29	340	25 Phocaea	12.1	91.60	3.37	HIP 114347	5.0	23 9.52	+ 8 40.6	31	15	12
	apr 14	23 5.0	86.92	311	218 Bianca	12.6	28.39	4.93	HIP 88175	4.7	18 0.49	- 3 41.4	113	116	0
	apr 16	17 2.8	78.75	20	35 Leukothea	13.8	36.95	3.32	HIP 35941	5.9	7 24.56	+27 38.3	82	56	5
	apr 21	10 11.0	99.17	148	216 Kleopatra	12.5	18.36	3.44	HIP 45336	3.9	9 14.37	+ 2 18.8	108	26	46
	apr 27	8 9.2	62.77	8	60 Echo	11.9	25.34	5.55	HIP 49637	4.5	10 7.90	+ 9 59.8	113	51	98
	apr 30	7 13.2	4.31	199	984 Gretia	13.7	31.86	3.88	FK6 519	3.3	14 6.37	-26 41.0	166	25	96
	may 4	7 37.1	57.03	9	43 Ariadne	13.1	46.59	3.38	HIP 37908	5.0	7 46.12	+18 30.6	71	177	67
	may 10	7 31.6	38.24	358	345 Tercidina	13.7	74.05	3.02	HIP 26777	4.8	5 41.30	+16 32.0	36	81	14
	may 11	9 41.2	72.70	1	52 Europa	12.0	54.62	2.68	HIP 32921	5.3	6 51.55	+21 45.7	51	83	8
	may 20	17 45.6	68.78	151	36 Atalante	13.4	62.62	3.45	FK6 897	5.9	23 50.25	- 9 58.4	65	150	47
	may 23	16 22.7	14.58	325	564 Dudu	12.6	44.90	8.01	HIP 81754	5.7	16 41.90	-19 55.5	170	64	79
	may 27	21 36.6	5.67	2	906 Repsolda	13.8	29.88	4.53	HIP 73184	5.9	14 57.48	-21 25.2	161	17	100
	jun 1	11 44.7	29.76	146	564 Dudu	12.3	48.23	8.20	FK6 3307	4.4	16 32.14	-21 28.0	178	54	80
	jun 2	12 48.1	74.32	224	276 Adelheid	14.0	22.61	3.46	HIP 94727	5.6	19 16.52	+ 4 50.1	133	33	72
	jun 2	16 19.8	48.56	181	346 Hermentaria	12.8	60.01	2.44	FK6 254	3.1	6 43.93	+25 7.9	28	142	71
	jun 5	16 49.0	73.21	347	221 Eos	13.1	45.77	3.18	HIP 145	5.1	0 1.82	- 3 1.7	75	10	43
	jun 6	6 23.1	27.16	26	198 Ampella	11.7	38.13	5.76	HIP 78265	2.8	15 58.85	-26 6.9	166	117	37
	jun 6	7 54.9	117.88	184	345 Tercidina	13.6	75.91	2.86	HIP 31681	1.9	6 37.71	+16 23.9	24	99	37
	jun 12	21 57.5	82.99	20	35 Leukothea	14.0	59.30	2.77	FK6 1228	4.7	8 43.28	+21 28.1	45	40	0
	jun 16	2 36.8	16.39	329	695 Bella	14.0	69.47	3.75	HIP 4267	5.8	0 54.59	+19 11.3	65	114	17
	jun 19	2 39.9	34.07	168	13 Egeria	10.7	35.86	4.99	HIP 85889	5.9	17 33.12	-41 10.4	161	87	49
	jun 20	17 22.1	8.00	197	32 Pomona	12.6	54.68	3.52	HIP 52452	5.9	10 43.35	+ 4 44.9	71	39	67
	jun 22	21 47.5	73.70	13	53 Kalypso	13.7	75.54	3.01	HIP 42911	4.1	8 44.68	+18 9.2	37	100	87
X	jun 25	8 19.2	2.24	171	177 Irma	13.4	29.07	5.00	HIP 95503	5.6	19 25.49	-23 57.7	163	29	99
	jun 25	10 40.7	46.58	170	747 Winchester	12.3	87.56	3.29	HIP 18089	5.7	3 52.00	+ 6 32.1	38	151	99
	jun 25	11 19.8	92.46	11	1321 Majuba	13.5	31.57	5.86	HIP 90185	1.8	18 24.17	-34 23.1	168	16	99
	jun 25	20 5.8	93.13	341	375 Ursula	13.4	52.72	2.27	HIP 17448	3.9	3 44.32	+32 17.3	34	153	100
	jul 8	16 31.7	33.98	21	60 Echo	13.0	59.98	3.45	FK6 2924	5.8	11 34.36	+ 3 3.6	66	108	13
X	jul 8	22 6.6	1.71	312	472 Roma	13.5	22.69	4.44	FK6 603	2.7	16 14.35	- 3 41.7	133	159	11
	jul 13	2 19.1	72.55	206	4 Vesta	7.9	64.25	3.34	HIP 55642	4.0	11 23.93	+10 31.8	57	40	2
	jul 13	14 23.9	11.38	199	32 Pomona	12.7	61.66	3.21	HIP 55137	5.3	11 17.29	+ 2 0.6	58	34	5
	jul 17	22 3.1	48.45	19	32 Pomona	12.7	62.70	3.16	HIP 55650	5.6	11 24.04	+ 1 24.5	56	27	44
	jul 22	9 0.8	19.79	16	313 Chaldaea	13.5	81.80	3.22	HIP 51802	5.7	10 35.04	+ 8 39.0	37	100	87
	jul 22	11 55.0	55.69	335	653 Berenike	13.4	31.52	4.30	HIP 96808	5.5	19 40.72	-16 17.6	172	36	88
	jul 24	12 13.7	62.62	196	192 Nausikaa	12.8	30.08	3.21	HIP 65639	4.9	13 27.45	-15 58.4	84	78	98
	jul 26	19 6.3	89.53	65	129 Antigone	10.7	26.11	5.55	HIP 80628	4.7	16 27.80	- 8 22.3	122	65	99

					Minor planet				Star						
	Date	(U.T.)	Minim. dist.	Pos. ang.	Name	Vis. mag.	App. mot.	Hor. par.	Designation	Vis. mag.	Right ascens. (2000.0)	Declination (2000.0)	Elongation Sun	Elongation Moon	Ill. frac Moon
		h m	"	0			"/h	"			h m	0 '	0	0	%
	jul 29	19 5.0	110.66	187	117 Lomia	12.4	30.66	4.30	FK6 3602	4.8	20 3.56	-37 56.5	159	56	88
	aug 1	10 55.2	90.19	153	165 Loreley	13.6	34.55	2.71	FK6 1088	5.7	3 9.61	+29 4.6	76	34	67
	aug 1	13 27.5	102.24	206	40 Harmonia	11.1	20.63	5.17	HIP 77939	5.9	15 55.01	-19 23.0	111	139	66
	aug 2	0 40.6	65.87	2	393 Lampetia	13.9	46.04	2.90	HIP 20648	4.3	4 25.49	+17 55.7	62	42	62
	aug 2	12 51.9	39.61	344	74 Galatea	11.7	32.50	6.30	HIP 98633	5.7	20 1.98	-13 38.2	167	92	57
	aug 12	11 6.5	46.98	191	227 Philosophia	13.0	24.68	4.59	HIP 98353	5.0	19 58.95	-26 11.7	156	123	8
	aug 12	20 3.3	24.99	339	240 Vanadis	12.2	34.89	5.49	FK6 1561	4.3	21 22.25	-16 50.1	177	139	11
	aug 13	3 5.6	26.92	212	582 Olympia	13.8	50.25	4.20	HIP 14293	5.3	3 4.28	- 7 36.0	98	132	13
	aug 17	6 26.9	5.96	337	82 Alkmene	13.3	26.46	3.75	HIP 114939	4.9	23 16.85	- 7 43.6	156	107	55
	aug 23	9 37.6	39.74	219	2 Pallas	10.0	40.22	2.83	FK6 570	5.2	15 25.79	+15 25.7	76	90	98
	aug 25	22 2.9	117.66	145	186 Celuta	13.2	43.78	4.74	HIP 17531	4.3	3 45.21	+24 28.0	92	74	99
	aug 26	12 57.8	47.05	145	186 Celuta	13.2	43.38	4.76	HIP 17579	5.8	3 45.91	+24 33.3	93	67	97
	aug 29	10 52.6	69.24	15	490 Veritas	13.5	18.95	3.65	HIP 14764	6.0	3 10.65	+11 52.4	107	23	81
	aug 30	5 11.7	23.61	5	33 Polyhymnia	13.9	50.69	2.75	FK6 1182	5.2	7 2.41	+24 12.9	52	67	74
	aug 30	7 37.2	106.82	181	198 Ampella	13.0	41.37	4.13	HIP 78933	3.9	16 6.81	-20 40.2	86	154	74
	aug 31	7 32.0	90.53	356	140 Siwa	13.9	33.76	3.10	HIP 23871	5.3	5 7.81	+20 25.1	79	28	64
	aug 31	11 10.9	62.91	223	105 Artemis	12.4	51.19	5.67	FK6 665	2.8	17 43.47	+ 4 34.1	105	136	63
	sep 5	4 18.7	79.88	358	554 Peraga	13.3	65.20	4.43	HIP 26640	5.1	5 39.74	+25 53.8	76	31	15
	sep 11	10 20.9	53.09	175	432 Pythia	14.0	28.45	3.58	HIP 24010	4.9	5 9.70	+15 35.8	90	131	13
	sep 16	7 29.0	48.18	14	308 Polyxo	13.5	49.71	3.07	HIP 78400	5.6	16 0.32	-16 32.1	68	34	61
	sep 16	19 31.2	19.31	196	714 Ulula	14.0	46.29	3.77	HIP 28716	4.7	6 3.92	+20 8.3	82	169	65
	sep 17	23 29.1	54.08	266	41 Daphne	13.1	13.37	2.98	HIP 18089	5.7	3 52.00	+ 6 32.1	116	121	76
	sep 25	0 37.4	102.15	9	40 Harmonia	11.7	56.48	3.80	HIP 82925	5.6	16 56.80	-23 9.0	73	124	97
	sep 27	6 56.2	46.69	205	478 Tergeste	13.8	15.79	3.06	FK6 1500	5.3	19 12.68	- 7 56.4	104	117	86
X	sep 30	20 16.4	0.27	10	148 Gallia	13.0	53.99	2.90	FK6 334	3.1	8 55.39	+ 5 56.7	53	42	53
	oct 2	14 54.9	74.01	192	349 Dembowska	11.7	47.68	2.48	HIP 77840	4.6	15 53.61	-25 19.6	52	123	34
	oct 6	21 27.9	39.45	177	122 Gerda	13.9	22.72	2.80	HIP 94141	3.0	19 9.76	-21 1.4	92	105	1
	oct 7	6 8.6	109.68	122	146 Lucina	13.1	13.55	4.06	HIP 104174	5.4	21 6.41	-32 20.5	114	120	1
	oct 7	22 19.6	9.40	174	172 Baucis	13.5	64.25	3.79	HIP 85442	6.0	17 27.63	-29 43.5	68	66	0
	oct 12	10 8.4	92.97	180	376 Geometria	13.8	81.03	4.00	HIP 84626	5.3	17 18.01	-24 17.2	61	0	26
	oct 15	3 41.2	86.67	11	270 Anahita	13.5	76.81	3.19	HIP 77811	5.0	15 53.33	-20 10.0	38	54	53
	oct 15	6 58.6	9.75	207	488 Kreusa	13.8	9.47	2.92	HIP 110529	5.7	22 23.52	-24 45.8	125	36	54
	oct 15	22 55.1	30.34	1	1 Ceres	9.1	43.02	2.82	FK6 3439	4.6	18 8.08	-28 27.4	69	33	60
	oct 18	10 37.8	115.80	197	145 Adeona	13.9	56.07	2.42	HIP 77939	5.9	15 55.01	-19 23.0	35	93	81
	oct 20	9 20.6	78.48	333	403 Cyane	13.2	30.18	4.69	HIP 12332	5.5	2 38.82	+21 57.7	161	47	93
	oct 20	13 48.3	91.27	293	154 Bertha	13.5	24.45	2.90	HIP 104738	5.3	21 13.05	-39 25.5	100	56	94
	oct 20	16 11.5	85.40	350	206 Hersilia	13.8	20.10	3.72	HIP 103226	5.9	20 54.80	-17 55.4	104	49	94
	oct 22	3 17.9	24.37	18	18 Melpomene	11.8	57.54	2.82	HIP 53449	5.6	10 56.02	+ 6 11.1	45	145	99
	oct 25	7 32.5	19.16	162	595 Polyxena	13.9	44.93	2.71	HIP 91989	5.6	18 44.95	-39 41.2	68	137	95
	oct 27	20 1.6	100.44	15	44 Nysa	10.9	59.52	4.48	HIP 43970	5.3	8 57.25	+15 19.4	81	42	78
	oct 28	7 56.1	100.95	202	171 Ophelia	13.9	58.41	2.65	FK6 427	4.1	11 21.14	+ 6 1.8	45	72	73
	nov 4	6 45.8	44.53	353	45 Eugenia	12.9	41.80	3.29	HIP 100195	5.4	20 19.39	-19 7.1	81	107	5
	nov 9	3 12.7	17.05	20	51 Nemausa	12.3	69.38	3.26	FK6 437	4.3	11 36.95	- 0 49.4	51	89	10
	nov 10	3 14.2	86.70	313	695 Bella	12.2	38.55	6.88	HIP 9570	5.5	2 2.97	+33 17.0	159	121	18
	nov 19	9 6.2	15.47	175	30 Urania	12.7	66.25	2.91	HIP 91405	5.8	18 38.51	-23 30.3	42	110	94
	nov 21	12 14.8	106.22	185	498 Tokio	12.4	36.21	5.68	HIP 22913	5.8	4 55.84	+15 2.4	162	21	100
	nov 23	5 19.0	40.61	299	170 Maria	13.2	26.36	5.47	HIP 5544	5.2	1 11.11	+31 25.5	141	53	98
	nov 25	15 4.5	45.72	161	84 Klio	13.5	86.86	4.20	HIP 100195	5.4	20 19.39	-19 7.1	59	169	83
	nov 29	8 34.1	97.50	352	578 Happelia	13.5	33.74	4.29	HIP 17527	5.6	3 45.16	+24 50.3	171	104	44
	dec 6	4 41.8	108.78	166	584 Semiramis	13.1	82.51	3.51	HIP 98258	5.0	19 57.95	-15 29.5	44	39	0
	dec 6	20 7.3	87.64	165	172 Baucis	13.6	78.32	3.12	HIP 96406	5.7	19 36.03	-24 43.1	37	24	1
X	dec 7	22 37.9	0.01	152	356 Liguria	13.3	46.73	3.42	FK6 3771	5.4	22 10.63	-11 33.9	74	48	5
	dec 9	12 52.3	75.27	158	683 Lanzia	12.6	33.52	4.07	HIP 28716	4.7	6 3.92	+20 8.3	165	148	15
	dec 11	9 28.5	72.39	161	63 Ausonia	12.3	72.11	3.29	HIP 103226	5.9	20 54.80	-17 55.4	52	15	30
	dec 12	2 52.4	39.40	175	129 Antigone	12.2	68.46	2.72	FK6 1517	4.9	19 46.36	-19 45.7	35	39	36
	dec 13	4 56.1	59.79	189	354 Eleonora	11.7	62.95	2.69	HIP 72631	5.1	14 51.02	- 2 18.0	41	123	46
	dec 13	10 57.3	62.66	357	419 Aurelia	13.1	33.71	3.86	HIP 29433	5.8	6 12.02	+19 47.4	167	103	49
	dec 19	4 45.3	111.85	195	405 Thia	13.0	86.20	3.41	FK6 3167	5.8	14 46.11	-23 9.2	41	165	95
	dec 21	0 16.9	42.35	156	103 Hera	12.8	47.88	3.45	HIP 115033	4.4	23 17.90	- 9 11.0	77	98	100
	dec 22	4 55.8	105.11	358	419 Aurelia	12.9	35.06	3.88	HIP 28691	5.1	6 3.46	+19 41.4	176	11	99
	dec 24	12 47.4	112.28	13	110 Lydia	13.4	60.83	2.44	HIP 78933	3.9	16 6.81	-20 40.2	28	110	87
	dec 25	10 3.4	73.76	40	747 Winchester	10.9	35.17	6.43	HIP 38712	5.9	7 55.52	+ 8 51.8	151	28	80
	dec 30	5 19.2	114.21	351	476 Hedwig	12.3	37.21	4.72	FK6 254	3.1	6 43.93	+25 7.9	177	115	28
	2011 jan 4	8 57.5	20.39	153	146 Lucina	13.9	55.30	2.64	FK6 849	5.2	22 34.70	-20 42.5	49	50	0
	jan 5	15 26.0	40.22	40	747 Winchester	10.7	43.27	6.49	FK6 1201	5.3	7 46.27	+10 46.1	164	172	2

CLOSE MUTUAL APPROACHES OF MINOR PLANETS IN 2010

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(Received: 5 May)

Tabulated are cases where one minor planet comes to within 120 arcseconds of another and both are of magnitude 16 or brighter. A challenge for visual minor planet observers!

Here I present a list of close approaches between numbered minor planets larger than 40 km during 2010 where:

- Solar elongation > 30°
- Both minor planets are brighter than V = 16
- Maximum geocentric separation < 120 arcseconds

The table gives the following data:

1. Date: date and time of closest geocentric approach (in UT). All other information is given for this instant.
2. Closest approach: gives the minimum geocentric distance (in arcseconds) and the position angle (in degrees) of the *nearest* minor planet with respect to the *farthest*.
3. Minor planet 1: information on the *nearest* asteroid:
   - Number, name, and visual magnitude
   - Parallax, in arcseconds
   - Apparent motion, in arcseconds per hour
   - Position angle of the direction of motion, in degrees
4. Minor planet 2: information about the *farthest* of the two. In addition to the J2000 RA and Declination, the same data as for the first asteroid are given.
5. Sun and Moon:
   - Solar elongation, in degrees
   - Lunar elongation, in degrees
   - Illuminated fraction of the moon, percent.

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                                          Close mutual approaches of minor planets

                                          ========================================                  "             0
                                                                                              (Dist. < 120 ; El. Sun > 30 ; magn. < 16.0)

   D a t e (U.T.)     Min.  Pos.          M i n o r   p l a n e t   1                M i n o r   p l a n e t   2
                      dist. ang.      N a m e    Vis.  Hor.   Motion          N a m e    Vis.  Hor.   Motion      Right    Decli-       Elon-    Ill.
                                                 mag. par.  per   pos.                   mag. par.  per   pos.  ascens.  nation       gation   frac.
                                                                 hour ang.                                hour ang. (2000.0) (2000.0)    Sun Moon Moon

                  h  m       "     0                           "    "/h    0                             "    "/h    0   h  m      0  '        0    0    %
      2010 feb  2  20 49.9    45.47 131     335 Roberta     14.26 3.36  36.23  65     872 Holda        15.49 3.10  31.02  69   2 33.28 + 9 29.2    85  146   81
           feb  5   8 42.0    80.35 169     476 Hedwig      14.07 2.86  54.72  73     760 Massinga     14.62 2.14  35.20  70   0 34.66 +13 45.9    57  149   57
           feb 14  17 43.7    27.50  38     564 Dudu        15.16 3.95  51.44 104     903 Nealley      15.94 2.65  29.59  83  16 08.43 - 9 57.1    83   91    2
           feb 22  13 30.0    36.22  24     362 Havnia      14.53 2.85  54.28  93     200 Dynamene     14.23 2.54  46.42  89  18 29.19 -28 44.9    57  144   55
           mar 10  17 28.6   115.06 110     715 Transvaalia 15.32 2.68  60.28  64     419 Aurelia      14.29 2.46  52.85  72   2 00.56 +12 29.9    42   96   23

           mar 24  13 54.9   110.98 341     207 Hedda       14.93 2.87  72.01  69     604 Tekmessa     15.04 2.37  58.17  69  22 17.82 -13 30.1    32  132   63
           mar 24  15  1.7   118.77 102     292 Ludovica    13.93 4.60  19.23 209     751 FaÔna        13.41 4.29  12.37 219   9 21.38 +36 20.5   124   47   63
           apr  3  17 27.0    72.49 166     282 Clorinde    15.73 3.28  73.00  74     202 ChryseÔs     13.26 2.54  52.37  73   4 04.28 +14 13.9    48  163   75
           apr  6  14 34.9   117.80  45     151 Abundantia  14.28 3.62  40.76 102     581 Tauntonia    15.25 2.87  28.91  84   6 47.98 +29 39.3    84  149   47
           apr  8   0 15.2    28.30  25     504 Cora        14.42 3.42  61.77  83     261 Prymno       14.51 3.31  53.67  77  20 54.10 -18 10.4    67   21   34

?          apr  9  10 48.1     3.24 317    1214 Richilde    15.94 3.52  52.67  70     351 Yrsa         14.95 2.72  34.24  84  20 24.92 -20 16.9    75   28   22
           apr 10  15  7.6    43.89 309     829 Academia    14.53 4.80  35.80 283     509 Iolanda      13.10 3.75  32.12 307  13 12.35 -14 24.6   173  138   13
           apr 10  23 25.4   116.27  39    1548 Palomaa     15.96 4.57   9.49  26     472 Roma         13.71 4.14  11.36   3  17 11.58 - 3 28.0   121   83   11
           apr 23   9  4.6    86.71 328     249 Ilse        15.89 3.41  84.55  62     108 Hecuba       14.50 2.17  45.49  65  23 22.49 - 4 53.3    43  152   70
           may  3  20  2.5    90.12  59     378 Holmia      15.42 2.92  45.74  95     130 Elektra      13.20 2.58  39.94  80   7 29.17 +15 22.7    68  164   69

           may  4  23 20.4   102.84  27     635 Vundtia     14.93 2.36  55.51  83     791 Ani          15.53 2.17  49.10  78   5 15.77 +14 14.8    35  135   59
           may  9   5  1.1    25.78 118     583 Klotilde    13.21 4.57  28.05 306    3036 Krat         14.74 3.69  31.33 271  13 51.48 -20 00.1   162  141   21
?          may 11   1 17.4     3.48 317     477 Italia      14.62 4.13  75.79  67     888 Parysatis    14.98 3.02  51.16  78  23 03.09 -10 30.2    67   32    9
           may 11   5  1.7    96.33 318     943 Begonia     14.98 3.22  56.67  96      35 Leukothea    13.94 3.03  48.75 108   7 54.47 +25 21.9    65   99    8
           may 18   9 16.9   110.54   6     816 Juliana     15.39 4.01  15.57 146     886 Washingtonia 15.24 2.49  12.25 201  11 50.27 +18 32.4   112   66   25

           may 21  20 49.8   119.45 203     390 Alma        15.49 2.85  70.03  99     830 Petropolitana15.13 2.30  53.32  94   6 24.92 +25 47.5    35   71   62
           may 26  12 35.8    45.80 218     100 Hekate      12.99 3.20  50.80  73     604 Tekmessa     14.79 2.97  47.42  66  23 42.51 - 4 42.6    70  128   96
           may 28  14 44.3    26.71 171     269 Justitia    14.64 3.11  61.08  71     223 Rosa         15.85 2.39  45.70  67   0 50.36 + 4 00.5    53  118   97
           may 29   0 19.1    63.61  63      38 Leda        13.45 2.96  68.69 102      19 Fortuna      12.42 2.89  65.48  98   7 30.88 +20 32.6    43  143   96
           may 29  14 36.2    15.88  70     122 Gerda       13.27 3.45   7.54 267    1867 Deiphobus    15.76 2.11  11.98 303  19 50.36 -18 55.1   131   34   94

           may 31  22  7.5    27.19 227     425 Cornelia    15.48 2.88  49.93 109     226 Weringia     15.74 2.59  39.75 101   9 03.73 +20 34.2    62  151   81
           jun  3   2  6.2    89.58  63       6 Hebe         9.89 4.54  59.50  81     606 Brang‰ne     14.85 4.33  56.68  59  23 11.77 - 5 02.7    85   27   64
           jun  3   5 49.4    65.93  75     100 Hekate      12.94 3.31  47.72  73     893 Leopoldina   14.80 3.25  48.13  81  23 52.13 - 3 59.1    75   35   62
           jun 11   2 24.7    72.88 132     425 Cornelia    15.52 2.78  52.86 110     626 Notburga     14.75 2.68  49.52 122   9 17.67 +19 24.9    56   77    5
           jun 19  15  8.3    51.66 349     407 Arachne     14.11 3.05  61.69  66     399 Persephone   15.25 2.35  43.77  61   1 57.60 +18 39.8    54  152   57

           jun 20  10 47.9    86.68 218     312 Pierretta   14.27 3.07  44.95 119     359 Georgia      14.89 2.64  36.48 117  10 43.51 + 9 14.9    69   37   65
           jun 22   3 56.2    43.49 239      97 Klotho      12.56 3.77  46.81  77     468 Lina         14.85 3.67  44.93  67   0 20.27 + 1 52.2    85  146   80
           jun 26  12  5.3   103.74 141     477 Italia      14.15 5.29  58.22  65     655 BriseÔs      15.03 3.30  32.22  77   0 20.86 - 1 54.1    90   90   96
           jun 30  10 48.8    82.96 355     300 Geraldina   14.34 3.99  23.17 256      24 Themis       12.25 3.50  24.21 256  20 12.70 -20 60.0   157   31   82
           jul  1   3 23.3    62.67 326     916 America     15.41 4.01  88.19  65     764 Gedania      15.31 2.61  51.11  72   2 40.48 +22 41.1    54   69   77

           jul  5  10 30.3    67.70 352     101 Helena      13.50 2.67  64.08  78     784 Pickeringia  15.82 1.90  40.49  75   4 29.34 +29 20.4    33   49   42
           jul  9  14 30.6   100.08 356     498 Tokio       13.82 3.36  67.00  77    1054 Forsytia     15.65 2.97  59.08  76   3 27.50 +11 11.0    55   27   10
?          jul 21  15  4.2     3.07 196     619 Triberga    14.75 3.84  50.81  85     162 Laurentia    14.96 2.64  30.51  69   2 28.12 +13 03.3    79  148   79
           jul 27   8 43.8    37.85 294     103 Hera        11.61 5.33  10.47 205     938 Chlosinde    14.87 5.12   5.92 206  23 18.36 - 6 48.4   136   33   95
           aug  2  19 55.3    41.81 319     249 Ilse        15.10 5.45  68.31  58     403 Cyane        14.65 3.17  31.36  70   2 34.00 +21 52.5    87   17   54

?          aug  4  16 13.0    21.43 357    3127 Bagration   15.78 6.08  11.02  51     398 Admete       15.84 3.32   7.92 321  17 01.51 -24 37.0   124  154   37
           aug  5  17 21.9    16.38 251    1459 Magnya      15.17 3.14  55.41  69     523 Ada          14.92 3.10  56.65  83   4 32.66 +23 57.8    62   22   27
?          aug  5  23 40.2    13.53 153     571 Dulcinea    15.32 5.52  70.38  67     243 Ida          15.31 3.33  34.71  71   2 54.85 +17 45.9    86   36   25
           aug  8   9 37.7    12.07  12      44 Nysa        11.51 3.16  76.67  92     404 ArsinoÎ      14.84 2.47  53.06  87   6 19.20 +21 01.8    41   27    7
           aug 11  22  5.9   117.71 122    1519 Kajaani     15.09 5.75   7.92 284    1013 Tombecka     15.05 3.94  15.19 242   0 17.58 - 9 36.8   137  156    7

           aug 14  15 23.7    16.61 160     289 Nenetta     14.48 3.53  55.68  89     393 Lampetia     13.92 3.02  40.51  97   4 40.81 +17 39.9    70  134   27
           aug 15  22  0.3    34.89 224     382 Dodona      14.29 2.58  62.84 114     176 Iduna        14.57 1.98  42.76 104  11 43.11 - 3 22.7    34   46   40
           aug 30  17  3.6    85.16 132     184 Dejopeja    13.80 3.37   1.66  44     758 Mancunia     13.89 3.14   2.83 219  18 39.89 -23 59.5   122  122   71
?          sep  5  23 17.2     6.81 274    1771 Makover     14.06 4.99  28.39 235     739 Mandeville   13.15 4.07  35.01 223   0 10.00 -18 01.0   159  123   10
           sep 18  19 52.8    79.85  78       6 Hebe         7.68 9.00  42.69 209    1569 Evita        15.02 5.00  29.61 240   0 25.66 -17 46.0   160   63   82

           sep 22   5 14.8    96.92 278      84 Klio        13.03 5.63  58.49  74     410 Chloris      12.53 4.74  53.36  96  18 04.08 -28 09.3    91   79   99
           sep 30  17  3.6    94.08 190      45 Eugenia     12.43 4.02  20.81  97     748 Simeisa      15.99 2.19   4.52  85  19 48.07 -19 25.3   108  149   54
           oct 19  10 21.7    63.83  82     619 Triberga    13.22 6.21  36.08 222     818 Kapteynia    13.47 4.46  27.47 268   3 13.86 + 5 29.9   155   63   89
           oct 29  18 29.6    20.13 331    1321 Majuba      15.39 3.37  56.30  75     758 Mancunia     14.43 2.46  34.53  85  19 11.74 -23 54.2    70  153   56
           nov  4  14 21.6    85.63 159      45 Eugenia     12.91 3.28  41.95  83    3317 Paris        15.70 1.88  20.57  98  20 19.74 -19 04.4    80  102    4
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	Date	(U.T.)	Min.	Pos.	Minor planet 1					Minor planet 2									
			dist.	ang.	Name	Vis. mag.	Hor. par.	Motion per hour	pos. ang.	Name	Vis. mag.	Hor. par.	Motion per hour	pos. ang.	Right ascens. (2000.0)	Decli- nation (2000.0)	Elon- gation Sun	Moon	Ill. frac. Moon
		h m	"	0			"	"/h	0			"	"/h	0	h m	0 '	0	0	%
	nov 14	8 3.6	62.09	347	797 Montana	15.57	3.22	54.25	81	190 Ismene	14.91	1.87	26.00	85	20 01.46	-16 19.5	67	35	59
	nov 22	0 44.5	80.08	353	376 Geometria	14.03	3.41	84.61	82	543 Charlotte	15.53	2.32	48.92	81	18 56.24	-22 46.5	43	135	97
	nov 22	10 11.4	19.40	342	282 Clorinde	15.81	3.45	61.17	107	224 Oceana	14.10	2.93	50.76	116	11 51.98	+ 2 19.3	62	110	97
	nov 26	0 9.0	91.25	323	580 Selene	15.35	2.99	27.03	105	1241 Dysona	15.63	2.65	21.74	132	10 26.81	+12 09.4	89	42	76
	nov 28	6 54.5	28.10	358	201 Penelope	13.33	2.97	73.12	87	232 Russia	15.58	2.75	66.35	87	18 59.88	-20 01.7	38	131	53
?	nov 30	5 28.8	15.62	12	44 Nysa	10.44	5.54	37.26	105	379 Huenna	14.92	2.82	9.42	112	9 41.22	+12 28.4	104	35	33
	dec 3	1 7.3	104.49	136	1080 Orchis	14.62	8.80	12.06	63	156 Xanthippe	14.10	3.37	13.35	211	1 10.92	+13 46.5	130	160	10
	dec 25	23 4.1	57.65	22	442 Eichsfeldia	14.87	3.30	72.37	104	365 Corduba	15.38	2.34	44.84	99	14 49.04	-11 27.7	50	67	71

ROTATION PERIOD DETERMINATION FOR 65 CYBELE

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The synodic rotation period and amplitude have been found for 65 Cybele: 6.082 ± 0.001 h, 0.04 ± 0.01 mag., ruling out shorter periods near four hours.

Pilcher at the Organ Mesa Observatory used a Meade 35-cm LX200 GPS S-C, SBIG STL-1001 E CCD, differential photometry only, unguided exposures, red filter. Stephens at GMARS used a 14-inch RCX at f/8, SBIG STL-1001E CCD, and Sloan ‘r filter. Image measurement, lightcurve analysis, and sharing of data were done by *MPO Canopus*. Due to the large number of data points acquired the lightcurve has been binned in sets of three data points with a maximum of five minutes between points. Stephens obtained the data for Aug. 23 and Sept. 13 and Pilcher for all other nights.

Schober et. al. (1980) obtained the first lightcurves and the most dense data set prior to the present investigation. They found a bimodal lightcurve with period 6.07 ± 0.05 hours, amplitude 0.06 mag. Weidenschilling et. al. (1987) obtained lightcurves in four separate oppositions. All were sufficiently noisy to prevent a definitive period determination, but appeared to rule out a period shorter than 6 hours. Weidenschillling et. al. (1990), Gil-Hutton (1990), Drummond et. al. (1991), and Shevchenko et. al. (1996) all obtained lightcurve sets in which they favored periods near 4 hours, but all of these were sparse and noisy and not capable of a definitive period determination. Drummond et. al. also published a rotational pole at longitude 25 degrees, latitude –49 degrees, but based it on an assumed triaxial shape with period near 4 hours. De Angelis (1995) applied the amplitude, epoch, and magnitude methods to the lightcurves of Schober (1980), Weidenschilling (1987) and (1990), and Hutton (1990) to claim a sidereal period of 4.04052 h and retrograde rotation with pole at longitude 214 degrees, latitude +23 degrees. Behrend (2009) presents a sparse lightcurve in which the variation is barely above the noise and admits his approximately 4 hour period is provisional. Except for Schober et. al. (1980), none of these published lightcurves shows in the judgment of these authors a definitive and unambiguous period. Our new observations on 7 nights 2009 July 31-Sept. 13 show a smooth bimodal lightcurve with period 6.082 ± 0.001 hours, amplitude 0.04 ± 0.01 magnitudes, and rule out a period near 4 hours.

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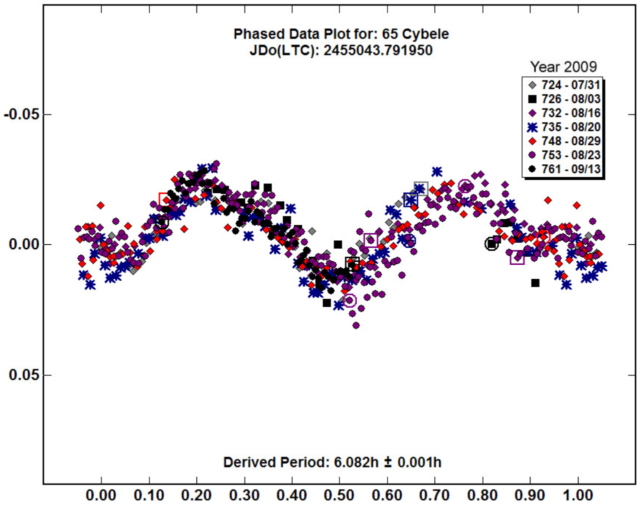

AN ENSEMBLE OF LIGHTCURVES FROM MODRA

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We searched for rotation periods of asteroids 131 Vala, 1276 Ucclia, 1512 Oulu, 2621 Goto, 3280 Grétry, 3940 Larion, 4357 Korinthos, 4601 Ludkewycz, 4925 Zhoushan, 5479 Grahamryder, 5986 Xenophon, (7036) 1995 BH3, 7421 Kusaka, 8885 Sette, (9068) 1993 OD, 14968 Kubáček, (15527) 1999 YY2, (16404) 1985 CM1, (39828) 1998 BH4, (44060) 1998 FU42, (46953) 1998 SB121, (50879) 2000 GT32, (56367) 2000 EF, (90698) 1984 EA, (96178) 1987 SA4, (120928) 1998 SP109, (154244) 2002 KL6, and 1995 UX1.

Photometric observations using a 0.6-m telescope with AP8 CCD camera at Modra have regularly contributed to the rotation period determination of asteroids with unknown or poorly known periods. Because of a large field of view (FOV ~ 25’x25’), it is possible to link sessions of main belt asteroids observed on consecutive nights to an internal system, which is important in those cases where the asteroid had a longer period, and to observe on occasion other asteroids in the same FOV down to a magnitude of ~17-18. Although we usually do not present lightcurves based on, e.g., one session, nor data with lightcurve amplitude that is comparable to noise, we decided to present some of the more promising examples.

131 Vala. This was a bright target observed in two sessions along with binary asteroid (11116) 1996 EK. The result for the rotation period is in agreement with the one obtained several weeks earlier and independently by Pilcher (2009).

1276 Ucclia. Our result for the rotation period is in agreement with those previously determined by Angeli (2001) and Behrend (2009). In our case, the amplitude of the lightcurve is a bit smaller.

1512 Oulu. Two sets of linked observations indicate a slow rotation. The third-order Fourier fit line misses some data, so the composite lightcurve is probably more complex.

2621 Goto. Though some sessions were done in poor weather conditions, they helped us link most of data and derive the rotation period unambiguously. Three sets of linkages were obtained during more than one month.

3280 Grétry. Despite the fact it was observed on just three consecutive nights two months after opposition and as faint as magnitude ~ 17, the rotation period was derived unambiguously thanks to the lightcurve’s large amplitude.

3940 Larion. No firm solution for the rotation period could be found based on our data. Four small groups of data that are internally linked to the same magnitude level were shifted among themselves to obtain some bimodal composite lightcurves. Our best result from visual inspection indicates a sluggish rotation, but it may be an alias since the fit line still misses some data. The derived value of the spin rate does not agree with one by Warner (2009b), but he accepted a solution with some deviation from bimodal shape. The true value could probably be revealed by a collaboration of several observers.

4357 Korinthos. Although the amplitude of the lightcurve is small, it seems that an unambiguous result was found. Fit lines for other periods are less probable.

4601 Ludkewycz. This asteroid was expected to be close in brightness to 1276 Ucclia but the average difference between the two was unexpectedly large. This could mean either that the absolute magnitude for 4601 should be larger by ~ 0.3 mag or that 1276 was brighter than predicted.

4925 Zhoushan. At first just two sessions for this object were obtained while in the same FOV as the binary asteroid (32008) 2000 HM53. The object was bright so extra observations could be added even four weeks later.

5479 Grahamryder. Based on our very short sessions during summer evenings, it seems that the composite lightcurve is complex. Some of data were linked to the same magnitude level, but we could not find a secure rotation period. Formally, the best solution for the rotation period seems to be 11.122 h. The lightcurve plot shows the data phased to a period of 7.549 h, which is a slightly worse fit. We consider this solution to be more likely even though there are still some voids in the composite lightcurve and some data are out of the fourth-order Fourier fit line. A couple of longer sessions at a favorable apparition could help reveal the true rotation period.

5986 Xenophon. This was a target in a Photometric Survey for Asynchronous Binary Asteroids (Pravec, 2006).

(7036) 1995 BH3. The asteroid was not observed at a favorable apparition, but the large amplitude of the lightcurve helped derive the rotation period quite rapidly.

7421 Kusaka. We could not find a simple fit line connecting all sessions and obtain bimodal lightcurve without deviating points exceeding the noise. Based on our linkages, it seems that this asteroid could be a tumbler. We hope that the period we found represents its rotation period, while the precession period remains unknown. In fact, a bimodal lightcurve could also be found for the period of 32.08 h, but it is a less probable solution due to larger deviations. In addition, known tumblers of the size of this asteroid are usually much slower rotators.

8885 Sette. From two groups of linked data we could not find a reliable rotation period. The best formal solution is presented but the deviations are still too large. It can be explained by its slow rotation (period probably longer than 140 h), so the asteroid is a candidate for being a tumbler. Based on brightness of other objects in the FOV, it seems that this object was brighter than predicted by ~ 0.4 mag.

(9068) 1993 OD. This Mars-crosser was bright but moving through crowded star fields which made data measurements a bit harder. Our result is in agreement with that given by Warner (2009a).

14968 Kubáček. This is a Modra discovery. It was fainter than magnitude 17 and some sessions were noisy since they were obtained in bad weather conditions.

(15527) 1999 YY2. This Trojan was fainter than magnitude 17, but good weather conditions and the large amplitude of the lightcurve helped derive rotation period unambiguously.

(16404) 1985 CM1. We obtained just two interrupted sessions and one very short one. Despite the fact that the data are linked and we present the best formal result among those with bimodal shape of the lightcurve, the period should be considered as tentative only.

(39828) 1998 BH4. Two linked sessions indicate the rotation period but at least one more solution (*P* ~ 19.4 h) cannot be ruled out. Moreover, the shape of the lightcurve may be more complex than the assumed bimodal shape.

(44060) 1998 FU42. We have just one long (~ 8 h) session and one very short session two nights later, but the data are linked. Our result is considered as a tentative only.

(46953) 1998 SB121. We can't distinguish between the two more probable, though still tentative, results based on two long sessions. One period, given here, is 3.97 h and the other is 3.69 h.

(50879) 2000 GT32. There were as many as five objects up to magnitude 18.5 in the FOV. This was the faintest of the group but the lightcurve indicates some tentative solution for the rotation period. Due to the large noise, a few other solutions, especially from the interval of 7.5 h to 15 h, cannot be ruled out. The brightest asteroid, 2380 Heilongjiang, was part of the Photometric Survey for Asynchronous Binary Asteroids (Pravec 2006). We mentioned above two other asteroids that were in the same field, (39828) 1998 BH4 and (46953) 1998 SB121. We do not present the remaining one, (31277) 1998 FK28, due to the low amplitude of the lightcurve that was comparable to the noise.

(56367) 2000 EF. This asteroid was observed with 2621 Goto and 8885 Sette mentioned above. The lightcurve indicates a slow rotation but several other solutions are also possible, e.g. ~ 84 h, or ~ 111 h, using two groups of linked data.

(90698) 1984 EA. We observed this at a favourable apparition in good weather conditions.

(96178) 1987 SA4. This asteroid was in the same field as (16404) 1985 CM1 that was mentioned above. Sessions were interrupted, so we can present only a tentative solution. A second solution with similar probability gives *P* ~ 13-14 h.

(120928) 1998 SP109. This object was in the same field as (7036) 1995 BH3. Despite the fact that it was extremely faint (> 18), we tried to obtain a lightcurve for it. The large amplitude of the lightcurve was promising but the noise was too large to get an unambiguous result. In addition to our tentative result of *P* = 10.73 h, a period of *P* = 8.78 h also fits a bimodal shape.

(154244) 2002 KL6. This is a near-Earth asteroid. Despite changing geometry while moving fast across the sky, the shape of the lightcurve remained the same.

1995 UX1. This Mars-crosser is a Modra discovery. It was observed at a favorable apparition having a visual magnitude ~ 17.

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Number	Name	Dates yyyy mm/dd	Phases deg	LPAB deg	BPAB deg	Period [h]	Amp [mag]
131	Vala	2009 04/04-05	13.8-14.1	168	6	5.181 ± 0.001	0.32
1276	Ucclia	2008 06/14-07/06	7.2-11.2	252	18	4.9073 ± 0.0004	0.29
1512	Oulu	2009 04/15-05/21	8.1-15.0	179	1	132.3 ± 0.1	0.33
2621	Goto	2009 04/15-05/19	4.6-8.3	216	13	22.006 ± 0.005	0.32
3280	Grétry	2009 01/09-11	19.8-20.1	53	2	10.558 ± 0.009	0.51
3940	Larion	2007 06/01-07/20	18.4-24.2	261	30	(46.91 ± 0.02)	(0.31)
4357	Korinthos	2009 07/21-28	10.5-12.5	329	11	6.619 ± 0.002	0.12
4601	Ludkewycz	2008 06/28-07/06	12.9-15.0	253	17	3.0250 ± 0.0002	0.33
4925	Zhoushan	2007 08/23-10/06	5.9-19.4	326	11	7.8656 ± 0.0002	0.43
5479	Grahamryder	2009 06/26-07/26	13.9-23.4	257	16	(7.596 ± 0.001)	0.30
5986	Xenophon	2009 07/09-27	15.4-21.7	326	10	6.9214 ± 0.0004	0.40
(7036)	1995 BH3	2008 09/04-19	3.5-6.8	338	10	11.245 ± 0.002	0.79
7421	Kusaka	2009 05/29-06/18	14.1-15.0	257	23	(96.5 ± 0.1)	(0.7)
8885	Sette	2009 04/15-05/04	7.5-8.4	215	13	(212.4 ± 0.8)	(0.5)
(9068)	1993 OD	2008 09/18-10/08	31.3-33.9	32	32	3.4074 ± 0.0001	0.19
14968	Kubáček	2008 04/06-25	2.5-9.5	195	5	4.8940 ± 0.0003	0.48
(15527)	1999 YY2	2007 06/28-07/20	7.0-10.5	322	14	6.9903 ± 0.0004	0.54
(16404)	1985 CM1	2008 12/28-30	2.3-3.1	101	-4	(7.37 ± 0.06)	(0.2)
(39828)	1998 BH4	2009 03/21-22	9.3-9.9	168	-1	(14.2 ± 0.2)	0.13
(44060)	1998 FU42	2006 12/09-11	8.2-9.4	65	-4	(4.36 ± 0.06)	0.06
(46953)	1998 SB121	2009 03/21-22	6.7-7.1	166	-1	(3.97 ± 0.01)	0.25
(50879)	2000 GT32	2009 03/21-22	6.3-6.7	166	-1	(9.77 ± 0.08)	0.33
(56367)	2000 EF	2009 04/17-05/04	6.9-8.1	215	12	(98 ± 2)	0.8
(90698)	1984 EA	2006 02/01-03	16.0-16.9	148	17	5.014 ± 0.003	0.23
(96178)	1987 SA4	2008 12/28-30	2.6-3.6	101	-3	(5.20 ± 0.05)	0.14
(120928)	1998 SP109	2008 09/06-10	6.2-7.4	339	9	(10.73 ± 0.02)	0.7
(154244)	2002 KL6	2009 06/25-07/06	53.8-68.7	305-324	14	4.6063 ± 0.0002	1.00
	1995 UX1	2008 10/18-21	6.8-7.4	27	7	10.95 ± 0.01	0.53

Table I. Asteroids with observation dates, minimum and maximum solar phase angles, phase angle bisector values, derived synodic rotation periods with uncertainties, and lightcurve amplitudes. Periods and amplitudes within parentheses are tentative.

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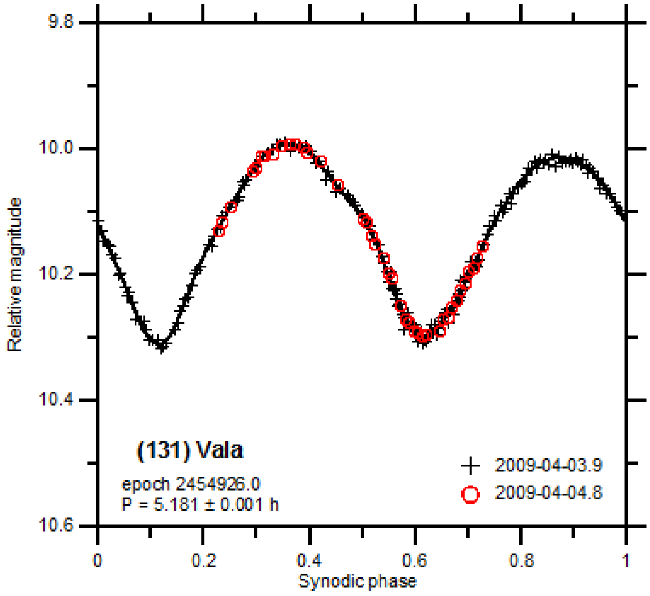
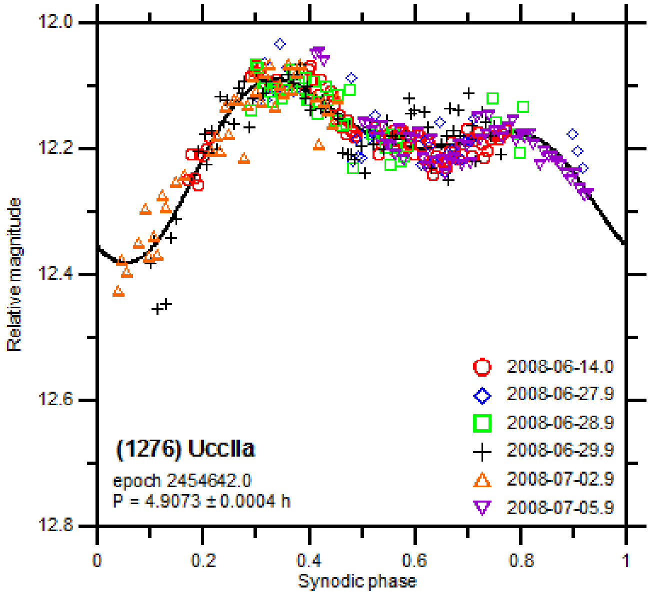
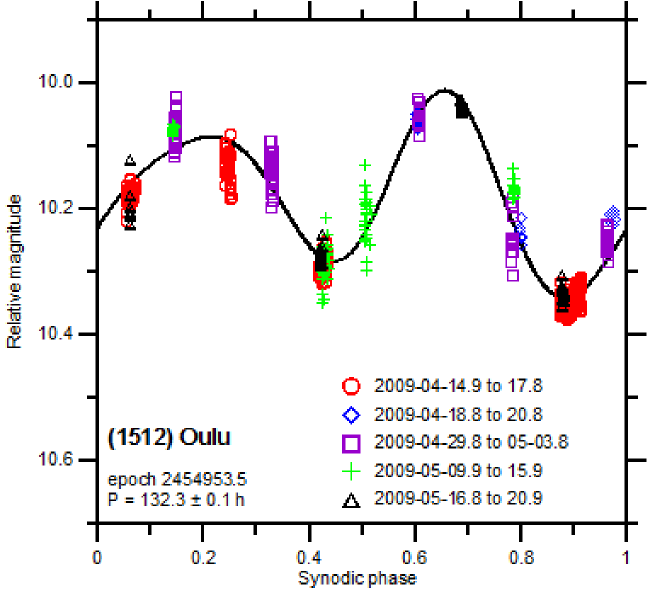
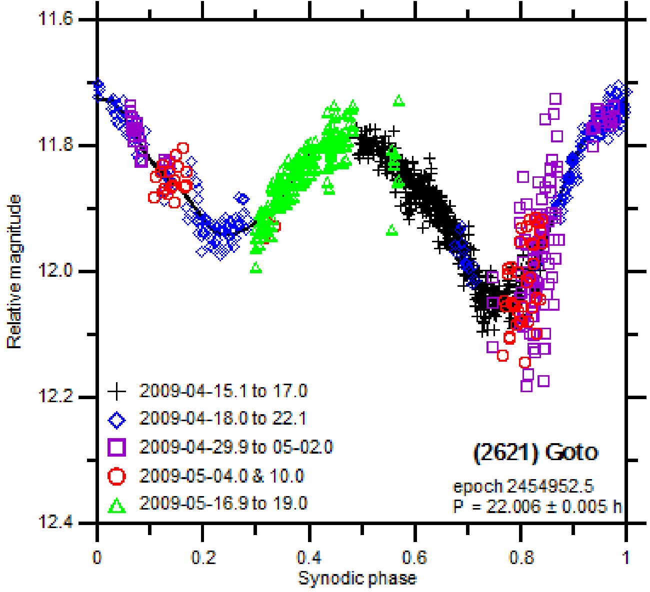
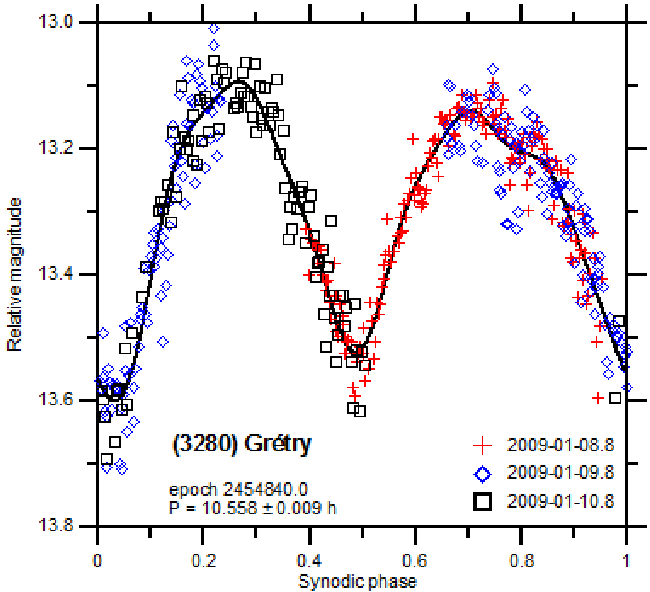
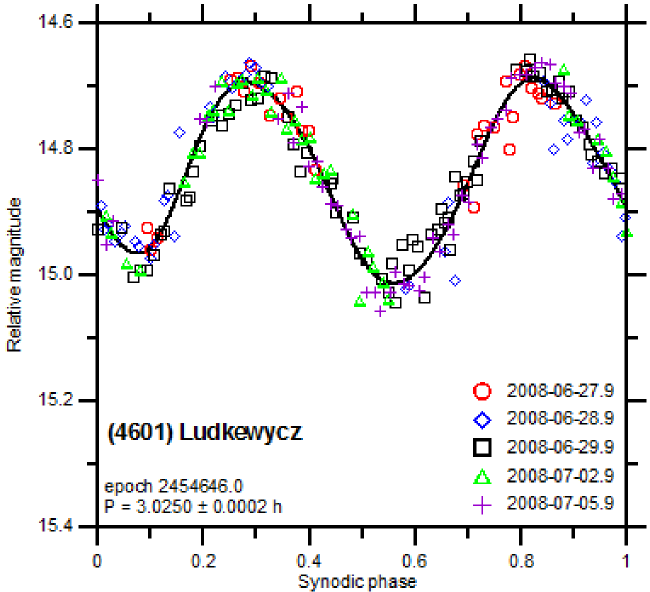


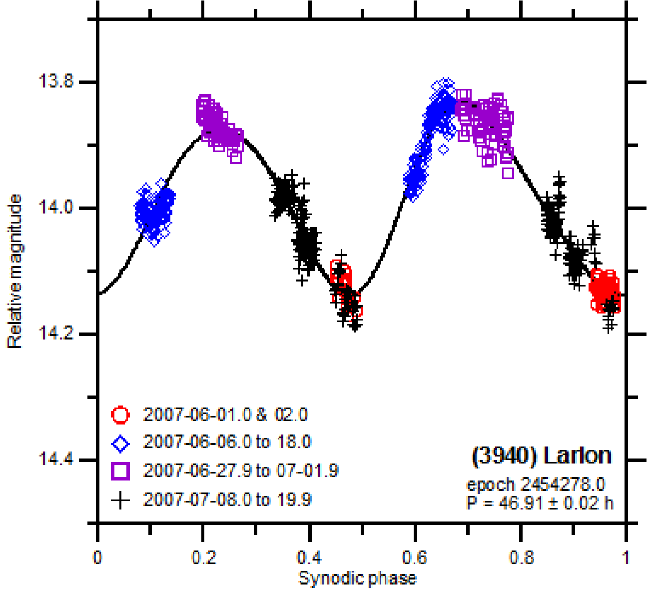


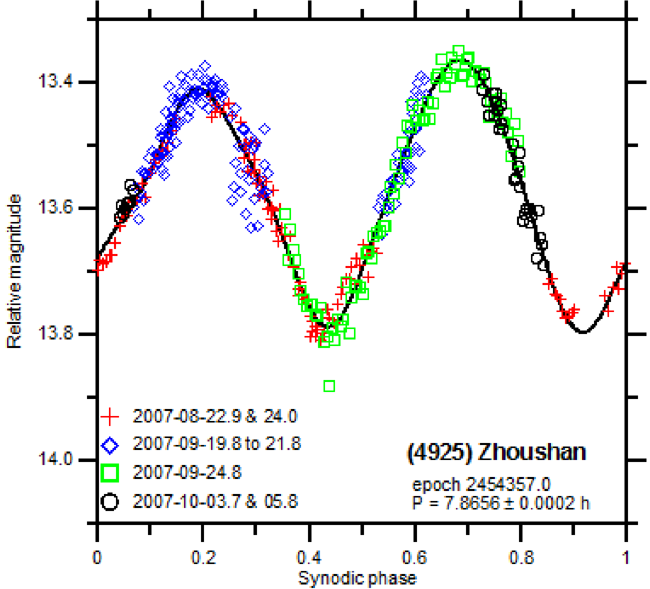


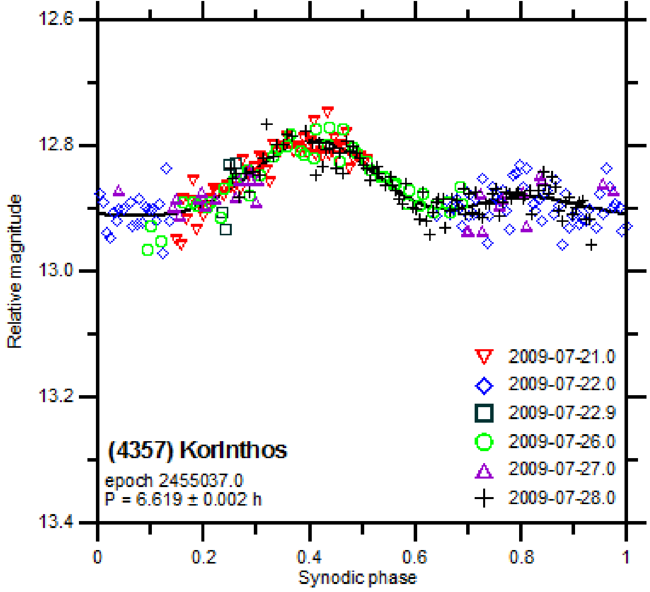


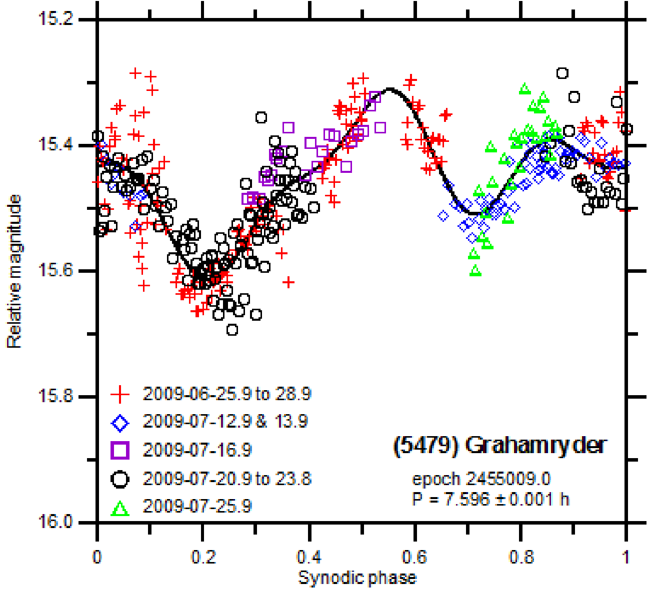

(3280) Grétry
epoch 2454840.0
P = 10.558 ± 0.009 h
2009-01-08.8
2009-01-09.8
2009-01-10.8
Relative magnitude
13.0
13.2
13.4
13.6
13.8
Synodic phase
0
0.2
0.4
0.6
0.8
1

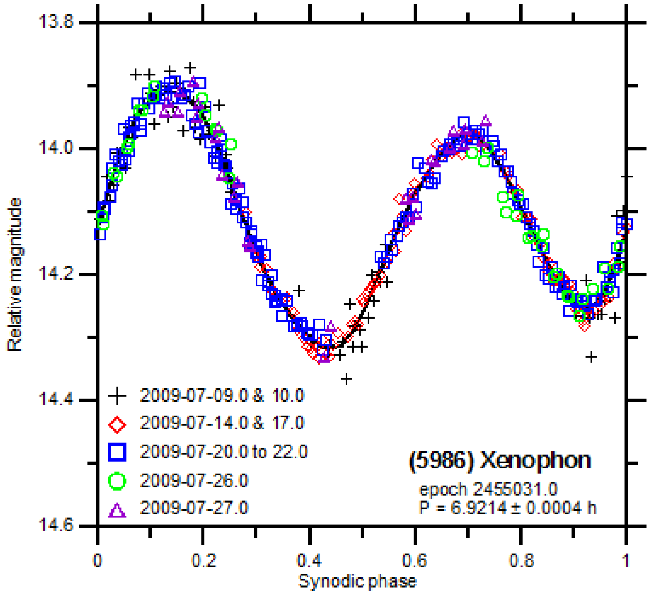

(4601) Ludkewycz
epoch 2454646.0
P = 3.0250 ± 0.0002 h
2008-06-27.9
2008-06-28.9
2008-06-29.9
2008-07-02.9
2008-07-05.9
Relative magnitude
14.6
14.8
15.0
15.2
15.4
Synodic phase
0
0.2
0.4
0.6
0.8
1

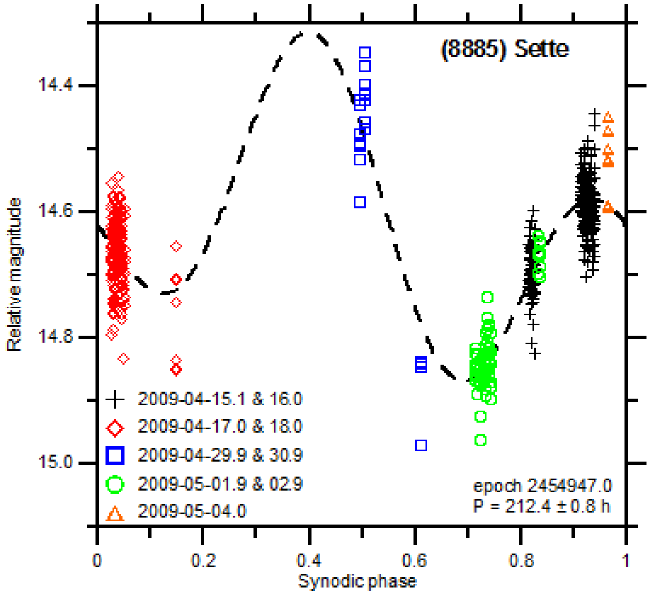

(3940) Larion
epoch 2454278.0
P = 46.91 ± 0.02 h
2007-06-01.0 & 02.0
2007-06-06.0 to 18.0
2007-06-27.9 to 07-01.9
2007-07-08.0 to 19.9
Relative magnitude
13.8
14.0
14.2
14.4
Synodic phase
0
0.2
0.4
0.6
0.8
1

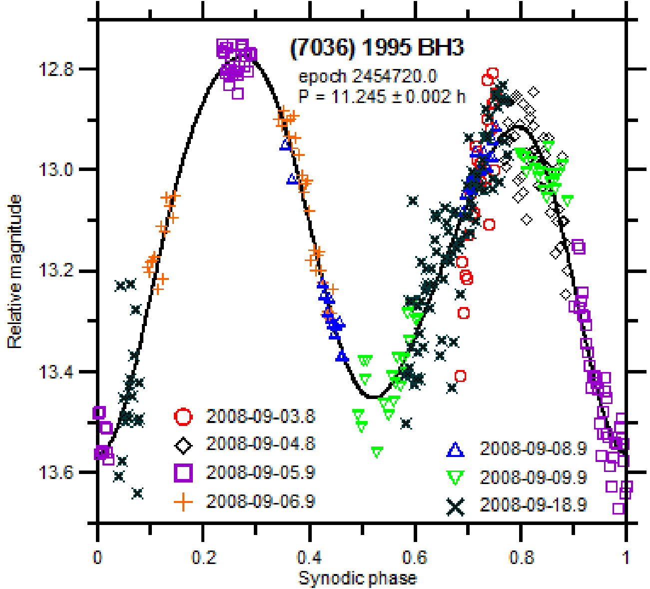

(4925) Zhoushan
epoch 2454357.0
P = 7.8656 ± 0.0002 h
2007-08-22.9 & 24.0
2007-09-19.8 to 21.8
2007-09-24.8
2007-10-03.7 & 05.8
Relative magnitude
13.4
13.6
13.8
14.0
Synodic phase
0
0.2
0.4
0.6
0.8
1

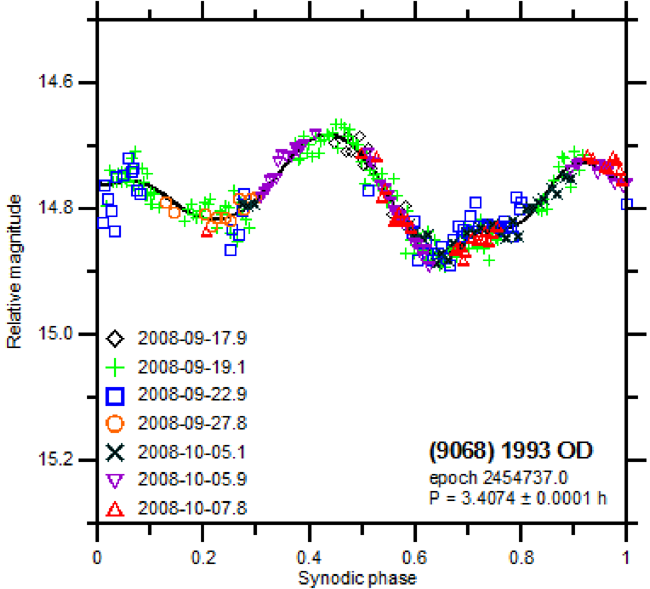

(4357) Korinthos
epoch 2455037.0
P = 6.619 ± 0.002 h
2009-07-21.0
2009-07-22.0
2009-07-22.9
2009-07-26.0
2009-07-27.0
2009-07-28.0
Relative magnitude
12.6
12.8
13.0
13.2
13.4
Synodic phase
0
0.2
0.4
0.6
0.8
1

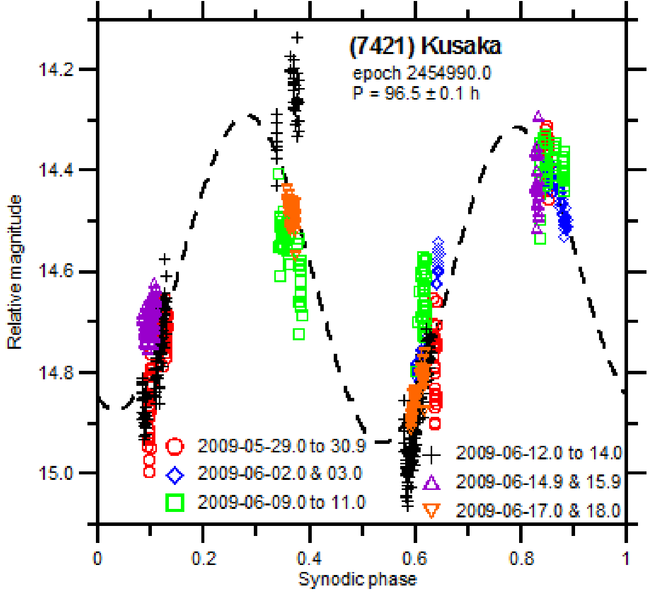

(5479) Grahamryder
epoch 2455009.0
P = 7.596 ± 0.001 h
2009-06-25.9 to 28.9
2009-07-12.9 & 13.9
2009-07-16.9
2009-07-20.9 to 23.8
2009-07-25.9
Relative magnitude
15.2
15.4
15.6
15.8
16.0
Synodic phase
0
0.2
0.4
0.6
0.8
1

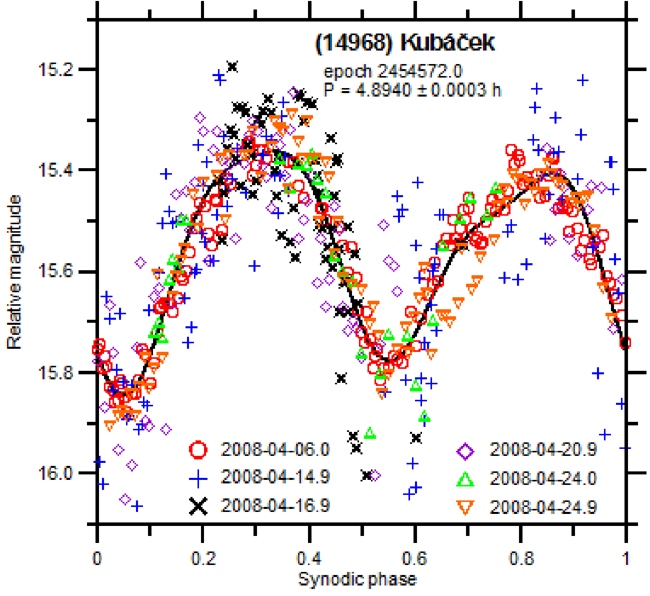

(5986) Xenophon
epoch 2455031.0
P = 6.9214 ± 0.0004 h
Relative magnitude
Synodic phase
2009-07-09.0 & 10.0
2009-07-14.0 & 17.0
2009-07-20.0 to 22.0
2009-07-26.0
2009-07-27.0
13.8
14.0
14.2
14.4
14.6
0
0.2
0.4
0.6
0.8
1

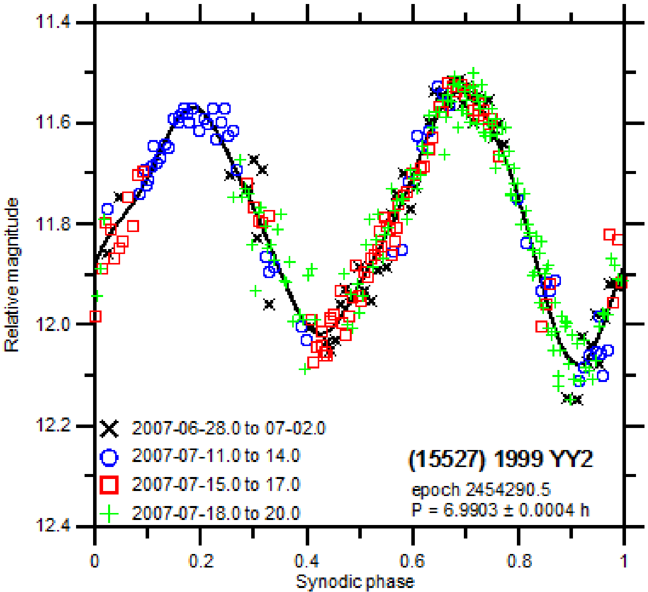

(8885) Sette
epoch 2454947.0
P = 212.4 ± 0.8 h
Relative magnitude
Synodic phase
2009-04-15.1 & 16.0
2009-04-17.0 & 18.0
2009-04-29.9 & 30.9
2009-05-01.9 & 02.9
2009-05-04.0
14.4
14.6
14.8
15.0
0
0.2
0.4
0.6
0.8
1

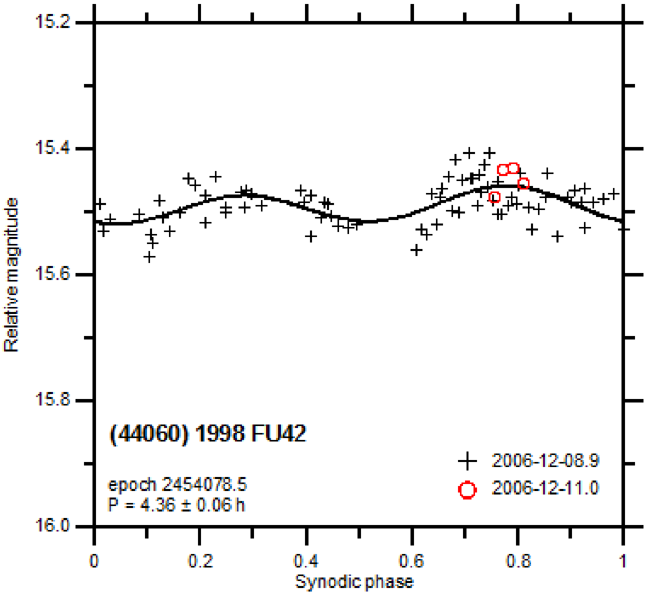

(7036) 1995 BH3
epoch 2454720.0
P = 11.245 ± 0.002 h
Relative magnitude
Synodic phase
2008-09-03.8
2008-09-04.8
2008-09-05.9
2008-09-06.9
2008-09-08.9
2008-09-09.9
2008-09-18.9
12.8
13.0
13.2
13.4
13.6
0
0.2
0.4
0.6
0.8
1

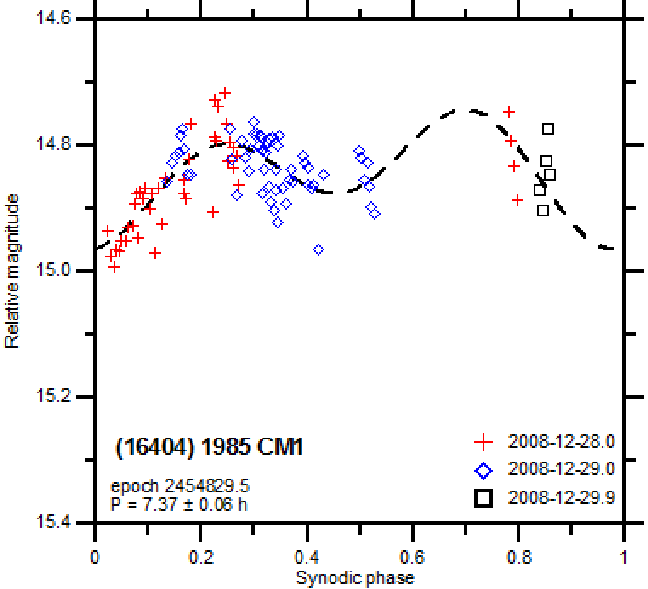

(9068) 1993 OD
epoch 2454737.0
P = 3.4074 ± 0.0001 h
Relative magnitude
Synodic phase
2008-09-17.9
2008-09-19.1
2008-09-22.9
2008-09-27.8
2008-10-05.1
2008-10-05.9
2008-10-07.8
14.6
14.8
15.0
15.2
0
0.2
0.4
0.6
0.8
1

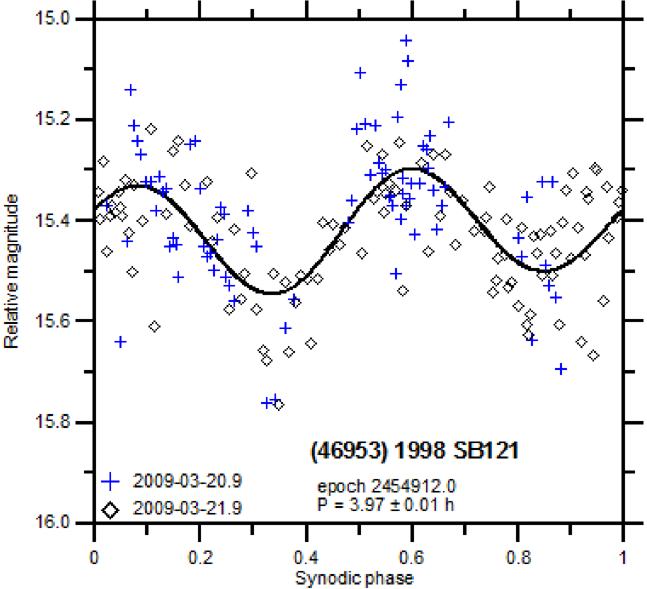

(7421) Kusaka
epoch 2454990.0
P = 96.5 ± 0.1 h
Relative magnitude
Synodic phase
2009-05-29.0 to 30.9
2009-06-02.0 & 03.0
2009-06-09.0 to 11.0
2009-06-12.0 to 14.0
2009-06-14.9 & 15.9
2009-06-17.0 & 18.0
14.2
14.4
14.6
14.8
15.0
0
0.2
0.4
0.6
0.8
1

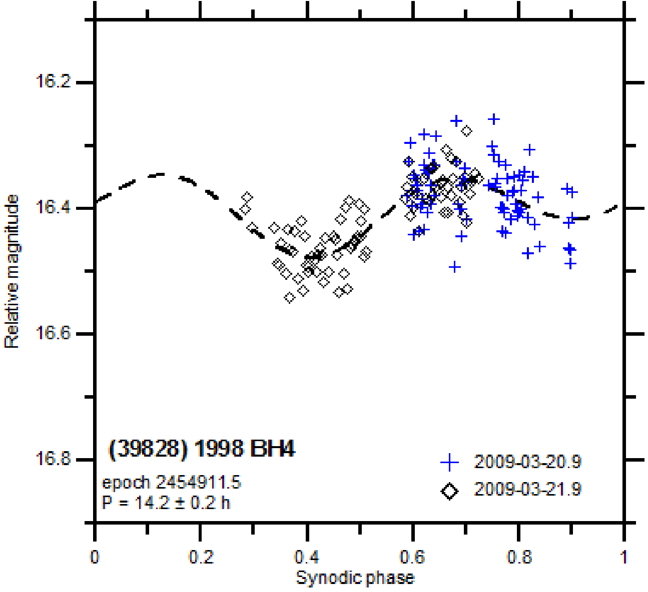

(14968) Kubáček
epoch 2454572.0
P = 4.8940 ± 0.0003 h
Relative magnitude
Synodic phase
2008-04-06.0
2008-04-14.9
2008-04-16.9
2008-04-20.9
2008-04-24.0
2008-04-24.9
15.2
15.4
15.6
15.8
16.0
0
0.2
0.4
0.6
0.8
1

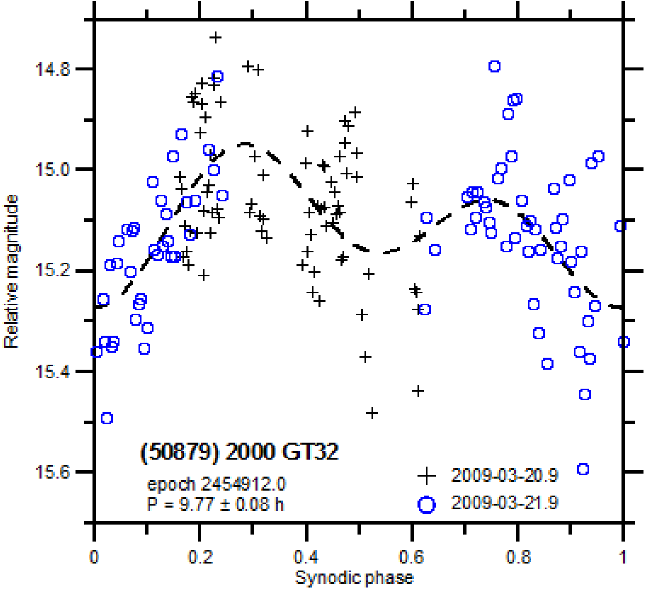

Relative magnitude
11.4
11.6
11.8
12.0
12.2
12.4
0
0.2
0.4
0.6
0.8
1
Synodic phase
✕ 2007-06-28.0 to 07-02.0
○ 2007-07-11.0 to 14.0
□ 2007-07-15.0 to 17.0
+ 2007-07-18.0 to 20.0
(15527) 1999 YY2
epoch 2454290.5
P = 6.9903 ± 0.0004 h

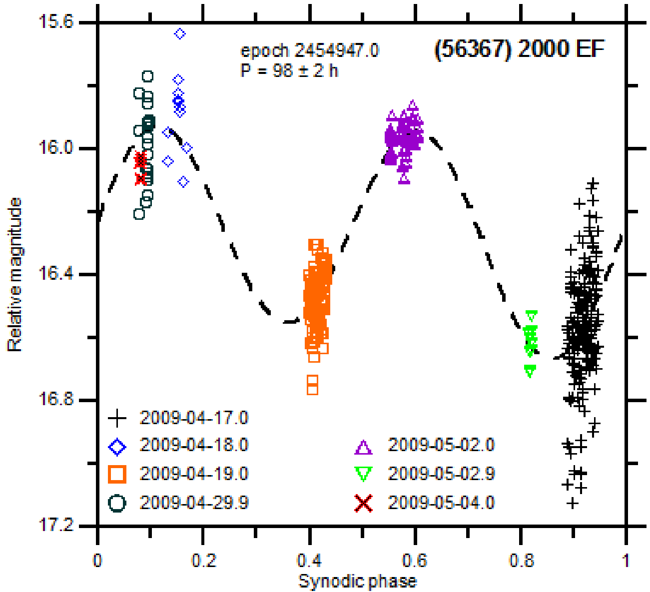

Relative magnitude
15.2
15.4
15.6
15.8
16.0
0
0.2
0.4
0.6
0.8
1
Synodic phase
(44060) 1998 FU42
epoch 2454078.5
P = 4.36 ± 0.06 h
+ 2006-12-08.9
○ 2006-12-11.0

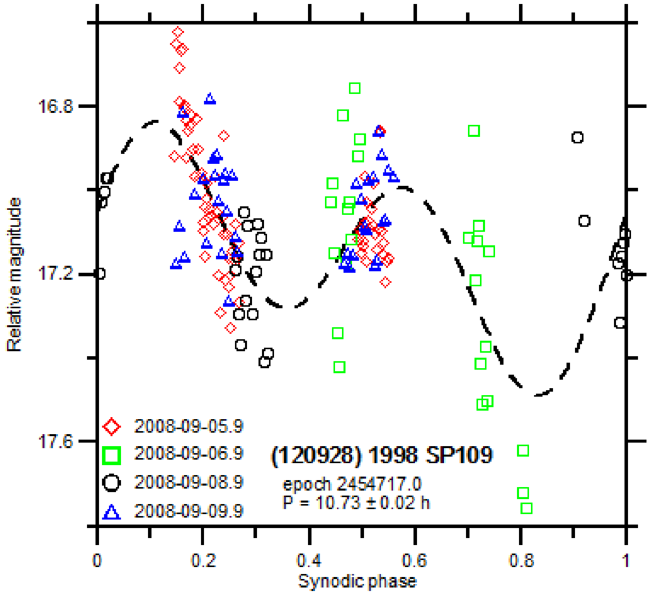

Relative magnitude
14.6
14.8
15.0
15.2
15.4
0
0.2
0.4
0.6
0.8
1
Synodic phase
(16404) 1985 CM1
epoch 2454829.5
P = 7.37 ± 0.06 h
+ 2008-12-28.0
◇ 2008-12-29.0
□ 2008-12-29.9

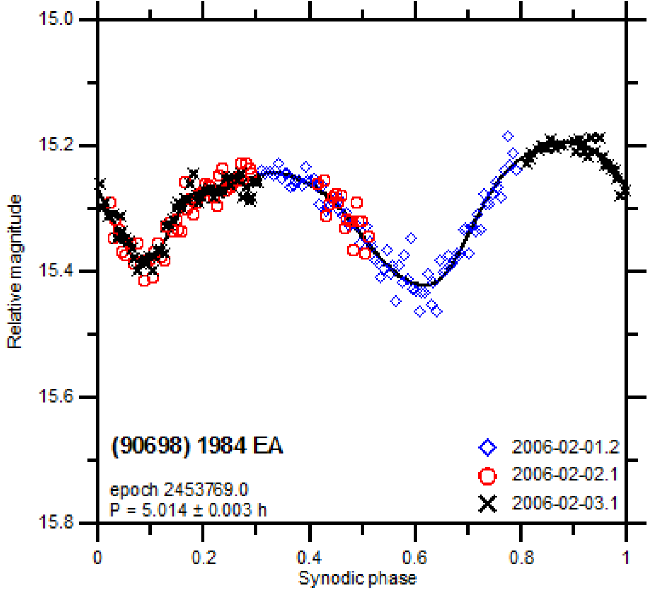

Relative magnitude
15.0
15.2
15.4
15.6
15.8
16.0
0
0.2
0.4
0.6
0.8
1
Synodic phase
+ 2009-03-20.9
◇ 2009-03-21.9
(46953) 1998 SB121
epoch 2454912.0
P = 3.97 ± 0.01 h

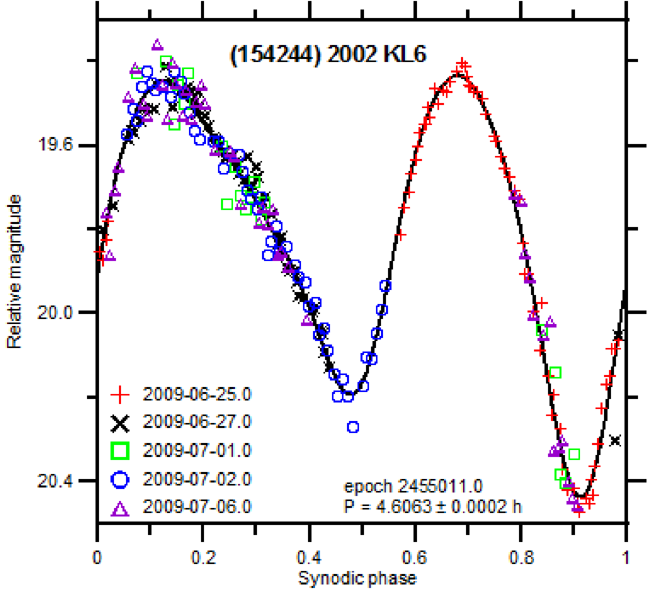

Relative magnitude
16.2
16.4
16.6
16.8
0
0.2
0.4
0.6
0.8
1
Synodic phase
(39828) 1998 BH4
epoch 2454911.5
P = 14.2 ± 0.2 h
+ 2009-03-20.9
◇ 2009-03-21.9

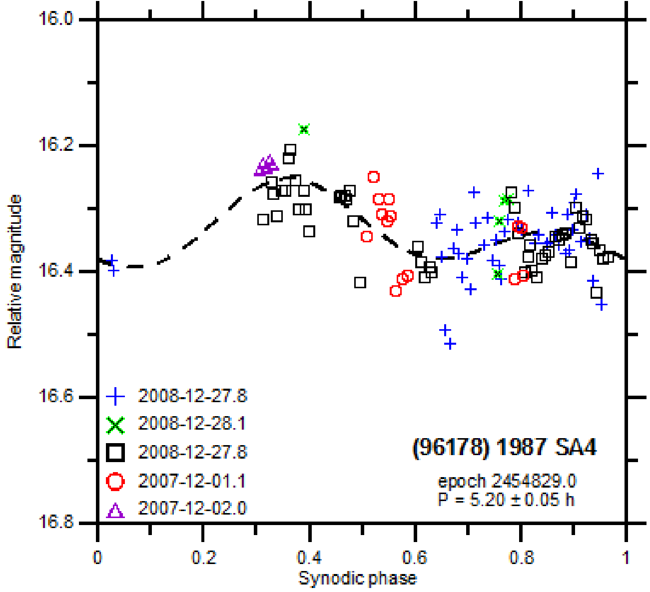

Relative magnitude
14.8
15.0
15.2
15.4
15.6
0
0.2
0.4
0.6
0.8
1
Synodic phase
(50879) 2000 GT32
epoch 2454912.0
P = 9.77 ± 0.08 h
+ 2009-03-20.9
○ 2009-03-21.9

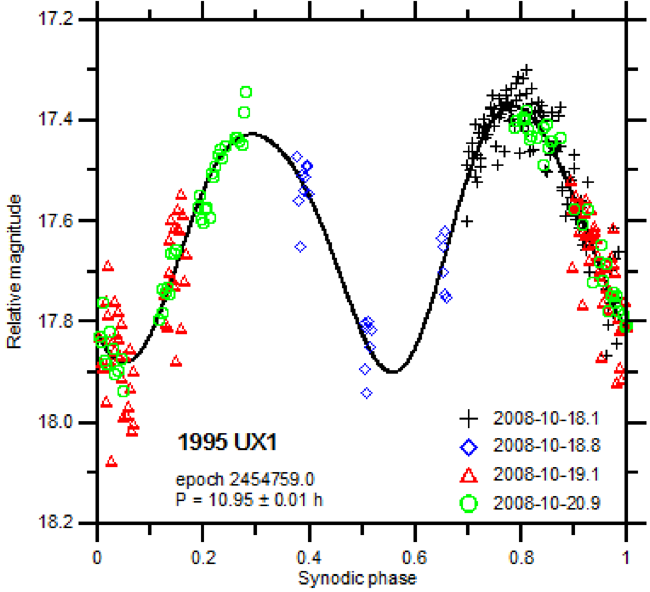

(56367) 2000 EF
epoch 2454947.0
P = 98 ± 2 h
Relative magnitude
15.6
16.0
16.4
16.8
17.2
Synodic phase
0
0.2
0.4
0.6
0.8
1
2009-04-17.0
2009-04-18.0
2009-04-19.0
2009-04-29.9
2009-05-02.0
2009-05-02.9
2009-05-04.0


(120928) 1998 SP109
epoch 2454717.0
P = 10.73 ± 0.02 h
Relative magnitude
16.8
17.2
17.6
Synodic phase
0
0.2
0.4
0.6
0.8
1
2008-09-05.9
2008-09-06.9
2008-09-08.9
2008-09-09.9


(90698) 1984 EA
epoch 2453769.0
P = 5.014 ± 0.003 h
Relative magnitude
15.0
15.2
15.4
15.6
15.8
Synodic phase
0
0.2
0.4
0.6
0.8
1
2006-02-01.2
2006-02-02.1
2006-02-03.1


(154244) 2002 KL6
epoch 2455011.0
P = 4.6063 ± 0.0002 h
Relative magnitude
19.6
20.0
20.4
Synodic phase
0
0.2
0.4
0.6
0.8
1
2009-06-25.0
2009-06-27.0
2009-07-01.0
2009-07-02.0
2009-07-06.0


(96178) 1987 SA4
epoch 2454829.0
P = 5.20 ± 0.05 h
Relative magnitude
16.0
16.2
16.4
16.6
16.8
Synodic phase
0
0.2
0.4
0.6
0.8
1
2008-12-27.8
2008-12-28.1
2008-12-27.8
2007-12-01.1
2007-12-02.0


1995 UX1
epoch 2454759.0
P = 10.95 ± 0.01 h
Relative magnitude
17.2
17.4
17.6
17.8
18.0
18.2
Synodic phase
0
0.2
0.4
0.6
0.8
1
2008-10-18.1
2008-10-18.8
2008-10-19.1
2008-10-20.9

ASTEROID-DEEPSKY APPULSES IN 2010

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(Received: 15 October 2009)

The following list is a very small subset of the search results for asteroid-deepsky appulses in 2010, presenting only the highlights for the year based on close approaches of brighter asteroids to brighter DSOs. The complete set of predictions is available at

http://www.minorplanetobserver.com/Misc/DSOAppulses.htm

For any event not covered, the Minor Planet Center's web site at *http://scully.harvard.edu/~cgi/CheckMP* allows you to enter the location of a suspected asteroid or supernova and check if there are any known targets in the area.

The table gives the following data:

Date/UT	Universal Date (MM DD) and Time (hh:mm) of closest approach
#/Name	The number and name of the asteroid
RA/Dec	The J2000 position of the asteroid
AM	The approximate visual magnitude of the asteroid
Sep/PA	The separation in arcseconds and the position angle in degrees from the DSO to the asteroid
DSO	The DSO name or catalog designation
DM	The approximate total magnitude of the DSO
DT	The type of DSO: OC = Open Cluster; GC = Globular Cluster; G = Galaxy
SE/ME	The elongation in degrees from the sun and moon respectively
MP	The phase of the moon: 0 = New, 1.0 = Full. Positive = waxing; Negative = waning

Date	UT	#	Name	RA	Dec	AM	Sep	PA	DSO	DM	DT	SE	ME	MP
01 12	19:48	104	Klymene	09:17.22	+20 08.3	12.5	280	22	NGC 2809	13.0	G	157	130	-0.05
01 13	08:42	305	Gordonia	02:53.67	+13 01.5	13.5	94	343	NGC 1134	12.1	G	112	133	-0.03
01 13	11:44	104	Klymene	09:16.77	+20 10.9	12.5	73	202	NGC 2804	12.9	G	157	138	-0.03
02 15	05:14	113	Amalthea	10:01.66	+15 50.9	11.2	272	30	NGC 3094	12.3	G	176	166	0.01
02 16	08:39	502	Sigune	10:43.36	+24 54.4	12.8	121	252	NGC 3344	9.9	G	164	152	0.05
02 19	20:47	354	Eleonora	08:01.57	+15 42.7	10.0	29	236	NGC 2507	12.2	G	148	85	0.28
03 10	14:30	21	Lutetia	11:03.31	+11 08.9	11.2	251	22	NGC 3506	12.5	G	172	130	-0.23
03 12	05:26	110	Lydia	12:13.18	+07 02.3	11.9	48	202	NGC 4180	12.6	G	168	131	-0.12
03 12	14:24	32	Pomona	09:45.59	+04 55.7	11.0	20	213	NGC 2987	12.9	G	154	168	-0.09
03 22	11:25	222	Lucia	12:25.79	+00 38.3	13.2	214	23	NGC 4385	12.5	G	175	106	0.39
04 08	22:56	566	Stereoskopia	12:43.49	+02 02.7	13.4	236	20	NGC 4643	10.8	G	169	127	-0.27
04 10	13:34	396	Aeolia	12:52.96	-09 16.3	13.1	284	206	NGC 4778	12.5	G	174	140	-0.14
04 10	15:55	396	Aeolia	12:52.88	-09 15.7	13.1	245	206	NGC 4776	13.0	G	174	141	-0.14
05 11	09:27	115	Thyra	17:38.13	-37 29.1	11.9	296	350	Cr 338	8.0	OC	143	114	-0.08
05 16	15:42	90	Antiope	14:47.71	-14 50.3	12.6	43	14	NGC 5756	12.3	G	168	135	0.08
05 17	01:31	95	Arethusa	14:45.08	-20 54.5	12.9	36	211	NGC 5743	13.0	G	168	131	0.11
05 17	03:34	95	Arethusa	14:45.02	-20 54.0	12.9	139	211	NGC 5734	12.7	G	168	129	0.12
05 20	13:31	381	Myrrha	15:00.10	+01 54.1	12.7	64	2	NGC 5806	11.7	G	155	80	0.45
06 05	03:18	674	Rachele	11:22.69	+16 32.1	12.7	246	226	NGC 3655	11.6	G	91	164	-0.48
06 10	19:14	508	Princetonia	14:24.46	-16 43.3	13.2	225	351	NGC 5597	12.0	G	140	161	-0.03
06 11	04:34	508	Princetonia	14:24.30	-16 43.7	13.2	21	351	NGC 5595	12.0	G	139	156	-0.02
06 15	08:51	704	Interamnia	13:55.78	-30 20.4	11.7	96	254	NGC 5357	12.0	G	131	94	0.11
07 07	00:16	105	Artemis	17:30.39	+16 20.6	11.5	283	320	NGC 6379	12.9	G	135	124	-0.27
07 07	20:39	97	Klotho	00:38.20	+02 42.7	12.3	19	172	NGC 182	12.4	G	96	44	-0.19
07 09	03:24	100	Hekate	00:28.00	-01 49.4	12.6	22	172	NGC 124	13.0	G	101	66	-0.09
07 13	09:11	444	Gyptis	14:06.54	-05 30.2	13.1	142	202	NGC 5468	12.5	G	101	79	0.04
07 16	20:53	15	Eunomia	18:03.42	-27 53.3	9.3	46	21	NGC 6520	7.6	OC	156	87	0.33
07 17	00:29	114	Kassandra	13:52.02	-06 01.5	13.2	36	25	NGC 5324	11.7	G	94	24	0.34
08 13	23:44	63	Ausonia	18:04.88	-30 03.6	10.7	74	118	NGC 6528	9.5	GC	130	75	0.21
08 14	05:16	82	Alkmene	23:18.79	-07 31.2	13.3	251	337	NGC 7600	11.9	G	154	148	0.23
09 03	18:46	8	Flora	23:38.93	-12 58.4	8.3	35	140	NGC 7723	11.2	G	167	107	-0.28
09 07	10:43	360	Carlova	23:08.47	-15 38.3	12.3	100	142	NGC 7492	11.5	GC	170	163	-0.01
09 08	06:15	83	Beatrix	22:02.40	-18 55.6	12.3	23	350	NGC 7183	11.9	G	160	160	0.00
09 09	02:45	39	Laetitia	23:38.94	-06 33.2	9.2	184	136	NGC 7721	11.6	G	173	171	0.01
09 09	06:41	233	Asterope	00:17.83	+11 25.2	11.5	53	150	NGC 63	11.6	G	156	169	0.01
09 10	06:24	100	Hekate	00:31.73	-05 08.5	11.5	113	324	NGC 145	12.7	G	161	165	0.05
09 11	04:30	84	Klio	17:46.42	-29 18.8	12.9	52	161	Cr 347	8.8	OC	99	60	0.11
10 02	02:34	912	Maritima	00:51.09	-07 03.3	13.1	42	353	NGC 274	11.8	G	169	101	-0.39
10 02	02:34	912	Maritima	00:51.09	-07 03.3	13.1	42	353	NGC 275	12.5	G	169	101	-0.39
10 05	01:24	5142	Okutama	00:48.02	+08 20.1	13.1	93	313	NGC 257	12.6	G	176	139	-0.11
10 07	01:26	606	Brangane	23:20.44	+08 28.6	12.7	282	349	NGC 7623	12.9	G	158	169	-0.01
11 03	07:32	70	Panopaea	01:50.50	+06 06.2	11.5	110	181	NGC 693	12.4	G	166	152	-0.11
11 03	17:16	403	Cyane	02:26.84	+20 29.0	12.9	72	150	NGC 924	12.4	G	174	147	-0.09
11 04	20:57	66146	1998 TU3	22:57.21	-36 24.0	13.5	58	8	IC 1459	10.0	G	106	119	-0.03
11 06	16:22	259	Aletheia	02:17.11	+01 12.9	12.8	64	172	NGC 875	12.9	G	164	157	0.00
11 11	05:47	233	Asterope	23:46.62	+03 46.4	12.2	85	244	NGC 7750	12.9	G	130	67	0.27
11 12	00:13	523	Ada	06:04.93	+24 02.0	13.5	133	334	IC 2157	8.4	OC	138	150	0.34
11 13	10:44	23	Thalia	08:27.12	+25 56.8	10.7	73	168	NGC 2592	12.3	G	108	162	0.48
11 29	14:21	675	Ludmilla	06:07.62	+24 02.7	10.9	224	154	NGC 2158	8.6	OC	155	75	-0.41
12 07	09:03	675	Ludmilla	06:00.93	+23 20.4	10.7	155	336	NGC 2129	6.7	OC	165	175	0.03
12 28	11:20	61	Danae	01:23.68	+33 17.8	12.5	127	30	NGC 507	11.2	G	114	153	-0.46

LIGHTCURVE ANALYSIS OF 740 CANTABIA

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We report CCD observations of 740 Cantabia. The derived lightcurve has a synodic period of 64.453 ± 0.003 h and amplitude of 0.16 ± 0.02 mag.

Two observing teams independently started observing 740 Cantabia, selecting it from a list of asteroid photometry opportunities published on the Collaborative Asteroid Lightcurve Link (CALL) website (Warner et al., 2009). Upon learning of each other's efforts, they decided to combine their datasets. Most images were unguided and unbinned with no filter. Buchheim used a Johnsons-Cousins R filter. Measurements were made using *MPO Canopus*, which employs differential aperture photometry to produce the raw data. Period analysis was done using *Canopus*, which incorporates the Fourier analysis algorithm (FALC) developed by Harris (Harris et al., 1989).

Between 2009 January 20 and April 4, 5,125 data points were obtained. The phase angle decreased from 12.9 to 3.6 degrees and then increased to 16.3 degrees. The average L_{PAB} was 153 degrees while the average B_{PAB} was 8 degrees (PAB is the phase angle bisector; see Harris et al., 1984, for the derivation of the PAB). Stephens initially determined the period to be 64.55 hours based upon 10 sessions, which was ~0.1 h different from that derived with the full data set. This demonstrates the value of combining datasets even when the period seems well-established. The details of the observing circumstances are listed in Table 1. Sessions on 2009 January 29, February 01, 02, 06 and 17 were not included in the final solution because they were too noisy or contained insufficient data points.

740 Cantabia was previously observed by Warner (1999) who determined only that the period exceeded 24 hours.

Acknowledgements

Thanks are given to Dr. Alan Harris of the Space Science Institute, Boulder, CO, for advice concerning the period.

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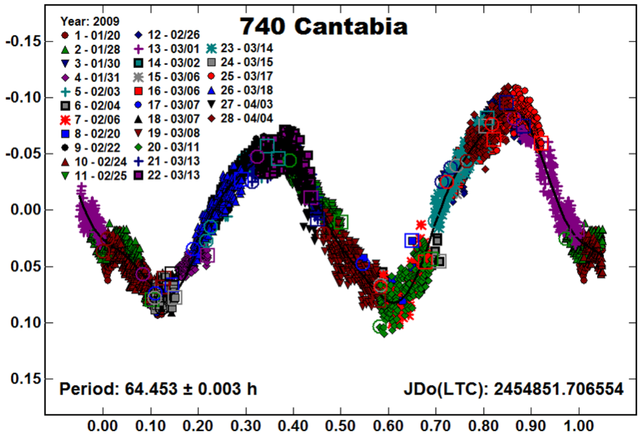

Observer	Data points	Dates Observed mm/dd/2009
Stephens 0.30-m SCT, SBIG STL-1001E	1899	02/24, 02/25, 03/06, 03/07, 03/08, 03/11, 03/13, 03/14, 03/17, 03/18
Stephens 0.35-m SCT, SBIG STL-1001E	228	03/01
Pilcher 0.35-m SCT, SBIG STL-1001E	2506	01/20, 01/28, 01/30, 01/31, 02/22, 02/26, 03/02, 03/13
Buchheim 0.28-m SCT, SBIG ST-8XE	101	02/03, 02/04, 02/20, 03/06, 03/07
Benishek 0.40-m SCT, Apogee AP47p	304	02/07, 04/03, 04/04
Warner 0.35-m SCT, SBIG STL-1001E	87	03/15

Table 1: Observing circumstances

ASTEROIDS OBSERVED FROM THE SHED OF SCIENCE OBSERVATORY: 2009 JULY-SEPTEMBER

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The analysis of lightcurve measurements for four asteroids from the Shed of Science Observatory for 2009 July to October is reported: 5620 Jasonwheeler, $P = 5.307 \pm 001$ h, $A = 1.55 \pm 0.05$ mag; 12868 Onken, $P = 115 \pm 1.0$ h, $A = 1.1$ mag; (21867) 2000 EG94, $P = 4.846 \pm 0.001$ h, $A = 0.22 \pm 0.05$ mag; (88161) 2000 XK18, $P = 6.806 \pm 0.002$ h.

Observations of four asteroids were made between 2009 July and October at the Shed of Science Observatory using a 0.35-m Schmidt Cassegrain (SCT) and SBIG ST10XE CCD camera. The scale on the CCD chip was 0.94 arcsec/pixel. Exposures were made through a Celestron UHC LPR filter. *MPO Canopus* was used to perform differential photometry on the reduced images.

5620 Jasonwheeler. This Amor near-Earth Asteroid (NEA) was observed on five nights between 2009 July 15 and 23. The data indicate a period of $P = 5.307 \pm 0.001$ h and amplitude of $A = 1.55$ mag. This is in agreement with earlier but unpublished data by G. Busenburg taken at Table Mt. Observatory on 1990 July 23 (Harris, personal communications). The earlier result indicated approximate parameters of $P = 5$ h and $A = 1.2$ mag with a reliability code $U = 2$. (See Warner et. al., 2009 for the definition of the U rating.)

12868 Onken. This object was observed over 8 nights in 2009 September. Using *MPO Canopus,* the science fields were calibrated on an internal magnitude scale to link the data from each night. Each science field was rapidly re-imaged on a later night using the same exposure times as the original images. The average magnitudes of each set of comparison stars in the linkage images were measured resulting in their average internal magnitude or “Delta-Comp”. The new “Delta-Comp” value for each science field was used for the science fields measured earlier. Our data fits a bimodal curve with a period of $P = 115 \pm 1.0$ h and amplitude of $A = 1.1$ mag.

(21867) 2000 EG94. The results of $P = 4.846 \pm 0.001$ h and $A = 0.22$ mag are the first published for this object.

(88161) 2000 XK18. A period of $P = 6.806$ h ± 0.0002 h and $A = 1.10$ mag were derived from four consecutive nights of observations.

Acknowledgements

Partial funding at the Shed of Science is provided by a 2009 Gene Shoemaker NEO Grant from the Planetary Society.

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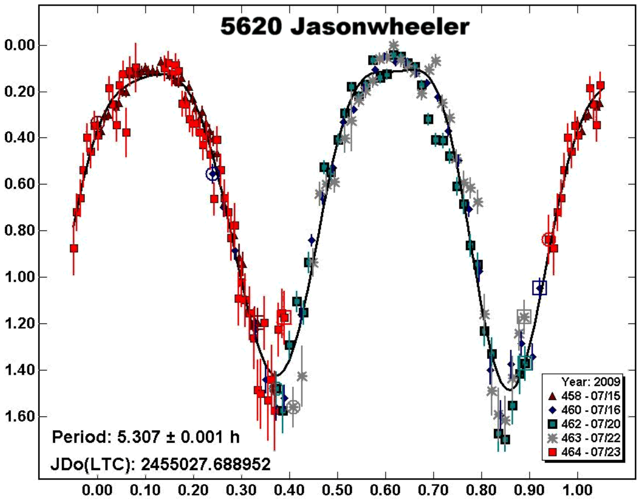

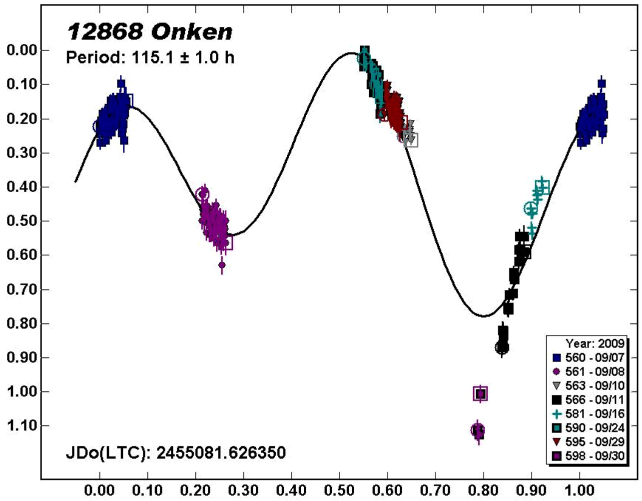

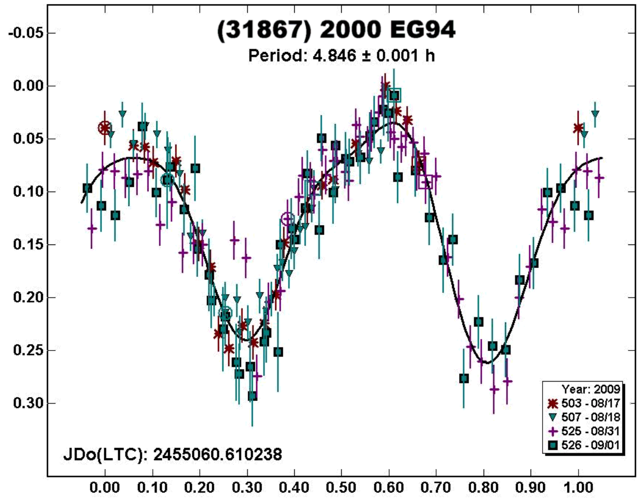

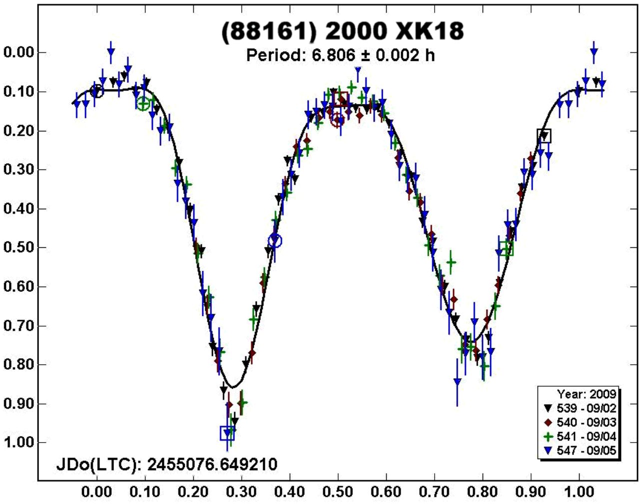

ASTEROID LIGHTCURVE ANALYSIS AT THE VIA CAPOTE OBSERVATORY: 2009 3RD QUARTER

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Six asteroids were observed and lightcurves measured at the Via Capote Observatory from 2009 June through September: 764 Gedania, *P* = 24.817 h; 890 Waltraut, *P* = 12.58 h; 1175 Margo, *P* > 6 h; 2636 Lassell, *P* = 5.012 h; 6867 Kuwano, *P* = 7.367 h; and 21607 Robel, *P* = 12.129 h.

Photometric observations of six asteroids were made at the Via Capote Observatory from 2009 June through September using a Meade LX-200 0.35-m f/10 Schmidt-Cassegrain (SCT) and Apogee Alta U6 CCD camera (1Kx1K, 24-micron) at prime focus. All observations were made unfiltered at 1x1 binning yielding an image scale of 1.44 arcsec/pixel. The images were dark and flat field corrected before being measured with *MPO Canopus* (Bdw Publishing) with a differential photometry technique. Period analysis on the light-time corrected data was also done with *Canopus*, which incorporates the Fourier analysis algorithm (FALC) developed by Harris (Harris et al., 1989). Most target selections were made using the Collaborative Asteroid Lightcurve Link (CALL) web-site and "Lightcurve Opportunities" articles from the *Minor Planet Bulletin*. Priority was given to asteroids that did not have a published rotational period.

Individual plots and a summary table of results are present below. Four of the six targets studied did not have previously published lightcurves.

764 Gedania. Behrend (2009) reports a period of 24.9751 h. This agrees reasonably well with the period of 24.817 h derived from this campaign. With the period nearly commensurate with the 24-hour Earth day, it was difficult to observe and measure the entire lightcurve cycle at a single observing site. The data are plotted in bins of 3 with no more than 5 min separation between the unbinned points.

1175 Margo. The data obtained during this campaign suggest a period of greater than 6 h and best fit a curve of 6.015 h. Examination of the period spectrum reveals a significant uncertainty in the period. The estimated magnitude of the curve exceeds 0.32 mag. Behrend (2009) reports very similar period and magnitude results while Oliver et al. (2008) report a preferred period of 11.99 hours (also considered possible in this study) with a lower amplitude.

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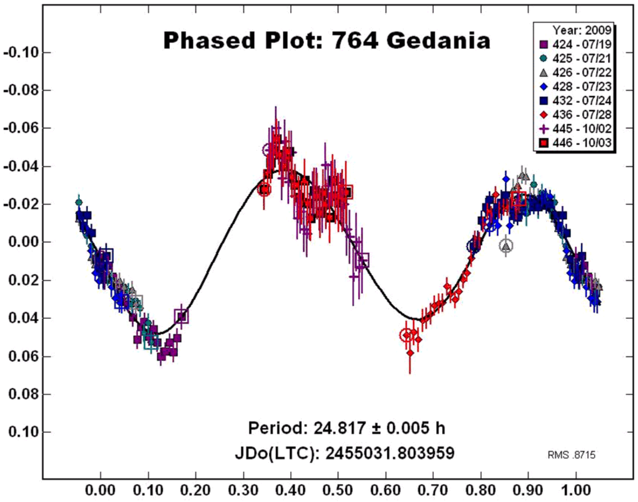

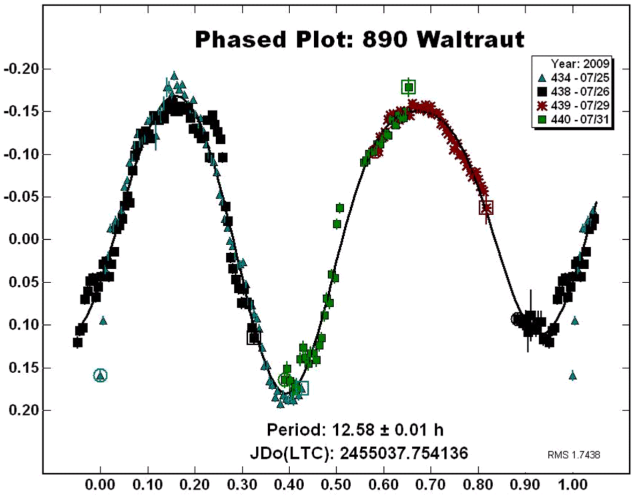

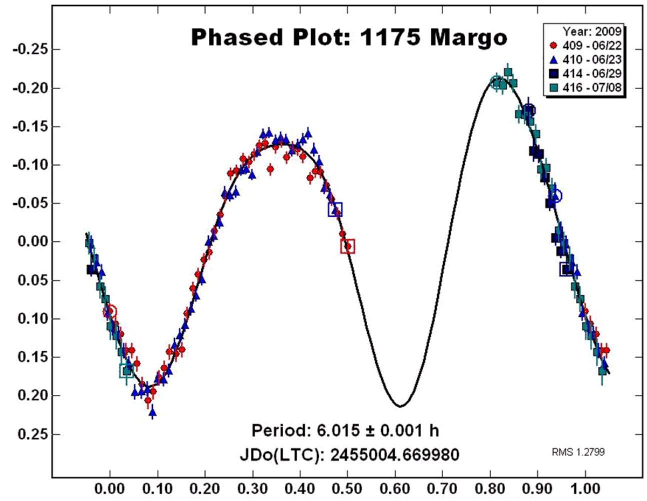

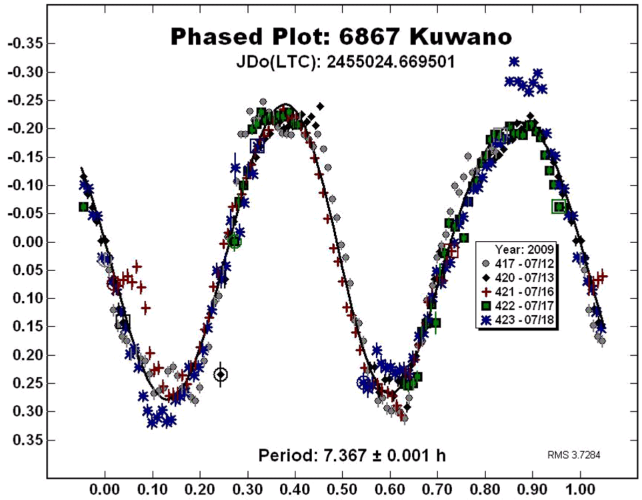

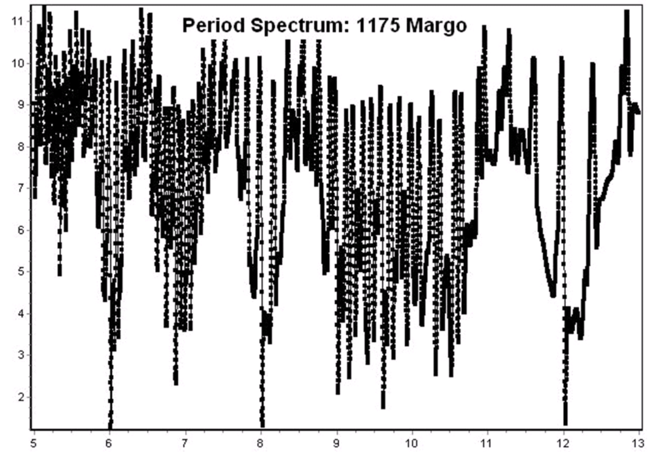

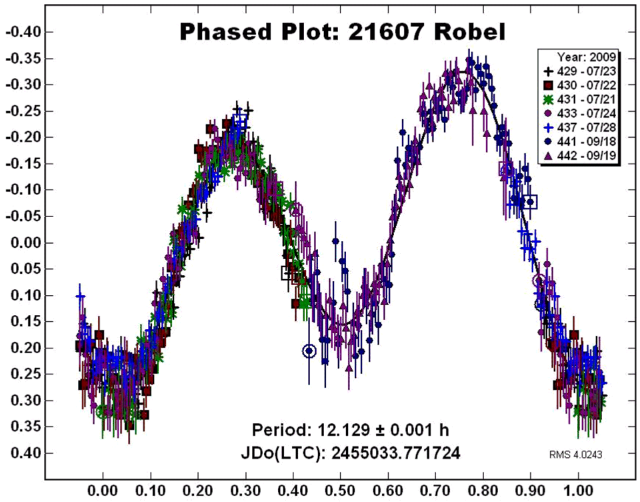

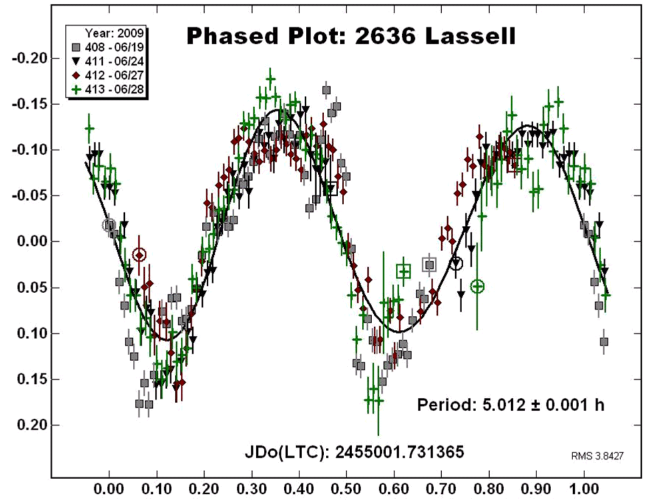

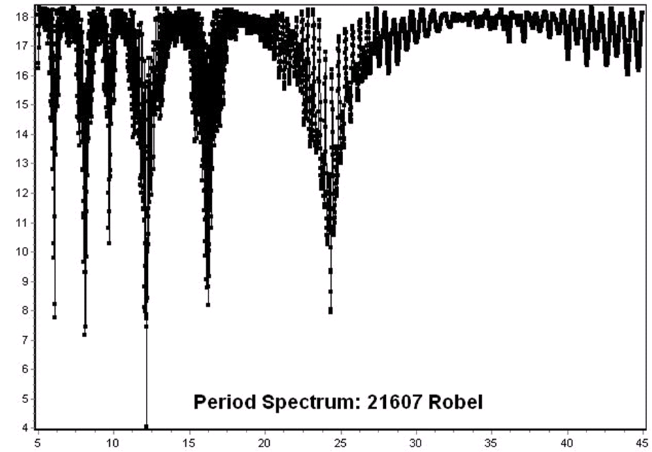

#	Name	Date Range (mm/dd) 2009	Data Points	Phase	L_{PAB}	B_{PAB}	Per(h)	PE	Amp(m)	AE
764	Gedania	07/19-10/03	218	11,4,15	326	11	24.817	0.005	>0.08	
890	Waltraut	07/25-07/31	240	4.3	313	7	12.58	0.01	0.35	0.02
1175	Margo	06/22-07/08	119	13.4	237	2	> 6		>0.32	
2636	Lassell	06/19-06/28	279	3.5	257	5	5.012	0.001	0.27	0.05
6867	Kuwano	07/12-07/18	358	14.4	279	17	7.367	0.001	0.52	0.02
21607	Robel	07/23-09/19	533	14.9	326	9	12.129	0.001	0.60	0.05

Table I. Observing circumstances. Phase is the average phase angle over the observation period. When three numbers are given, measurements of the target occurred over opposition. The middle value is the minimum phase angle observed and the two end values are the phase angles at the beginning and end of the observing campaign.

THE ROTATIONAL PERIOD OF 3748 TATUM

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Lightcurve data of 3748 Tatum was acquired at both the Via Capote Observatory in California, USA, and Hunters Hill Observatory in Australia. A rotation period of 58.210 ± 0.008h with a lightcurve amplitude of 0.54 mag was obtained in this collaborative effort.

Observations at the Via Capote Observatory were made using a Meade LX200 0.35-m Schmidt-Cassegrain (SCT) at prime focus with a resulting focal length of 3.56 m. The CCD imager was an Apogee Alta U6 featuring a 1024x1024 array of 24-micron pixels. All observations were made unfiltered at 1x binning yielding an image scale of 1.44 arcsec/pixel. All images were dark and flat field corrected. Observations at Hunters Hill Observatory were made using a 0.35-m Meade LX200 GPS SCT and focal reducer producing an effective focal length of 1.40 m. The CCD imager was an SBIG ST-8E with a 1530 x 1020 array of 9-micron pixels. The CCD was operated at a temperature of -15° C. All observations were taken at a sub-frame of 1148 x 765 pixels at 1x binning yielding an image scale of 1.31 arcsec/pixel. All images were dark and flat field corrected; no other image enhancements were made. All sessions except 418 and 419 (see lightcurve plot) were acquired at the Via Capote Observatory. Without the collaboration, a definitive solution would probably not have been found.

Images were measured using *MPO Canopus* (Bdw Publishing). All observations were made using unfiltered differential photometry and the data were light-time corrected. Period analysis was also done with *Canopus*, incorporating the Fourier analysis algorithm developed by Harris (1989). Our search found no previously reported lightcurves for this object.

References

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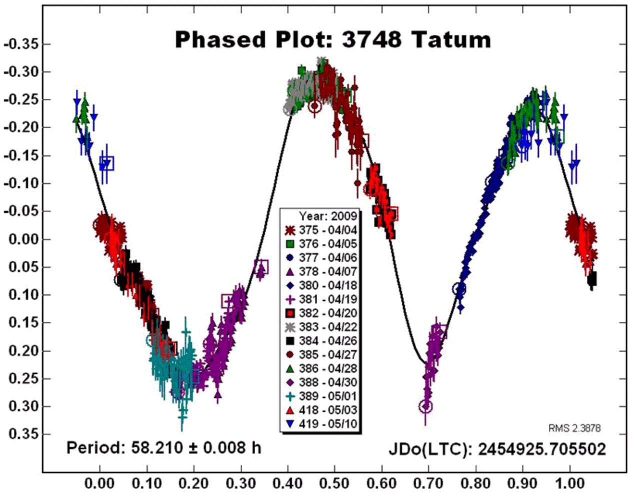

ROTATION PERIOD DETERMINATIONS FOR 23 THALIA, 204 KALLISTO, AND 207 HEDDA, AND NOTES ON 161 ATHOR AND 215 OENONE

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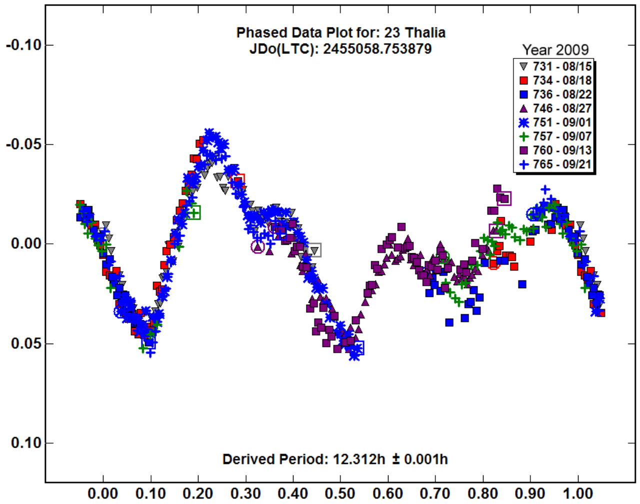
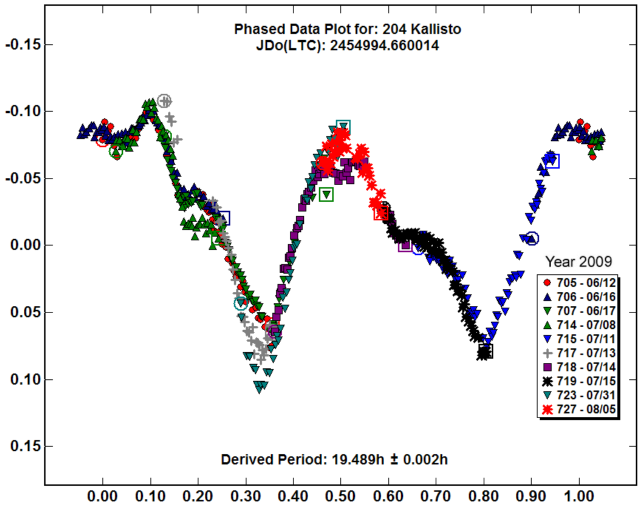
(Received: 23 September)

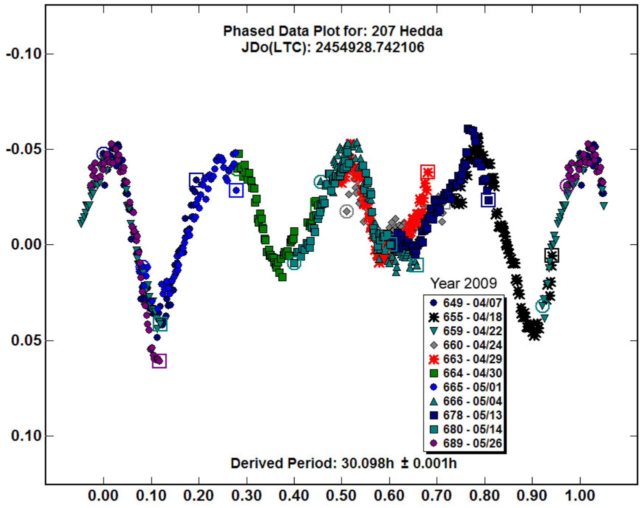
Synodic rotation periods and amplitudes have been found for: 23 Thalia 12.312 ± 0.001 h, 0.10 ± 0.01 mag; 204 Kallisto 19.489 ± 0.002h, 0.18 ± 0.02 mag; and 207 Hedda 30.098 ± 0.001 h, 0.09 ± 0.01 mag with 4 maxima and minima per cycle. For 161 Athor an amplitude 0.02 magnitudes is found near longitude 6 degrees, latitude –8 degrees, and for 215 Oenone an amplitude $\geq$ 0.16 mag and long period probably >24h.

Observations to produce these determinations have all been made at the Organ Mesa Observatory. Equipment consists of a Meade 35-cm LX200 GPS S-C, SBIG STL 1001-E CCD, differential photometry only, unguided exposures, red filter. Image measurement and lightcurve analysis were done by *MPO Canopus*. Due to the large number of data points acquired for each target in this study the lightcurves have been binned in sets of three data points with a maximum of five minutes between points.

23 Thalia. Three factors have combined to prevent previous investigations from obtaining a secure synodic period (Harris et al. 2009). The lightcurve is irregular, has small amplitude 0.08 – 0.15 magnitudes and because the period is nearly commensurate with Earth's, observation sets spanning only a few days do not cover the entire lightcurve. Yang et al. (1965) obtained a period of 12.308 hours. Van Houten-Groeneveld et al. (1979) preferred a period of 6.150 hours on the basis of only two nights, although they could not rule out the double period. Their data are fully compatible with but cover only 65% of a 12.3 hour lightcurve. Harris and Young (1983) plotted a lightcurve phased to 12.30 hours. Zeigler and Florence (1985) published lightcurves of comparably good fit phased to both 9.768 and 12.310 hours and favored the shorter period because the resultant lightcurve was more symmetric. Hainaut-Rouelle et al. (1995) obtained a period of 12.388 hours. Lagerkvist et al. (1995) in the most dense lightcurve obtained prior to the current study found a period of 12.308 hours with three irregularly spaced maxima. This study also favored retrograde rotation. Michalowski (1993) published the first spin model with sidereal period 12.321504 hours and direct rotation. Torppa et al. (2003) obtained a sidereal period 12.31241 hours and retrograde rotation, completely discordant with Michalowski's.







For an object with a period nearly commensurable with Earth's the phase of the lightcurve observable from a single location slowly circulates from night to night. New observations on 8 nights 2009 Aug. 15 – Sept. 21, extending over two complete circulations, show a period of 12.312 ± 0.001 hours, amplitude 0.10 ± 0.01 magnitudes. A careful search between 5 and 30 hours of all local minima in the period spectrum found no viable alias periods. Durech (personal communications) has performed lightcurve inversion combining these new observations with the previous ones and states that the expanded set (Durech, 2009) is very similar to the determination by Torppa et al. (2003), and rules out the period and pole by Michalowski (1993).

161 Athor. Debehogne and Zappala (1980) obtained a moderately dense bimodal lightcurve with period 7.288 hours which looks convincing. Pilcher and Higgins (2008) obtained another dense lightcurve showing period 7.281 ± 0.001h. Other sparse data determinations, Carlsson and Lagerkvist (1983); and Harris and Young (1989); are consistent with this period. The total range of observed amplitudes is 0.08 – 0.27 magnitudes. Additional observations were made of a target with a secure period to assist in defining a spin/shape model. Observations on 3 nights, 2009 Aug. 17, 30, Sept. 9 show an amplitude only 0.02 ± 0.01 magnitudes. From the small amplitude and large interval between sessions, the observations can be fit to several alias periods. This study does not provide an independent period determination, but one of the alias periods is 7.287 hours. Hence this data set is consistent with the established period. The very small amplitude is noteworthy, and indicates that the pole of rotation is very near longitude 6 degrees, latitude –8 degrees, the mean position of the object on the dates of observation. Whether this is the north or south pole is indeterminate.

204 Kallisto. Weidenschilling et al. (1990) state a period of 14.1 ± 0.05 hours. Behrend (2009) has two period determinations of 12.489 and 20.943 hours, respectively. New observations on 10 nights 2009 June 12 – Aug. 5 rule out all of these periods and show a period of 19.489 ± 0.002 hours, amplitude 0.18 ± 0.02 magnitudes.

207 Hedda. The only previous effort to determine the period appears to be by Behrend (2009), who states a period > 12 hours, amplitude > 0.03 magnitudes. Observations on 11 nights 2009 Apr. 7 – May 26 show a period 30.098 ± 0.001 hours, amplitude 0.09 ± 0.01 magnitudes with 4 unequal maxima and minima per cycle. Lightcurves phased to 2, 3, 5, or 6 maxima and minima per cycle all superimposed deep and shallow minima. Hence I claim the quadrimodal 30.098 hour period is the correct one.

215 Oenone. The only previous study of this object is by Behrend (2009), who presents a period >20 hours and amplitude >0.1 mag. A single lightcurve 2009 Apr. 7, 6:00 – 11:30 UT showed an irregular brightening of 0.16 ± 0.02 magnitudes. A moderate amplitude and long period > 24 hours is suggested. It was considered more productive to organize a global campaign at a future opposition and not attempt further observations from a single site at this occasion.

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LIGHTCURVE PHOTOMETRY OF THE NEO 2007 PU11

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The Apollo asteroid 2007 PU11 was observed over 24 nights between 2007 October and December at the Observatorio Astronomico de Mallorca (620). From the collected data we determined a synodic rotation period of 56.70921 ± 0.00158 h and lightcurve amplitude of 0.98 ± 0.03 mag.

2007 PU11 is an Apollo type near-Earth object discovered by LINEAR (704) on 2007 August 13. We tracked the asteroid over 24 nights between 2007 October 5 and December 3 with one, or sometimes two identical, telescopes (0.30-m f/9 Schmidt-Cassegrain) located at the Observatorio Astronomico de Mallorca in Spain. Both were equipped with an SBIG STL-1001E CCD camera. Image acquisition and calibration were performed using *Maxim DL*. All 3931 images were unfiltered and had exposures of 90 seconds. Image analysis was accomplished using differential aperture photometry with *MPO Canopus*. Period analysis was also done in *Canopus*, which implements the algorithm developed by Harris (Harris et al., 1989). From the data we determined a synodic period of 56.70921 ± 0.00158 h and a lightcurve amplitude of 0.98 ± 0.03 mag. The results are in good agreement with those reported by Carbognani et al. (2008).

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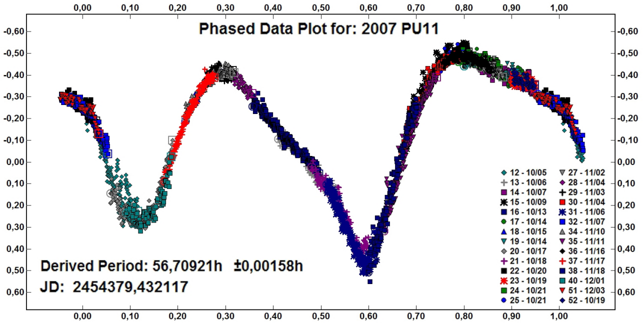

ASTEROID LIGHTCURVE ANALYSIS AT THE PALMER DIVIDE OBSERVATORY: 2009 JUNE–SEPTEMBER

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Lightcurves for 17 asteroids were obtained at the Palmer Divide Observatory (PDO) from 2009 June through September: 434 Hungaria, 790 Pretoria, 950 Ahrensa, 1203 Nanna, 1575 Winifred, (5639) 1989 PE, 6447 Terrycole, (6461) 1993 VB5, 6859 Datemasamune, (8639) 1986 VB1, 15374 Teta, (20614) 1999 SN3, (26916) 1996 RR2, 27776 Cortland, (32209) 2000 OW9, (46818) 1998 MZ24, and (77799) 2001 QV88.

Observations of 17 asteroids were made at the Palmer Divide Observatory from 2009 June through September. One of four telescopes/camera combinations was used: 0.5m Ritchey-Chretien/SBIG STL-1001E, 0.35m SCT/FLI PL-1001E, 0.35m SCT/ST-9E, or 0.35m SCT/STL-1001E. All images were 1x1 binning, resulting in a scale of approximately 1.2 arcseconds per pixel. Exposures were generally unfiltered and guided with exposures of 120-240 s. All images were processed and measured using *MPO Canopus* employing differential aperture photometry. Period analysis was also done using *MPO Canopus*, which incorporates the Fourier analysis algorithm developed by Harris (Harris et al., 1989).

The results are summarized in the table below, as are individual plots. The data and curves are presented without comment except when warranted. An "(H)" follows the name of an asteroid in the table if it is a member of the Hungaria group/family, which is a primary target of the PDO observing program. The plots are "phased", i.e., they range from 0.0 to 1.0 of the stated period. Most of the plots are scaled such that 0.8 mag has the same linear size as the horizontal axis from 0.0 to 1.0. This is done to allow direct comparison of amplitudes and to avoid the visual impression that the amplitude variation is greater than it actually is, which can create the impression of a physically implausible lightcurve. For low amplitude lightcurves, the scale has been expanded so that the curve is more than a nearly flat line. Even so, this was done as little as possible to avoid creating misleading interpretations. Night-to-night calibration of the data (generally < ±0.05 mag) was done using field stars converted to approximate Cousins R magnitudes based on 2MASS J-K colors (see Warner 2007 and Stephens 2008).

434 Hungaria. This asteroid was worked to provide an additional data set for spin axis and shape modeling. The derived model confirmed the strong likelihood that this largest member of the Hungaria family is in prograde rotation (Durech, 2006). See Warner et al (2009b) for a discussion of the Hungarias.

790 Pretoria. This was previously worked by Schober and Stanzel (1979) and Warner (2005), both reporting a period of 10.37 h. Behrend (2009) found a period of 10.48 h. The most recent work here finds a period of 10.379 h.

950 Ahrensa. The tumbling damping time for this asteroid (see Pravec et al. 2005) is greater than the age of the Solar System. However, there were no obvious signs that it was in non-principal axis rotation (tumbling).

1203 Nanna. Behrend (2009) reports a period of 15.6 h. However, the data obtained here favors either a period of 25.8 or 12.9 h, depending on whether one accepts a bimodal or monomodal solution. The latter would probably imply a pole-on viewing aspect.

1575 Winifred. Behrend (2009) reports a period of 129 h with 0.5 mag amplitude based on data obtained in 2005. The PDO data indicate a similar period but an amplitude of 1.2 mag. The tumbling damping time is just about 4.5 Gy. As with 950 Ahrensa, there were no obvious signs of tumbling.

(6461) 1993 VB5. Using data from 2001, Behrend (2009) reports a period of 4.54 h. However, that is with an amplitude of only 0.04 mag and a quality rating of U = 1 (see Warner et al. 2009a). The PDO data give a period of 6.17 h. Thus, the period cannot is not yet determined with full certainty.

6859 Datemasamune. Warner (2006) reported a period of 12.95 h. The PDO data do not fit that solution but instead favor a period of 22.1 or 11.3 h. Plots with the data phased to those two periods are shown below. Furthermore, a re-examination of the 2006 data yields a better solution at 15.7 h. The period for this asteroid remains a mystery.

(26916) 1996 RR2. This was previously worked by the author (Warner 2008) where a nearly-identical period was determined but with a much greater amplitude (*A* = 1.05 mag).

27776 Cortland. Given the very low amplitude, a monomodal solution of 20.5 h was assumed from the PDO data. Other solutions cannot be ruled out. The next apparition in 2011 April (V = 17.5, Dec = –45°) will provide a viewing aspect that differs by only 35° in the Phase Angle Bisector longitude and so the odds for a significantly different lightcurve amplitude are not good.

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#	Name	mm/dd 2009	Data Pts	α	L_{PAB}	B_{PAB}	Per (h)	PE	Amp (mag)	AE
434	Hungaria (H)	07/07-07/23	921	26.8,21.8	316	25	26.499	0.005	0.69	0.02
790	Pretoria	09/04-09/08	375	11.2,10.5	3	24	10.379	0.004	0.17	0.01
950	Ahrensa	06/16-07/23	823	16.4,21.6	256	30	202	1	0.40	0.03
1203	Nanna	09/04-09/20	269	10.2,16.0	322	7	25.80/12.90	0.05	0.15	0.03
1575	Winfred	07/09-07/27	395	16.7,16.4,16.7	293	33	125	2	1.20	0.05
5639	1989 PE (H)	07/17-08/16	421	18.0,9.8,11.2	312	14	45.4	0.1	0.44	0.03
6447	Terrycole (H)	07/24-08/04	251	28.5,26.3	342	27	10.278	0.005	0.25	0.03
6461	1993 VB5 (H)	06/24-07/08	76	18.6,15.3	293	24	6.17	0.01	0.30	0.03
6859	Datemasamune (H)	06/16-07/11	249	27.0,19.0	298	25	22.1/11.3	0.1	0.18	0.03
8639	1986 VB1	08/21-08/29	292	10.2,6.6	343	7	4.626	0.002	0.12	0.02
15374	Teta (H)	07/24-08/04	114	26.1,29.6	275	21	2.8204	0.0005	0.39	0.02
20614	1999 SN3	08/02-08/21	274	20.8,24.2	308	30	48.6	0.5	>0.3	
26916	1996 RR2 (H)	08/10-08/16	316	16.3,14.1	338	14	10.322	0.004	0.33	0.02
27776	Cortland (H)	08/17-08/29	405	13.6,8.2	342	7	20.5	0.1	0.09	0.01
32209	2000 OW9	09/04-09/09	113	12.2,13.9	332	16	4.559	0.002	0.21	0.01
46818	1998 MZ24	08/05-08/09	171	31.3,31.1	340	32	2.779	0.001	0.26	0.02
77799	2001 QV88 (H)	08/10-08/29	664	25.0,21.4	347	26	40.01	0.02	0.74	0.03

Table I. Observing circumstances. The phase angle is given at the start and end of each date range, unless it reached a minimum, which is then the second of three values. If a single value is given, the phase angle did not change significantly and the average value is given. L_{PAB} and B_{PAB} are each the average phase angle bisector longitude and latitude, unless two values are given (first/last date in range).

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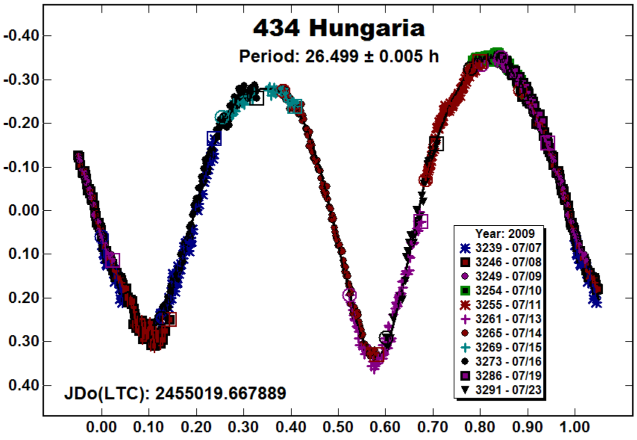
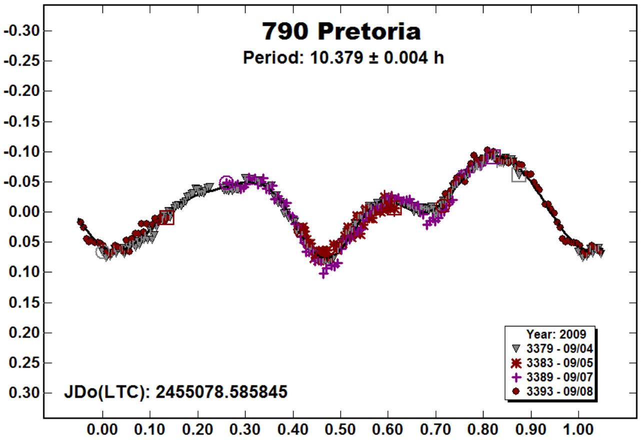
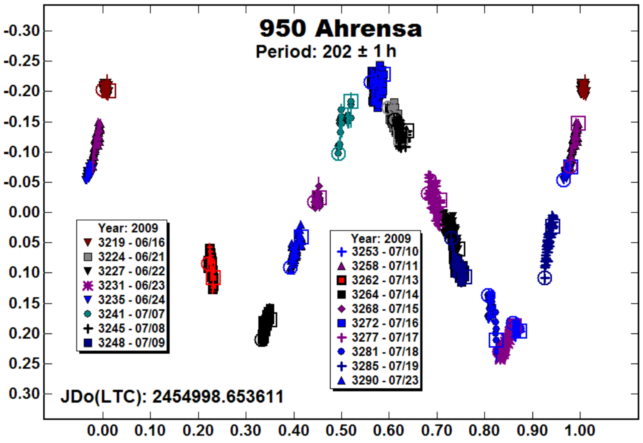
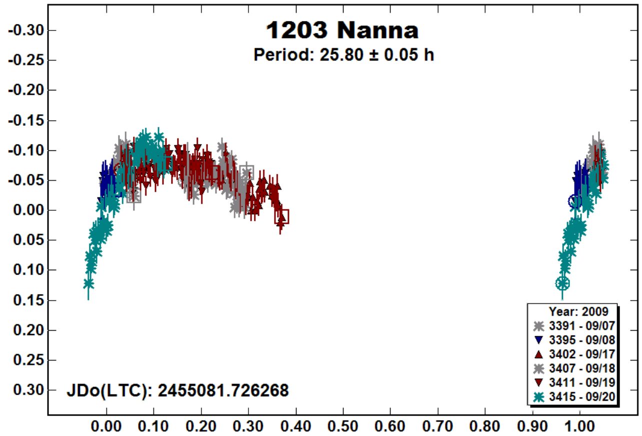
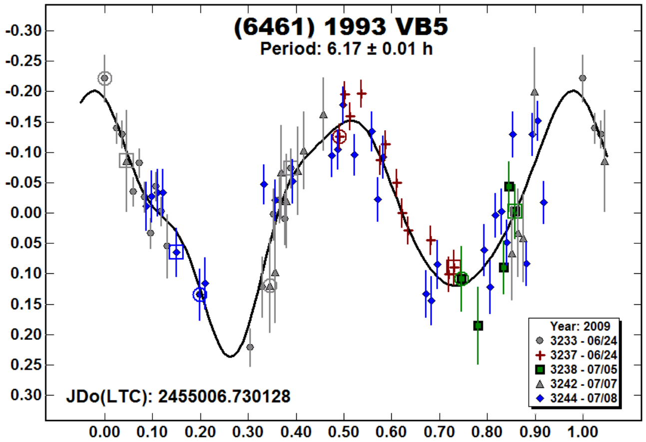
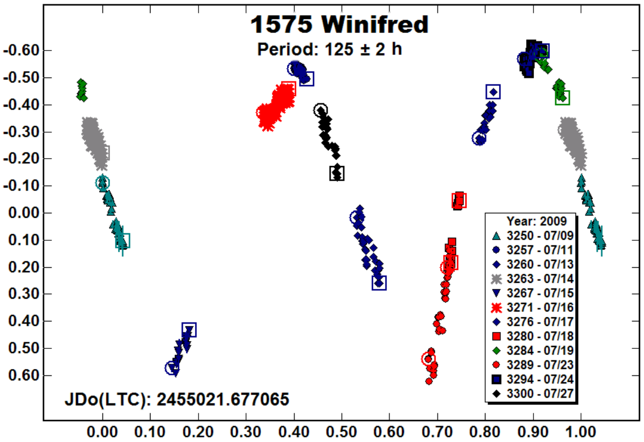


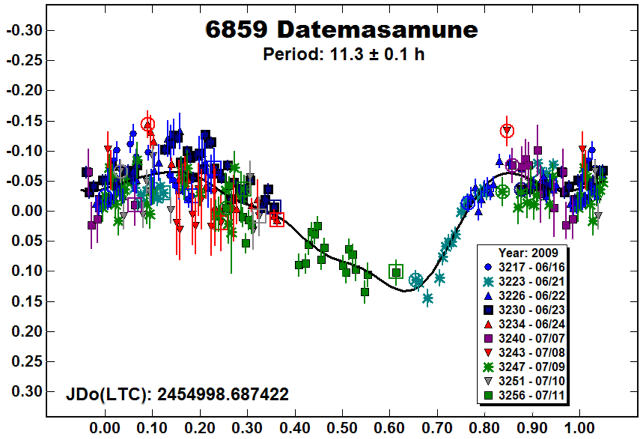





1203 Nanna
Period: 25.80 ± 0.05 h
Year: 2009
3391 - 09/07
3395 - 09/08
3402 - 09/17
3407 - 09/18
3411 - 09/19
3415 - 09/20
JDo(LTC): 2455081.726268
-0.30 -0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25 0.30
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


(6461) 1993 VB5
Period: 6.17 ± 0.01 h
Year: 2009
3233 - 06/24
3237 - 06/24
3238 - 07/05
3242 - 07/07
3244 - 07/08
JDo(LTC): 2455006.730128
-0.30 -0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25 0.30
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


1575 Winifred
Period: 125 ± 2 h
Year: 2009
3250 - 07/09
3257 - 07/11
3260 - 07/13
3263 - 07/14
3267 - 07/15
3271 - 07/16
3276 - 07/17
3280 - 07/18
3284 - 07/19
3289 - 07/23
3294 - 07/24
3300 - 07/27
JDo(LTC): 2455021.677065
-0.60 -0.50 -0.40 -0.30 -0.20 -0.10 0.00 0.10 0.20 0.30 0.40 0.50 0.60
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


6859 Datemasamune
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Year: 2009
3217 - 06/16
3223 - 06/21
3226 - 06/22
3230 - 06/23
3234 - 06/24
3240 - 07/07
3243 - 07/08
3247 - 07/09
3251 - 07/10
3256 - 07/11
JDo(LTC): 2454998.687422
-0.30 -0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25 0.30
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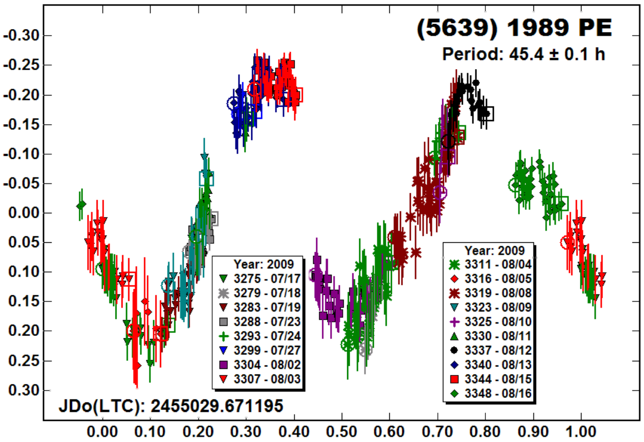
(5639) 1989 PE
Period: 45.4 ± 0.1 h
Year: 2009
3275 - 07/17
3279 - 07/18
3283 - 07/19
3288 - 07/23
3293 - 07/24
3299 - 07/27
3304 - 08/02
3307 - 08/03
Year: 2009
3311 - 08/04
3316 - 08/05
3319 - 08/08
3323 - 08/09
3325 - 08/10
3330 - 08/11
3337 - 08/12
3340 - 08/13
3344 - 08/15
3348 - 08/16
JDo(LTC): 2455029.671195
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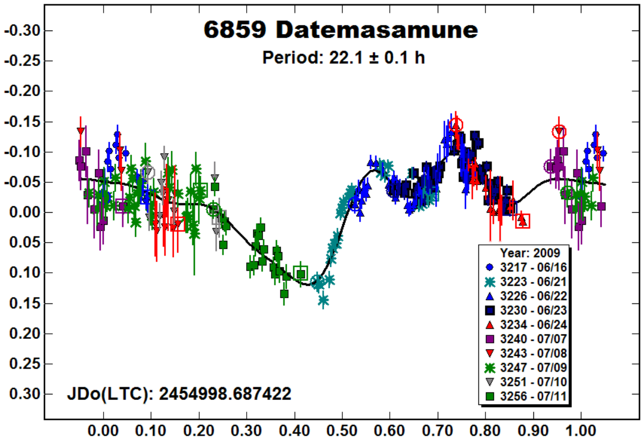
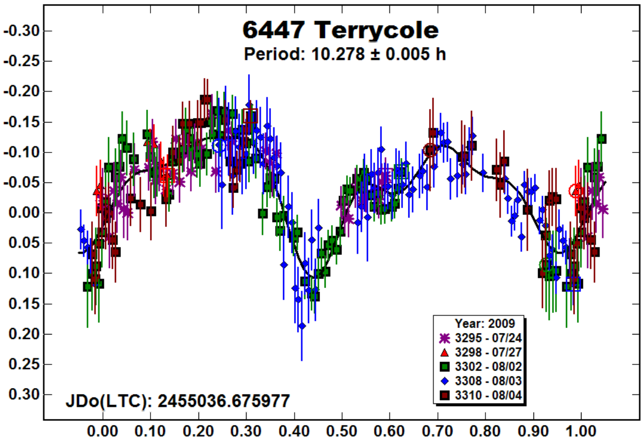
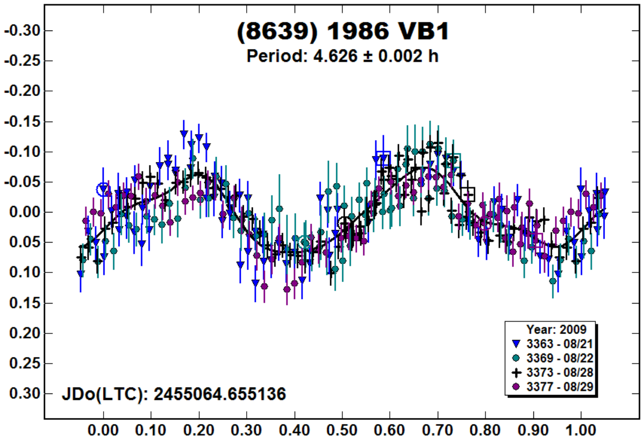
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


6859 Datemasamune
Period: 22.1 ± 0.1 h
Year: 2009
3217 - 06/16
3223 - 06/21
3226 - 06/22
3230 - 06/23
3234 - 06/24
3240 - 07/07
3243 - 07/08
3247 - 07/09
3251 - 07/10
3256 - 07/11
JDo(LTC): 2454998.687422
-0.30 -0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25 0.30
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


6447 Terrycole
Period: 10.278 ± 0.005 h
Year: 2009
3295 - 07/24
3298 - 07/27
3302 - 08/02
3308 - 08/03
3310 - 08/04
JDo(LTC): 2455036.675977
-0.30 -0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25 0.30
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


(8639) 1986 VB1
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Year: 2009
3363 - 08/21
3369 - 08/22
3373 - 08/28
3377 - 08/29
JDo(LTC): 2455064.655136
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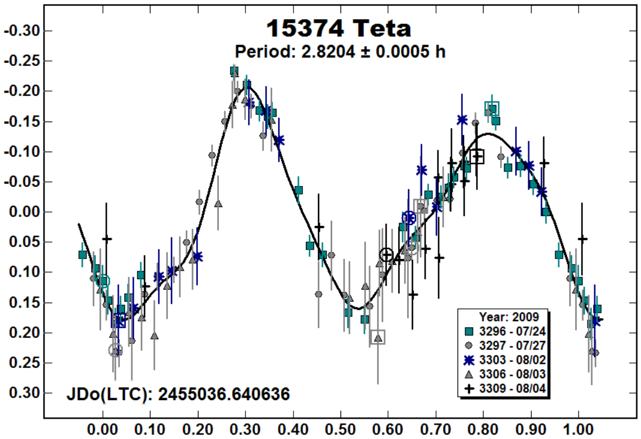
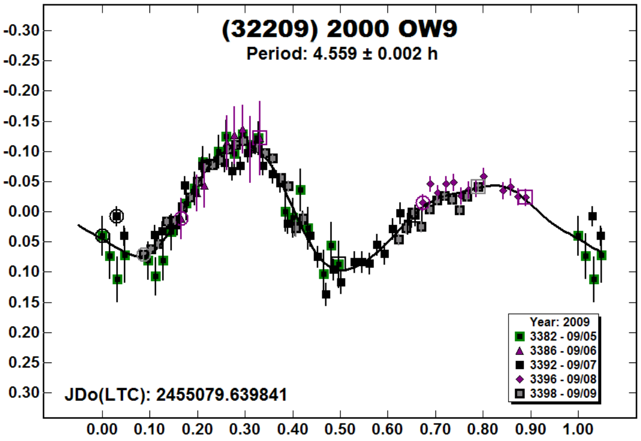
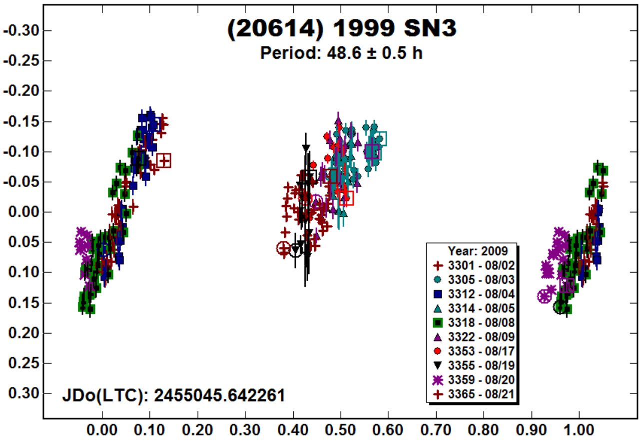
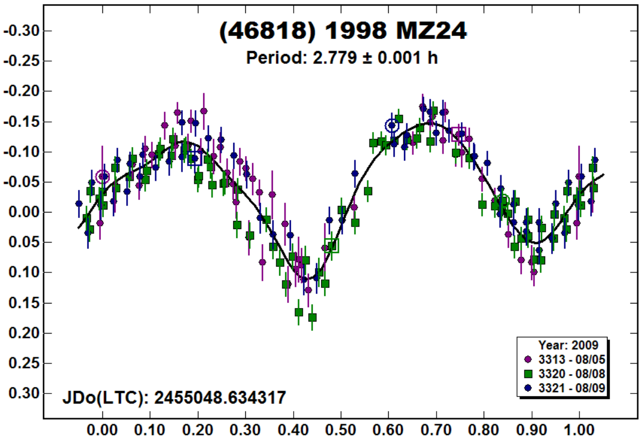
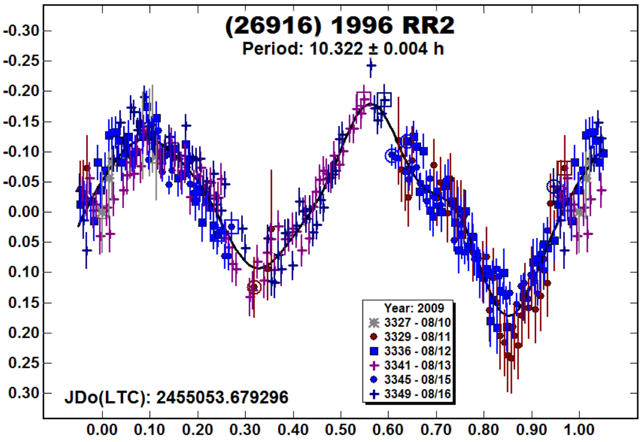
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00

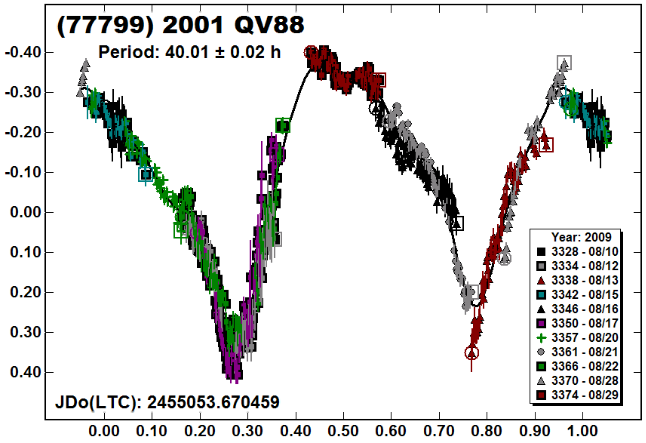

15374 Teta
Period: 2.8204 ± 0.0005 h
JDo(LTC): 2455036.640636
Year: 2009
3296 - 07/24
3297 - 07/27
3303 - 08/02
3306 - 08/03
3309 - 08/04
-0.30 -0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25 0.30
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00

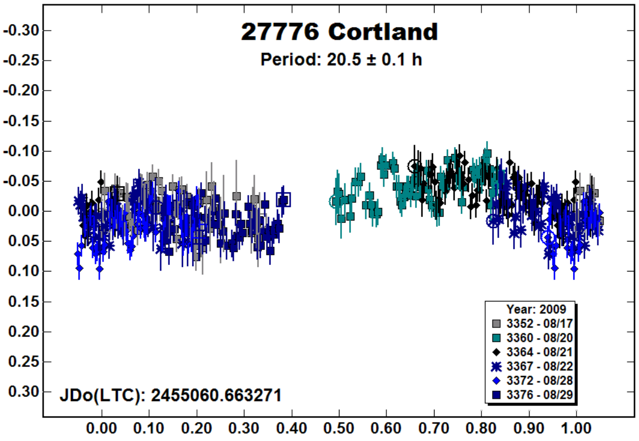

(32209) 2000 OW9
Period: 4.559 ± 0.002 h
JDo(LTC): 2455079.639841
Year: 2009
3382 - 09/05
3386 - 09/06
3392 - 09/07
3396 - 09/08
3398 - 09/09
-0.30 -0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25 0.30
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


(20614) 1999 SN3
Period: 48.6 ± 0.5 h
JDo(LTC): 2455045.642261
Year: 2009
3301 - 08/02
3305 - 08/03
3312 - 08/04
3314 - 08/05
3318 - 08/08
3322 - 08/09
3353 - 08/17
3355 - 08/19
3359 - 08/20
3365 - 08/21
-0.30 -0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25 0.30
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


(46818) 1998 MZ24
Period: 2.779 ± 0.001 h
JDo(LTC): 2455048.634317
Year: 2009
3313 - 08/05
3320 - 08/08
3321 - 08/09
-0.30 -0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25 0.30
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


(26916) 1996 RR2
Period: 10.322 ± 0.004 h
JDo(LTC): 2455053.679296
Year: 2009
3327 - 08/10
3329 - 08/11
3336 - 08/12
3341 - 08/13
3345 - 08/15
3349 - 08/16
-0.30 -0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25 0.30
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


(77799) 2001 QV88
Period: 40.01 ± 0.02 h
JDo(LTC): 2455053.670459
Year: 2009
3328 - 08/10
3334 - 08/12
3338 - 08/13
3342 - 08/15
3346 - 08/16
3350 - 08/17
3357 - 08/20
3361 - 08/21
3366 - 08/22
3370 - 08/28
3374 - 08/29
-0.40 -0.30 -0.20 -0.10 0.00 0.10 0.20 0.30 0.40
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


27776 Cortland
Period: 20.5 ± 0.1 h
JDo(LTC): 2455060.663271
Year: 2009
3352 - 08/17
3360 - 08/20
3364 - 08/21
3367 - 08/22
3372 - 08/28
3376 - 08/29
-0.30 -0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25 0.30
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00

ASTEROIDS OBSERVED FROM GMARS AND SANTANA OBSERVATORIES: 2009 JUNE - SEPTEMBER

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Lightcurves for five asteroids were obtained from Santana and GMARS Observatories from 2009 June to September: 237 Coelestina, 514 Armida, 579 Sidonia, 1341 Edmee, 1621 Druzhba.

Observations at Santana Observatory (MPC Code 646) were made with a 0.30-m Schmidt-Cassegrain (SCT) with a SBIG STL-1001E. Observations at GMARS (Goat Mountain Astronomical Research Station, MPC G79) were made with two telescopes, both 0.35-m SCT using SBIG STL-1001E CCD Cameras. All images were unguided and unbinned with no filter. Measurements were made using *MPO Canopus*, which employs differential aperture photometry to produce the raw data. Period analysis was done using *Canopus*, which incorporates the Fourier analysis algorithm (FALC) developed by Harris (1989). Except for 1341 Edmee, the asteroids were selected from the list of asteroid photometry opportunities published on the Collaborative Asteroid Lightcurve Link (CALL) website (Warner et al. 2009).

The results are summarized in the table below, as are individual plots. The plots are "phased", i.e., they range from 0.0 to 1.0 of the stated period. Most of the plots are scaled such that 1.0 mag has the same linear size as the horizontal axis from 0.0 to 1.0. This is done to avoid the visual impression that the amplitude variation is greater than it actually is, which can create the impression of a physically implausible lightcurve. The scale was shrunk for high amplitude lightcurves. Night-to-night calibration of the data (generally < ±0.05 mag) was done using field stars converted to approximate Cousins R magnitudes based on 2MASS J-K colors (Warner 2007 and Stephens 2008).

237 Coelestina. All images were taken at Santana Observatory. Based upon a single night's observations in March 2007, Behrend (2009) reported the period was greater than 20 h.

514 Armida. Images on 08/11, 08/13 and 08/15 were obtained at GMARS. All others were at Santana Observatory. Previous findings include Koff (2006) of 21.874 h, Behrend (2009) of 21.893 h and Lagerkvist (1978) of greater than 20 h. This period of 21.851 h is in good agreement with those results.

579 Sidonia. All images were taken at Santana Observatory. Tedesco (1979) obtained a single night in August 1977 and estimated the period to be 13 h. Binzel (1987) got three nights of observations in February 1985 which revealed no variation in the lightcurve. Weidenschilling (1990) observed Sidonia in November 1983 and estimated its period to be 16.5 h. Behrend (2009) reported its period to be 18.72 h based upon two nights of observations covering 30% of the lightcurve. This result of 16.286 h is in good agreement with the Weidenschilling period.

1341 Edmee. All observations were obtained at GMARS. Piironen (1994) got two consecutive nights of observations in January 1985, but could not determine a period. Stephens (2004) got five nights in April 2004. Noisy data at the start of two of the sessions lead the author to believe a second asymmetrical extrema was present in the lightcurve. Not being satisfied with the result, Edmee was reobserved at the next good opposition. The data at the 2009 opposition strongly suggests a period almost synchronized with the Earth's rotational period. Replotting the phased 2004 data to the new period of 23.745 h shows that it fits better with this solution.

1621 Druzhba. Images on 08/10, 08/12, 08/15, 08/20 and 08/21 were obtained at GMARS. All others were obtained at Santana Observatory. Wisniewski (1997) obtained a single night lightcurve in September 1989 reporting the period to exceed 12 h. Ditteon (2007) got observations on four consecutive nights in November 2007. The Ditteon raw plot show two maxima extrema approximately two days apart with an amplitude of 1.0 magnitudes. The resulting period was reported to be 47.9 h which would result in a single modal period with a high amplitude. This seems unlikely and is probably the half period. With the high amplitude, a bimodal lightcurve is more plausible.

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#	Name	mm/dd 2009	Data Pts	α	L_{PAB}	B_{PAB}	Per (h)	PE	Amp (mag)	AE
237	Coelestina	09/17 - 09/27	1,332	8.8, 6.0	10	-12	29.215	0.006	0.16	0.02
514	Armida	07/29 - 08/16	1,766	2.1, 1.3, 5.4	310	3	21.851	0.002	0.27	0.02
579	Sidonia	09/07 - 09/16	1,345	11.5, 8.9	10	-13	16.286	0.001	0.18	0.02
1341	Edmee	05/27 - 07/28	974	6.5, 4.7, 19.5	255	8	23.745	0.005	0.22	0.04
1621	Druzhba	08/10 - 08/31	2,098	8.4, 1.3, 3.5	332	2	99.20	0.03	0.75	0.03

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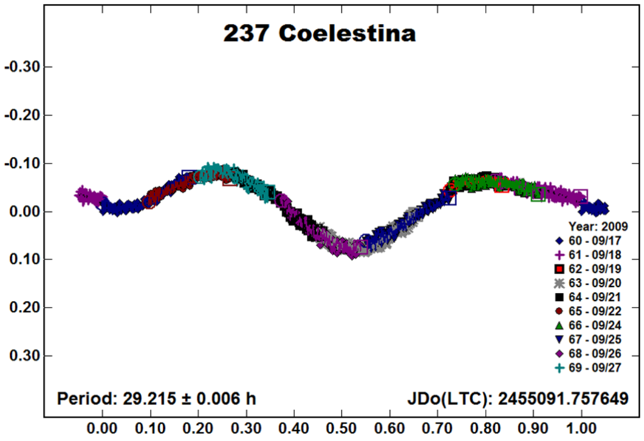

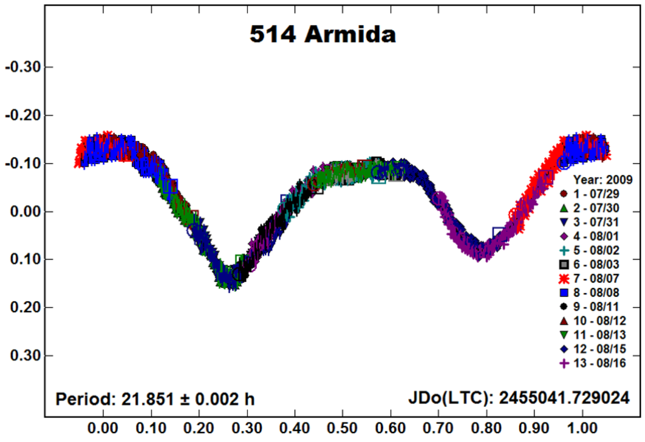

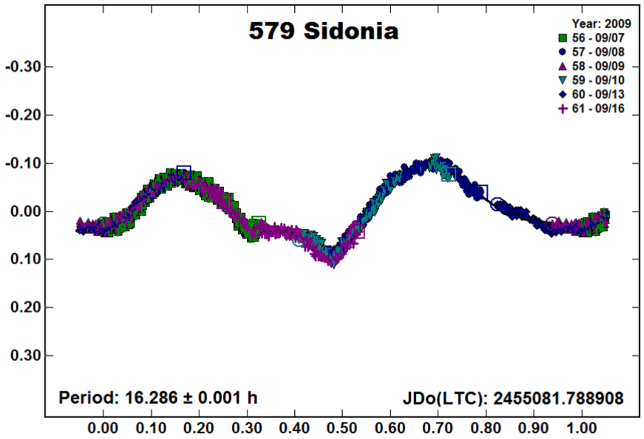

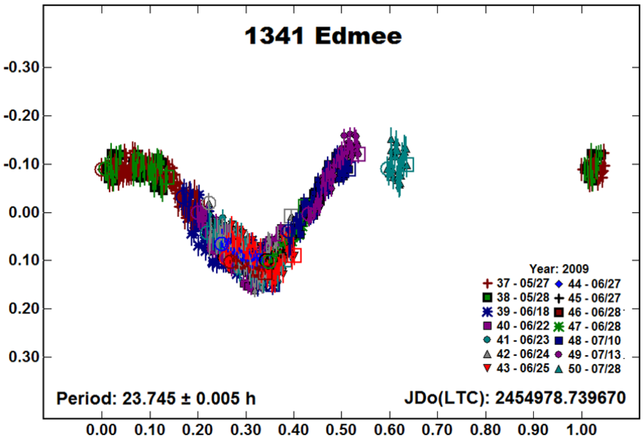

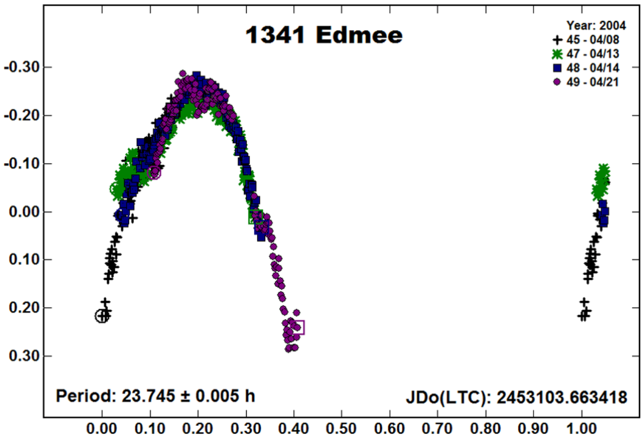

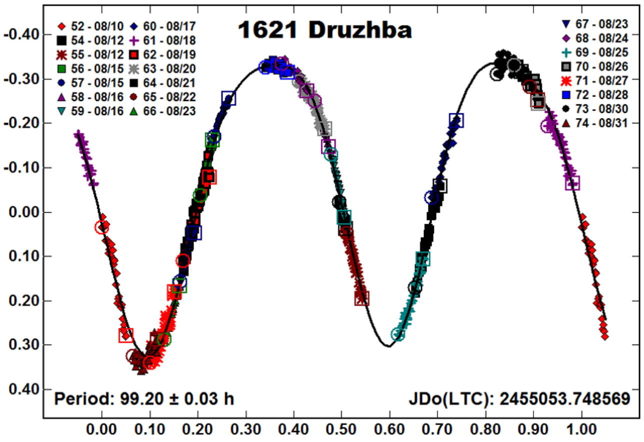

MINOR PLANETS AT UNUSUALLY FAVORABLE ELONGATIONS IN 2010

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(Received: 2009 Oct 4)

A list is presented of minor planets which are much brighter than usual at their 2010 apparitions.

The minor planets in the lists which follow will be much brighter at their 2010 apparitions than at their average distances at maximum elongation. Many years may pass before these minor planets will be again as bright as in 2010. Observers are encouraged to give special attention to those which lie near the limit of their equipment.

The closest Earth approach of any currently numbered minor planet in calendar 2010 is by (137032) 1998 UO1 to a distance of 0.083 AU on 2010 Oct. 1. Other moderately close approaches within 0.31 AU are by 1864 Daedalus May 4, 3838 Epona on Nov. 7, (4197) 1982 TA on Oct. 15, (54789) 2001 MZ7 on Feb. 2, (66146) 1998 TU3 on Oct. 17, and (154029) 2002 CY46 on Sept. 2. Of these the brightest is (66146) 1998 TU3, at magnitude 12.6 on Oct. 13. These events are especially worthy of observational scrutiny.

These lists have been prepared by an examination of the maximum elongation circumstances of minor planets computed by the author for all years through 2060 with a full perturbation program written by Dr. John Reed, and to whom he expresses his thanks. Elements are from EMP 1992, except that for all planets for which new or improved elements have been published subsequently in the Minor Planet Ciculars or in electronic form, the newer elements have been used. Planetary positions are from the JPL DE-200 ephemeris, courtesy of Dr. E. Myles Standish. Dr. Reed's ephemeris generating program, a list of minor planet elements, and the JPL planetary ephemeris are freeware which may be obtained from the author by sending a writeable CD ROM, or alternatively an empty flash drive 1 GB or larger, and stamped, addressed return mailer. They cannot be downloaded directly over the Internet.

Any planets whose brightest magnitudes near the time of maximum elongation vary by at least 2.0 in this interval and in 2010 will be within 0.3 of the brightest occuring, or vary by at least 3.0 and in 2010 will be within 0.5 of the brightest occuring; and which are visual magnitude 14.5 or brighter, are included. For planets brighter than visual magnitude 13.5, which are within the range of a large number of observers, these standards have been relaxed somewhat to include a larger number of planets. Magnitudes have been computed from the updated magnitude parameters published in MPC28104-28116, on 1996 Nov. 25, or more recently in the Minor Planet Circulars.

Oppositions may be in right ascension or in celestial longitude. Here we use still a third representation, maximum elongation from the Sun, instead of opposition. Though unconventional, it has the advantage that many close approaches do not involve actual opposition to the Sun near the time of minimum distance and greatest brightness and are missed by an opposition-based program. Other data are also provided according to the following tabular listings: Minor planet number, date of maximum elongation from the Sun in format yyyy/mm/dd, maximum elongation in degrees, right ascension on date of maximum elongation, declination on date of maximum elongation, both in J2000 coordinates, date of brightest magnitude in format yyyy/mm/dd, brightest magnitude, date of minimum distance in format yyyy/mm/dd, and minimum distance in AU.

Users should note that when the maximum elongation is about 177° or greater, the brightest magnitude is sharply peaked due to enhanced brightening near zero phase angle. Even as near as 10 days before or after minimum magnitude the magnitude is generally about 0.4 greater. This effect takes place in greater time interval for smaller maximum elongations. There is some interest in very small minimum phase angles. For maximum elongations E near 180° at Earth distance Δ, an approximate formula for the minimum phase angle ϕ is $\phi=(180°-E)/(\Delta+1)$.

Table I. Numerical Sequence of Favorable Elongations

Planet	Max Elon D	Max E	RA	Dec	Br Mag D	Br Mag	Min Dist D	Min Dist
6	2010/09/19	161.0°	0h25m	-17°	2010/09/20	7.7	2010/09/21	0.976
36	2010/10/09	167.5°	0h47m	+18°	2010/10/10	10.4	2010/10/14	0.976
37	2010/11/28	175.2°	4h12m	+25°	2010/11/28	9.6	2010/11/28	1.200
39	2010/09/14	175.6°	23h35m	- 7°	2010/09/14	9.1	2010/09/14	1.454
60	2010/02/23	175.9°	10h19m	+ 5°	2010/02/23	10.2	2010/02/18	1.085
63	2010/06/29	170.2°	18h31m	-33°	2010/06/28	9.6	2010/06/28	1.086
64	2010/01/29	179.9°	8h47m	+17°	2010/01/29	10.2	2010/01/29	1.359
69	2010/02/04	169.1°	8h55m	+ 6°	2010/02/03	10.3	2010/02/02	1.521
97	2010/10/03	168.8°	0h57m	- 5°	2010/10/05	10.1	2010/10/11	1.194
103	2010/09/04	176.1°	22h57m	-10°	2010/09/04	10.7	2010/09/02	1.483
129	2010/06/02	160.1°	16h49m	- 2°	2010/06/02	9.9	2010/06/02	1.282
144	2010/11/13	176.1°	3h19m	+14°	2010/11/13	10.0	2010/11/06	1.133
169	2010/10/02	177.4°	0h27m	+ 5°	2010/10/01	11.6	2010/09/27	1.099
175	2010/10/22	179.3°	1h46m	+11°	2010/10/22	11.5	2010/10/15	1.592
219	2010/10/07	177.0°	0h45m	+ 8°	2010/10/07	10.6	2010/09/30	0.870
232	2010/05/26	168.7°	16h19m	-10°	2010/05/25	12.7	2010/05/21	1.176
247	2010/10/04	169.5°	0h32m	+14°	2010/10/05	10.5	2010/10/09	1.186
296	2010/10/16	176.3°	1h31m	+ 5°	2010/10/16	13.9	2010/10/14	0.878
319	2010/10/28	171.6°	2h21m	+ 5°	2010/10/28	13.4	2010/10/29	1.692
325	2010/12/04	166.6°	4h35m	+35°	2010/12/04	12.4	2010/12/02	1.745
354	2010/01/25	171.6°	8h20m	+10°	2010/01/26	9.6	2010/01/27	1.520
380	2010/07/30	174.2°	20h47m	-23°	2010/07/31	12.3	2010/08/01	1.389
410	2010/06/15	175.1°	17h35m	-18°	2010/06/15	10.3	2010/06/17	1.072
448	2010/09/01	162.0°	23h 7m	-25°	2010/09/01	13.8	2010/08/30	1.576
453	2010/04/11	178.0°	13h18m	-10°	2010/04/11	12.2	2010/04/15	0.968
468	2010/10/03	179.4°	0h34m	+ 3°	2010/10/03	12.8	2010/09/30	1.520
471	2010/09/26	154.3°	0h53m	-22°	2010/09/29	9.7	2010/10/01	1.346
477	2010/10/04	179.8°	0h39m	+ 4°	2010/10/04	11.9	2010/09/27	1.021
486	2010/04/01	158.4°	13h17m	+15°	2010/04/03	12.9	2010/04/06	1.033
502	2010/02/17	163.6°	10h42m	+25°	2010/02/17	12.8	2010/02/18	0.985
504	2010/08/23	162.5°	22h40m	-27°	2010/08/24	12.0	2010/08/25	1.166
512	2010/07/09	179.8°	19h14m	-22°	2010/07/09	11.8	2010/07/22	0.843
519	2010/09/30	167.9°	0h42m	- 8°	2010/09/30	11.9	2010/09/27	1.296
523	2010/12/17	179.4°	5h40m	+22°	2010/12/17	12.4	2010/12/17	1.469
532	2010/03/12	154.3°	12h17m	+26°	2010/03/13	8.9	2010/03/14	1.348
547	2010/09/20	170.6°	23h29m	+ 6°	2010/09/21	12.0	2010/09/24	1.181
554	2010/12/30	178.3°	6h39m	+24°	2010/12/30	10.8	2010/12/26	1.079
563	2010/12/13	178.6°	5h22m	+21°	2010/12/13	10.5	2010/12/09	1.117
564	2010/05/31	179.4°	16h33m	-21°	2010/05/31	12.3	2010/06/08	1.067
571	2010/11/23	170.7°	3h48m	+29°	2010/11/22	13.1	2010/11/16	0.889
574	2010/11/23	166.8°	3h43m	+33°	2010/11/23	13.4	2010/11/20	0.739
604	2010/09/26	178.8°	0h12m	+ 0°	2010/09/26	12.4	2010/09/29	1.603
606	2010/09/20	169.3°	23h34m	+ 8°	2010/09/20	12.4	2010/09/22	1.038
645	2010/10/28	173.8°	2h 1m	+18°	2010/10/28	13.8	2010/10/31	1.873
664	2010/07/13	167.3°	19h19m	- 9°	2010/07/12	13.3	2010/07/10	1.529
672	2010/09/05	179.4°	22h58m	- 6°	2010/09/05	13.6	2010/08/31	1.297
675	2010/12/19	178.8°	5h48m	+22°	2010/12/19	10.3	2010/12/15	1.285
680	2010/06/14	157.0°	17h40m	-46°	2010/06/16	12.4	2010/06/18	1.318
690	2010/12/07	179.4°	4h56m	+22°	2010/12/07	11.7	2010/12/01	1.845
725	2010/10/20	175.0°	1h46m	+ 5°	2010/10/20	13.6	2010/10/20	1.014
755	2010/05/27	175.2°	16h19m	-16°	2010/05/27	13.4	2010/05/25	1.734
786	2010/04/08	158.2°	13h39m	+13°	2010/04/09	12.5	2010/04/12	1.725
800	2010/09/10	176.2°	23h10m	- 1°	2010/09/10	12.6	2010/09/03	0.793
846	2010/11/16	179.5°	3h27m	+19°	2010/11/16	13.4	2010/11/13	1.592
893	2010/09/24	163.0°	0h38m	-14°	2010/09/24	13.1	2010/09/24	1.614
902	2010/10/27	171.8°	1h55m	+20°	2010/10/27	14.2	2010/10/24	1.026
910	2010/05/11	179.6°	15h10m	-17°	2010/05/11	13.2	2010/05/14	1.495
937	2010/09/11	171.9°	23h 3m	+ 2°	2010/09/10	13.0	2010/09/03	0.786
938	2010/09/05	176.9°	22h59m	- 9°	2010/09/05	13.9	2010/09/04	1.530
942	2010/10/29	169.9°	2h24m	+ 3°	2010/10/29	14.3	2010/10/27	1.624
943	2010/01/03	176.0°	6h52m	+18°	2010/01/03	12.8	2010/01/05	1.497
949	2010/06/02	163.2°	16h25m	-38°	2010/05/31	13.1	2010/05/28	1.512
953	2010/07/18	164.7°	20h 6m	-35°	2010/07/18	13.1	2010/07/18	1.273
954	2010/08/19	179.3°	21h51m	-12°	2010/08/19	13.1	2010/08/17	1.600
967	2010/07/11	174.6°	19h28m	-27°	2010/07/12	13.4	2010/07/15	0.859

Planet	Max Elon D	Max E	RA	Dec	Br Mag D	Br Mag	Min Dist D	Min Dist
981	2010/10/29	179.4°	2h14m	+12°	2010/10/29	13.8	2010/10/22	1.624
997	2010/06/04	177.9°	16h49m	-20°	2010/06/04	14.5	2010/06/10	1.276
1080	2010/10/19	175.9°	1h32m	+14°	2010/10/20	13.5	2010/10/25	0.856
1115	2010/12/29	169.0°	6h39m	+34°	2010/12/29	12.9	2011/01/01	1.655
1133	2010/11/07	177.2°	2h50m	+13°	2010/11/06	13.4	2010/10/31	0.846
1150	2010/08/19	175.1°	21h48m	- 8°	2010/08/20	13.6	2010/08/22	0.748
1178	2010/03/07	179.2°	11h10m	+ 4°	2010/03/07	13.8	2010/03/08	1.194
1187	2010/08/26	177.9°	22h19m	- 8°	2010/08/27	13.8	2010/09/03	1.298
1196	2010/11/23	159.4°	4h 2m	- 0°	2010/11/20	13.4	2010/11/16	1.370
1253	2010/10/28	179.7°	2h 9m	+12°	2010/10/28	14.4	2010/10/27	1.494
1312	2010/11/20	146.0°	4h 6m	-13°	2010/11/17	14.5	2010/11/15	1.576
1383	2010/10/21	179.7°	1h42m	+10°	2010/10/21	14.5	2010/10/16	1.536
1396	2010/06/25	170.3°	18h16m	-33°	2010/06/25	13.5	2010/06/24	0.872
1427	2010/06/03	178.2°	16h43m	-20°	2010/06/03	13.5	2010/06/11	1.421
1493	2010/09/21	177.5°	23h51m	+ 1°	2010/09/21	13.6	2010/09/16	0.965
1507	2010/07/24	177.0°	20h12m	-16°	2010/07/24	14.1	2010/08/01	0.829
1514	2010/09/03	177.2°	22h55m	- 9°	2010/09/03	13.6	2010/08/30	0.794
1519	2010/09/18	172.0°	23h52m	- 9°	2010/09/18	14.3	2010/09/17	1.368
1550	2010/10/29	170.1°	2h23m	+ 3°	2010/10/28	13.0	2010/10/22	0.782
1594	2010/07/31	163.0°	21h 9m	-34°	2010/07/30	13.8	2010/07/27	0.844
1619	2010/09/26	168.7°	0h30m	- 9°	2010/09/27	13.7	2010/09/29	0.881
1663	2010/10/09	169.3°	1h13m	- 3°	2010/10/08	13.7	2010/10/05	0.857
1680	2010/05/15	176.2°	15h31m	-15°	2010/05/15	13.6	2010/05/17	1.219
1687	2010/10/16	176.0°	1h32m	+ 5°	2010/10/16	13.6	2010/10/18	1.640
1693	2010/05/27	178.3°	16h15m	-19°	2010/05/27	13.4	2010/06/06	1.260
1699	2010/09/01	176.1°	22h35m	- 4°	2010/09/01	13.7	2010/08/29	0.842
1708	2010/01/24	169.7°	8h15m	+ 9°	2010/01/22	14.2	2010/01/16	1.173
1730	2010/09/06	177.6°	22h54m	- 4°	2010/09/06	14.1	2010/09/12	1.317
1746	2010/08/16	179.6°	21h41m	-13°	2010/08/16	14.5	2010/08/20	2.331
1756	2010/11/28	172.9°	4h10m	+28°	2010/11/27	14.2	2010/11/22	1.042
1864	2010/04/07	132.0°	15h12m	-46°	2010/04/26	14.4	2010/05/04	0.271
1982	2010/10/05	172.3°	0h52m	- 2°	2010/10/03	13.9	2010/09/23	0.852
2301	2010/12/18	177.3°	5h46m	+26°	2010/12/18	13.9	2010/12/18	1.519
2360	2010/11/04	179.3°	2h39m	+15°	2010/11/04	14.5	2010/11/03	1.162
2375	2010/04/22	155.7°	14h31m	+10°	2010/04/22	14.2	2010/04/23	1.540
2501	2010/05/27	174.4°	16h10m	-26°	2010/05/26	13.7	2010/05/26	0.942
2607	2010/08/17	177.3°	21h51m	-15°	2010/08/17	14.5	2010/08/19	0.829
2699	2010/10/27	164.6°	2h19m	- 2°	2010/10/26	14.5	2010/10/22	1.265
2848	2010/11/01	178.7°	2h23m	+15°	2010/11/01	14.2	2010/10/30	1.578
2880	2010/07/21	167.5°	20h17m	-32°	2010/07/21	14.0	2010/07/19	0.834
2896	2010/06/12	166.8°	17h25m	- 9°	2010/06/13	14.2	2010/06/18	0.842
3053	2010/08/18	173.3°	21h57m	-19°	2010/08/18	14.3	2010/08/17	0.878
3112	2010/08/13	172.0°	21h43m	-22°	2010/08/13	14.5	2010/08/11	0.900
3133	2010/10/26	178.9°	2h 4m	+11°	2010/10/26	13.7	2010/10/25	0.837
3184	2010/09/06	164.7°	23h26m	-20°	2010/09/05	14.1	2010/09/03	0.972
3198	2010/12/31	166.0°	7h 6m	+36°	2011/01/01	14.2	2011/01/05	0.712
3277	2010/11/04	169.7°	2h49m	+ 5°	2010/11/04	14.1	2010/10/31	1.330
3408	2010/09/18	175.7°	23h51m	- 5°	2010/09/18	14.4	2010/09/13	0.844
3444	2010/01/03	168.9°	7h 1m	+33°	2010/01/02	14.3	2009/12/27	0.984
3459	2010/06/20	178.1°	17h54m	-21°	2010/06/20	14.2	2010/06/25	0.885
3662	2010/08/19	169.1°	22h 3m	-23°	2010/08/19	14.5	2010/08/18	1.192
3674	2010/08/12	158.1°	21h25m	+ 6°	2010/08/20	13.6	2010/09/01	0.788
3833	2010/08/14	155.7°	20h34m	+ 4°	2010/08/23	14.5	2010/08/29	0.377
3838	2010/11/25	126.1°	0h17m	+14°	2010/11/11	14.4	2010/11/07	0.197
3921	2010/09/16	171.8°	23h52m	- 9°	2010/09/16	14.3	2010/09/19	0.904
4082	2010/11/30	164.8°	4h 6m	+36°	2010/11/28	14.5	2010/11/22	0.857
4197	2010/09/17	117.4°	3h33m	+23°	2010/10/09	14.3	2010/10/15	0.251
4297	2010/07/22	179.3°	20h 7m	-19°	2010/07/22	13.9	2010/07/23	0.869
4298	2010/11/03	175.5°	2h39m	+10°	2010/11/03	14.4	2010/11/02	1.155
4349	2010/10/16	160.2°	1h49m	- 9°	2010/10/15	13.9	2010/10/12	1.020
4729	2010/11/23	179.1°	3h53m	+21°	2010/11/23	14.3	2010/11/16	0.910
4744	2010/03/28	173.9°	12h19m	- 8°	2010/03/28	13.7	2010/03/27	1.292
4860	2010/08/29	178.7°	22h31m	-10°	2010/08/29	14.2	2010/08/30	1.249
5131	2010/01/16	146.7°	9h59m	+40°	2010/01/28	14.1	2010/02/05	0.397
5142	2010/10/07	177.3°	0h46m	+ 7°	2010/10/07	13.7	2010/10/11	0.876
5325	2010/07/31	172.7°	20h26m	-11°	2010/07/30	14.3	2010/07/23	0.961
5430	2010/07/22	176.5°	20h 2m	-16°	2010/07/22	14.5	2010/07/14	0.966
5534	2010/11/20	167.8°	3h33m	+31°	2010/11/20	13.5	2010/11/19	0.864
5567	2010/09/29	178.3°	0h23m	+ 0°	2010/09/29	13.6	2010/09/22	1.429
6361	2010/04/24	172.5°	14h15m	- 5°	2010/04/24	14.1	2010/04/26	1.021
6386	2010/12/20	169.8°	5h50m	+13°	2010/12/18	14.0	2010/12/06	0.795
6425	2010/10/15	175.6°	1h12m	+12°	2010/10/15	13.8	2010/10/08	1.091
7091	2010/05/20	175.4°	15h55m	-15°	2010/05/19	14.5	2010/05/15	0.933
7476	2010/04/26	161.7°	14h29m	+ 4°	2010/04/26	14.2	2010/04/26	1.449
7736	2010/09/09	175.5°	23h 1m	- 1°	2010/09/09	14.3	2010/09/05	1.096
7749	2010/07/06	140.6°	21h09m	-53°	2010/07/16	13.9	2010/07/20	0.876
10452	2010/09/16	174.9°	23h25m	+ 1°	2010/09/16	14.5	2010/09/12	0.788
14425	2010/08/12	165.6°	21h48m	-28°	2010/08/11	14.4	2010/08/09	0.685
15491	2010/07/15	172.9°	19h39m	-28°	2010/07/15	14.5	2010/07/20	0.741
19261	2010/07/09	170.6°	19h20m	-13°	2010/07/09	14.4	2010/07/09	0.865
20898	2010/01/27	146.0°	8h44m	-15°	2010/01/31	14.5	2010/02/03	1.460
54789	2010/01/28	170.0°	8h 6m	+13°	2010/01/29	13.6	2010/02/02	0.304
66146	2010/10/09	143.8°	2h11m	-25°	2010/10/13	12.6	2010/10/17	0.177
137032	2010/10/20	125.3°	21h55m	+19°	2010/10/04	14.5	2010/10/01	0.083
154029	2010/09/09	128.5°	0h40m	+41°	2010/09/04	14.5	2010/09/02	0.164

Table II. Temporal Sequence of Favorable Elongations

Planet	Max Elon D	Max E	RA	Dec	Br Mag D	Br Mag	Min Dist D	Min Dist
943	2010/01/03	176.0°	6h52m	+18°	2010/01/03	12.8	2010/01/05	1.497
3444	2010/01/03	168.9°	7h 1m	+33°	2010/01/02	14.3	2009/12/27	0.984
5131	2010/01/16	146.7°	9h59m	+40°	2010/01/28	14.1	2010/02/05	0.397
1708	2010/01/24	169.7°	8h15m	+ 9°	2010/01/22	14.2	2010/01/16	1.173
354	2010/01/25	171.6°	8h20m	+10°	2010/01/26	9.6	2010/01/27	1.520
20898	2010/01/27	146.0°	8h44m	-15°	2010/01/31	14.5	2010/02/03	1.460
54789	2010/01/28	170.0°	8h 6m	+13°	2010/01/29	13.6	2010/02/02	0.304
64	2010/01/29	179.9°	8h47m	+17°	2010/01/29	10.2	2010/01/29	1.359
69	2010/02/04	169.1°	8h55m	+ 6°	2010/02/03	10.3	2010/02/02	1.521
502	2010/02/17	163.6°	10h42m	+25°	2010/02/17	12.8	2010/02/18	0.985
60	2010/02/23	175.9°	10h19m	+ 5°	2010/02/23	10.2	2010/02/18	1.085
1178	2010/03/07	179.2°	11h10m	+ 4°	2010/03/07	13.8	2010/03/08	1.194
532	2010/03/12	154.3°	12h17m	+26°	2010/03/13	8.9	2010/03/14	1.348
4744	2010/03/28	173.9°	12h19m	- 8°	2010/03/28	13.7	2010/03/27	1.292
486	2010/04/01	158.4°	13h17m	+15°	2010/04/03	12.9	2010/04/06	1.033
1864	2010/04/07	132.0°	15h12m	-46°	2010/04/26	14.4	2010/05/04	0.271
786	2010/04/08	158.2°	13h39m	+13°	2010/04/09	12.5	2010/04/12	1.725
453	2010/04/11	178.0°	13h18m	-10°	2010/04/11	12.2	2010/04/15	0.968
2375	2010/04/22	155.7°	14h31m	+10°	2010/04/22	14.2	2010/04/23	1.540
6361	2010/04/24	172.5°	14h15m	- 5°	2010/04/24	14.1	2010/04/26	1.021
7476	2010/04/26	161.7°	14h29m	+ 4°	2010/04/26	14.2	2010/04/26	1.449
910	2010/05/11	179.6°	15h10m	-17°	2010/05/11	13.2	2010/05/14	1.495
1680	2010/05/15	176.2°	15h31m	-15°	2010/05/15	13.6	2010/05/17	1.219
7091	2010/05/20	175.4°	15h55m	-15°	2010/05/19	14.5	2010/05/15	0.933
232	2010/05/26	168.7°	16h19m	-10°	2010/05/25	12.7	2010/05/21	1.176
755	2010/05/27	175.2°	16h19m	-16°	2010/05/27	13.4	2010/05/25	1.734
1693	2010/05/27	178.3°	16h15m	-19°	2010/05/27	13.4	2010/06/06	1.260
2501	2010/05/27	174.4°	16h10m	-26°	2010/05/26	13.7	2010/05/26	0.942
564	2010/05/31	179.4°	16h33m	-21°	2010/05/31	12.3	2010/06/08	1.067
129	2010/06/02	160.1°	16h49m	- 2°	2010/06/02	9.9	2010/06/02	1.282
949	2010/06/02	163.2°	16h25m	-38°	2010/05/31	13.1	2010/05/28	1.512
1427	2010/06/03	178.2°	16h43m	-20°	2010/06/03	13.5	2010/06/11	1.421
997	2010/06/04	177.9°	16h49m	-20°	2010/06/04	14.5	2010/06/10	1.276
2896	2010/06/12	166.8°	17h25m	- 9°	2010/06/13	14.2	2010/06/18	0.842
680	2010/06/14	157.0°	17h40m	-46°	2010/06/16	12.4	2010/06/18	1.318
410	2010/06/15	175.1°	17h35m	-18°	2010/06/15	10.3	2010/06/17	1.072
3459	2010/06/20	178.1°	17h54m	-21°	2010/06/20	14.2	2010/06/25	0.885
1396	2010/06/25	170.3°	18h16m	-33°	2010/06/25	13.5	2010/06/24	0.872
63	2010/06/29	170.2°	18h31m	-33°	2010/06/28	9.6	2010/06/28	1.086
7749	2010/07/06	140.6°	21h09m	-53°	2010/07/16	13.9	2010/07/20	0.876
512	2010/07/09	179.8°	19h14m	-22°	2010/07/09	11.8	2010/07/22	0.843
19261	2010/07/09	170.6°	19h20m	-13°	2010/07/09	14.4	2010/07/09	0.865
967	2010/07/11	174.6°	19h28m	-27°	2010/07/12	13.4	2010/07/15	0.859
664	2010/07/13	167.3°	19h19m	- 9°	2010/07/12	13.3	2010/07/10	1.529
15491	2010/07/15	172.9°	19h39m	-28°	2010/07/15	14.5	2010/07/20	0.741
953	2010/07/18	164.7°	20h 6m	-35°	2010/07/18	13.1	2010/07/18	1.273
2880	2010/07/21	167.5°	20h17m	-32°	2010/07/21	14.0	2010/07/19	0.834
4297	2010/07/22	179.3°	20h 7m	-19°	2010/07/22	13.9	2010/07/23	0.869
5430	2010/07/22	176.5°	20h 2m	-16°	2010/07/22	14.5	2010/07/14	0.966
1507	2010/07/24	177.0°	20h12m	-16°	2010/07/24	14.1	2010/08/01	0.829
380	2010/07/30	174.2°	20h47m	-23°	2010/07/31	12.3	2010/08/01	1.389
1594	2010/07/31	163.0°	21h 9m	-34°	2010/07/30	13.8	2010/07/27	0.844
5325	2010/07/31	172.7°	20h26m	-11°	2010/07/30	14.3	2010/07/23	0.961
3674	2010/08/12	158.1°	21h25m	+ 6°	2010/08/20	13.6	2010/09/01	0.788
14425	2010/08/12	165.6°	21h48m	-28°	2010/08/11	14.4	2010/08/09	0.685
3112	2010/08/13	172.0°	21h43m	-22°	2010/08/13	14.5	2010/08/11	0.900
3833	2010/08/14	155.7°	20h34m	+ 4°	2010/08/23	14.5	2010/08/29	0.377
1746	2010/08/16	179.6°	21h41m	-13°	2010/08/16	14.5	2010/08/20	2.331
2607	2010/08/17	177.3°	21h51m	-15°	2010/08/17	14.5	2010/08/19	0.829
3053	2010/08/18	173.3°	21h57m	-19°	2010/08/18	14.3	2010/08/17	0.878
954	2010/08/19	179.3°	21h51m	-12°	2010/08/19	13.1	2010/08/17	1.600
1150	2010/08/19	175.1°	21h48m	- 8°	2010/08/20	13.6	2010/08/22	0.748
3662	2010/08/19	169.1°	22h 3m	-23°	2010/08/19	14.5	2010/08/18	1.192
504	2010/08/23	162.5°	22h40m	-27°	2010/08/24	12.0	2010/08/25	1.166
1187	2010/08/26	177.9°	22h19m	- 8°	2010/08/27	13.8	2010/09/03	1.298
4860	2010/08/29	178.7°	22h31m	-10°	2010/08/29	14.2	2010/08/30	1.249
448	2010/09/01	162.0°	23h 7m	-25°	2010/09/01	13.8	2010/08/30	1.576
1699	2010/09/01	176.1°	22h35m	- 4°	2010/09/01	13.7	2010/08/29	0.842
1514	2010/09/03	177.2°	22h55m	- 9°	2010/09/03	13.6	2010/08/30	0.794
103	2010/09/04	176.1°	22h57m	-10°	2010/09/04	10.7	2010/09/02	1.483
672	2010/09/05	179.4°	22h58m	- 6°	2010/09/05	13.6	2010/08/31	1.297
938	2010/09/05	176.9°	22h59m	- 9°	2010/09/05	13.9	2010/09/04	1.530
1730	2010/09/06	177.6°	22h54m	- 4°	2010/09/06	14.1	2010/09/12	1.317
3184	2010/09/06	164.7°	23h26m	-20°	2010/09/05	14.1	2010/09/03	0.972
7736	2010/09/09	175.5°	23h 1m	- 1°	2010/09/09	14.3	2010/09/05	1.096
154029	2010/09/09	128.5°	0h40m	+41°	2010/09/04	14.5	2010/09/02	0.164
800	2010/09/10	176.2°	23h10m	- 1°	2010/09/10	12.6	2010/09/03	0.793
937	2010/09/11	171.9°	23h 3m	+ 2°	2010/09/10	13.0	2010/09/03	0.786
39	2010/09/14	175.6°	23h35m	- 7°	2010/09/14	9.1	2010/09/14	1.454
3921	2010/09/16	171.8°	23h52m	- 9°	2010/09/16	14.3	2010/09/19	0.904
10452	2010/09/16	174.9°	23h25m	+ 1°	2010/09/16	14.5	2010/09/12	0.788
4197	2010/09/17	117.4°	3h33m	+23°	2010/10/09	14.3	2010/10/15	0.251
1519	2010/09/18	172.0°	23h52m	- 9°	2010/09/18	14.3	2010/09/17	1.368
3408	2010/09/18	175.7°	23h51m	- 5°	2010/09/18	14.4	2010/09/13	0.844
6	2010/09/19	161.0°	0h25m	-17°	2010/09/20	7.7	2010/09/21	0.976
547	2010/09/20	170.6°	23h29m	+ 6°	2010/09/21	12.0	2010/09/24	1.181
606	2010/09/20	169.3°	23h34m	+ 8°	2010/09/20	12.4	2010/09/22	1.038
1493	2010/09/21	177.5°	23h51m	+ 1°	2010/09/21	13.6	2010/09/16	0.965
893	2010/09/24	163.0°	0h38m	-14°	2010/09/24	13.1	2010/09/24	1.614
471	2010/09/26	154.3°	0h53m	-22°	2010/09/29	9.7	2010/10/01	1.346
604	2010/09/26	178.8°	0h12m	+ 0°	2010/09/26	12.4	2010/09/29	1.603
1619	2010/09/26	168.7°	0h30m	- 9°	2010/09/27	13.7	2010/09/29	0.881
5567	2010/09/29	178.3°	0h23m	+ 0°	2010/09/29	13.6	2010/09/22	1.429
519	2010/09/30	167.9°	0h42m	- 8°	2010/09/30	11.9	2010/09/27	1.296
169	2010/10/02	177.4°	0h27m	+ 5°	2010/10/01	11.6	2010/09/27	1.099
97	2010/10/03	168.8°	0h57m	- 5°	2010/10/05	10.1	2010/10/11	1.194
468	2010/10/03	179.4°	0h34m	+ 3°	2010/10/03	12.8	2010/09/30	1.520
247	2010/10/04	169.5°	0h32m	+14°	2010/10/05	10.5	2010/10/09	1.186
477	2010/10/04	179.8°	0h39m	+ 4°	2010/10/04	11.9	2010/09/27	1.021
1982	2010/10/05	172.3°	0h52m	- 2°	2010/10/03	13.9	2010/09/23	0.852

Planet	Max Elon D	Max E	RA	Dec	Br Mag D	Br Mag	Min Dist D	Min Dist
219	2010/10/07	177.0°	0h45m	+ 8°	2010/10/07	10.6	2010/09/30	0.870
5142	2010/10/07	177.3°	0h46m	+ 7°	2010/10/07	13.7	2010/10/11	0.876
36	2010/10/09	167.5°	0h47m	+18°	2010/10/10	10.4	2010/10/14	0.976
1663	2010/10/09	169.3°	1h13m	- 3°	2010/10/08	13.7	2010/10/05	0.857
66146	2010/10/09	143.8°	2h11m	-25°	2010/10/13	12.6	2010/10/17	0.177
6425	2010/10/15	175.6°	1h12m	+12°	2010/10/15	13.8	2010/10/08	1.091
296	2010/10/16	176.3°	1h31m	+ 5°	2010/10/16	13.9	2010/10/14	0.878
1687	2010/10/16	176.0°	1h32m	+ 5°	2010/10/16	13.6	2010/10/18	1.640
4349	2010/10/16	160.2°	1h49m	- 9°	2010/10/15	13.9	2010/10/12	1.020
1080	2010/10/19	175.9°	1h32m	+14°	2010/10/20	13.5	2010/10/25	0.856
725	2010/10/20	175.0°	1h46m	+ 5°	2010/10/20	13.6	2010/10/20	1.014
137032	2010/10/20	125.0°	21h55m	+19°	2010/10/04	14.5	2010/10/01	0.083
1383	2010/10/21	179.7°	1h42m	+10°	2010/10/21	14.5	2010/10/16	1.536
175	2010/10/22	179.3°	1h46m	+11°	2010/10/22	11.5	2010/10/15	1.592
3133	2010/10/26	178.9°	2h 4m	+11°	2010/10/26	13.7	2010/10/25	0.837
902	2010/10/27	171.8°	1h55m	+20°	2010/10/27	14.2	2010/10/24	1.026
2699	2010/10/27	164.6°	2h19m	- 2°	2010/10/26	14.5	2010/10/22	1.265
319	2010/10/28	171.6°	2h21m	+ 5°	2010/10/28	13.4	2010/10/29	1.692
645	2010/10/28	173.8°	2h 1m	+18°	2010/10/28	13.8	2010/10/31	1.873
1253	2010/10/28	179.7°	2h 9m	+12°	2010/10/28	14.4	2010/10/27	1.494
942	2010/10/29	169.9°	2h24m	+ 3°	2010/10/29	14.3	2010/10/27	1.624
981	2010/10/29	179.4°	2h14m	+12°	2010/10/29	13.8	2010/10/22	1.624
1550	2010/10/29	170.1°	2h23m	+ 3°	2010/10/28	13.0	2010/10/22	0.782
2848	2010/11/01	178.7°	2h23m	+15°	2010/11/01	14.2	2010/10/30	1.578
4298	2010/11/03	175.5°	2h39m	+10°	2010/11/03	14.4	2010/11/02	1.155
2360	2010/11/04	179.3°	2h39m	+15°	2010/11/04	14.5	2010/11/03	1.162
3277	2010/11/04	169.7°	2h49m	+ 5°	2010/11/04	14.1	2010/10/31	1.330
1133	2010/11/07	177.2°	2h50m	+13°	2010/11/06	13.4	2010/10/31	0.846
144	2010/11/13	176.1°	3h19m	+14°	2010/11/13	10.0	2010/11/06	1.133
846	2010/11/16	179.5°	3h27m	+19°	2010/11/16	13.4	2010/11/13	1.592
1312	2010/11/20	146.0°	4h 6m	-13°	2010/11/17	14.5	2010/11/15	1.576
5534	2010/11/20	167.8°	3h33m	+31°	2010/11/20	13.5	2010/11/19	0.864
571	2010/11/23	170.7°	3h48m	+29°	2010/11/22	13.1	2010/11/16	0.889
574	2010/11/23	166.8°	3h43m	+33°	2010/11/23	13.4	2010/11/20	0.739
1196	2010/11/23	159.4°	4h 2m	- 0°	2010/11/20	13.4	2010/11/16	1.370
4729	2010/11/23	179.1°	3h53m	+21°	2010/11/23	14.3	2010/11/16	0.910
3838	2010/11/25	126.1°	0h17m	+14°	2010/11/11	14.4	2010/11/07	0.197
37	2010/11/28	175.2°	4h12m	+25°	2010/11/28	9.6	2010/11/28	1.200
1756	2010/11/28	172.9°	4h10m	+28°	2010/11/27	14.2	2010/11/22	1.042
4082	2010/11/30	164.8°	4h 6m	+36°	2010/11/28	14.5	2010/11/22	0.857
325	2010/12/04	166.6°	4h35m	+35°	2010/12/04	12.4	2010/12/02	1.745
690	2010/12/07	179.4°	4h56m	+22°	2010/12/07	11.7	2010/12/01	1.845
563	2010/12/13	178.6°	5h22m	+21°	2010/12/13	10.5	2010/12/09	1.117
523	2010/12/17	179.4°	5h40m	+22°	2010/12/17	12.4	2010/12/17	1.469
2301	2010/12/18	177.3°	5h46m	+26°	2010/12/18	13.9	2010/12/18	1.519
675	2010/12/19	178.8°	5h48m	+22°	2010/12/19	10.3	2010/12/15	1.285
6386	2010/12/20	169.8°	5h50m	+13°	2010/12/18	14.0	2010/12/06	0.795
1115	2010/12/29	169.0°	6h39m	+34°	2010/12/29	12.9	2011/01/01	1.655
554	2010/12/30	178.3°	6h39m	+24°	2010/12/30	10.8	2010/12/26	1.079
3198	2010/12/31	166.0°	7h 6m	+36°	2011/01/01	14.2	2011/01/05	0.712

PHOTOMETRIC OBSERVATIONS AND LIGHTCURVE ANALYSIS OF ASTEROIDS 397 VIENNA AND (5153) 1940 GO

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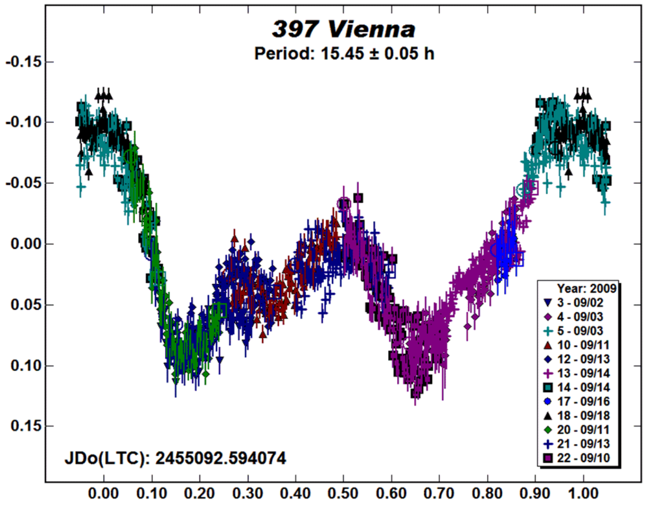
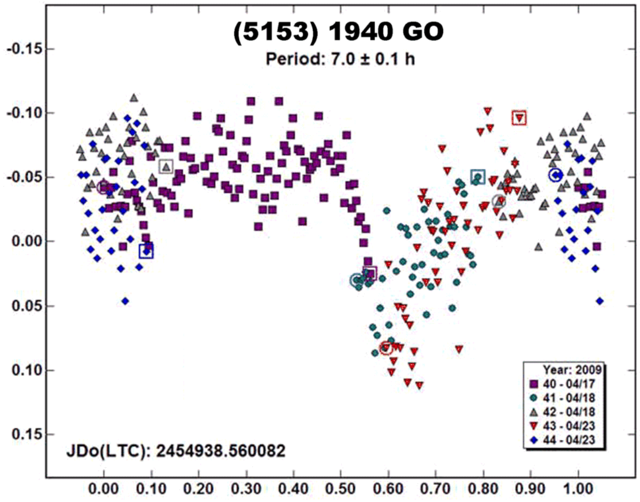
Photometric data were obtained from 2009 April through September for asteroids 397 Vienna and (5153) 1940 GO. For 397 Vienna, analysis of the data found a synodic period of 15.45 ± 0.05 h and lightcurve amplitude of 0.20 ± 0.05 mag. Due to limited measurements, no reliable period was determined for (5153) 1940 GO which displayed a lightcurve amplitude of less than 0.2 mag.

Main-belt asteroids 397 Vienna and 5153 (1940 GO) were observed from 2009 April through September. All observations were made with a 0.3-m Schmidt-Cassegrain (SCT) operating at f/6 on a German equatorial mount (GEM). The imager was an SBIG ST9 working at 1x1 binning which resulted in an image scale of 2.22 arc seconds/pixel. An SBIG AO-8 adaptive optics unit was employed. A Johnson V-band filter was used for all images of 397 Vienna. Observations of (5153) 1940 GO were unfiltered. The camera temperature was set to between –12°C and –16°C depending on ambient air temperature. Image acquisition and reduction were done with *CCDSoft*. All images were reduced with master dark, bias and sky-flat frames. An observing session began when the target reached approximately 40 degrees elevation. The GEM required that imaging be halted around target transit time in order to move the telescope to the other side of the pier. Other than this interruption, the camera took continuous exposures, pausing only to download each image. Exposures for 397 Vienna were 105 seconds while those for (5153) 1940GO were 120 seconds.

MPO Canopus v.9.5.0.10 was used for period analysis, which incorporates the Fourier algorithm (FALC) developed by Harris (Harris et al., 1989). A minimum of two comparison stars from the 2MASS catalog was used on each image. Observations from both asteroids were reduced using differential photometry.





<u>397 Vienna</u>. This asteroid was chosen for study for two reasons: 1) only one published lightcurve was found (Harris and Young, 1983) and so additional observations could confirm that the published lightcurve was accurate; and 2) a "first apparition"

lightcurve is needed to allow future study of Vienna's spin and shape using lightcurve inversion (Kassalainen et. al., 2002). Observations made over 11 observing sessions from 2009 September 3 to 18 produced 1046 data points. The derived period of 15.45 h ± 0.05 h is in good agreement with the period of 15.48 h reported by Harris and Young (1983). The phase angle bisectors at the middle of the observing run were longitude 338.4° and latitude 17.3°. The phase angle was 12.9°.

(5153) 1940 GO. This asteroid was chosen due to its favorable position in the sky and to its scant attention in the past. Only one published lightcurve was found, that being from Behrend (2009) with a period of 4.58 and *U* = 1 (see Warner et al., 2009, for the U definition). Data were collected during 5 observing sessions from 2009 April 17 to 23. A prolonged period of cloudy weather afterwards prevented gathering more observations. My data are not of sufficient quality or length to draw any reasonable conclusions. The accompanying plot shows a period of 7 hours, which is likely incorrect.

Acknowledgements

I thank Brian Warner for his continued advice and guidance on all things having to do with asteroid lightcurves. This paper makes use of data products from the Two Micron All Sky Survey, which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation.

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LIGHTCURVE ANALYSIS OF MINOR PLANETS 4820 FAY AND 6463 ISODA

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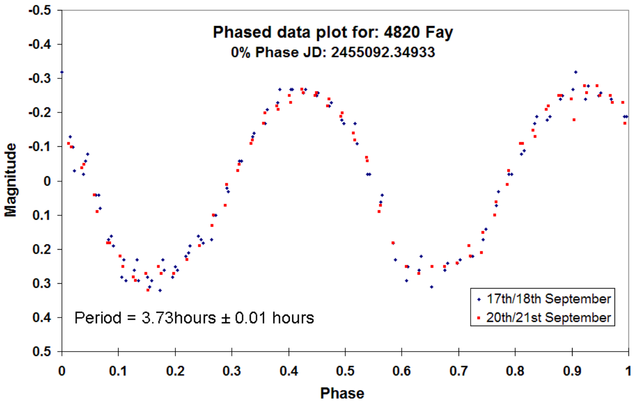
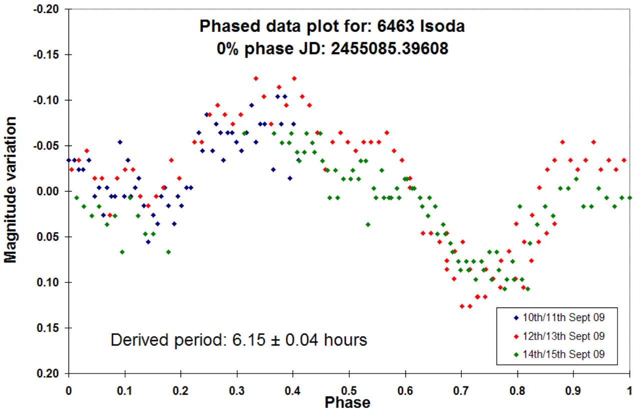
Observations during 2009 September yielded lightcurves for minor planets 4820 Fay and 6463 Isoda. For 4820 Fay, the synodic period was found to be 3.73 ± 0.01 h; for 6463 Isoda, a period of 6.15 ± 0.04 h was determined.

Gothers Observatory is equipped with a Meade 0.25-m LX-200 Schmidt-Cassegrain with a Meade f/3.3 focal reducer. The detector is a QHY6 Pro CCD, binned at 1x1. The resulting optical train produces an image scale of 1.69 x 1.63 arcsec/pixel. The camera was used with cooling set point cooling of –10°C. All observations were made unguided and unfiltered with exposures of 210 s. The typical FWHM of point sources was 4 to 4.5 arcsec for the reduced data sets. Automated computer control of the mount and CCD camera allows unsupervised imaging for extended durations of up to 8 hours. Image calibration and differential photometry were done using *Astrometrica* (Raab, 2009) with the Carlsberg Meridian Catalogue 14 (Evans et al., 2002) used for reference magnitudes. Period determination was performed using *Peranso* lightcurve analysis software (Vanmunster, 2009). Both targets were selected from the CALL lightcurve targets page (Warner, 2009).





4820 Fay This is a main-belt object that was at a favorable opposition in 2009 September. No previously reported lightcurve or rotational period could be found. The object was imaged 178 times over two nights. Its short period allowed four complete cycles to be observed and so there is a high level of confidence in the reported solution. The lightcurve exhibits a typical bimodal curve with a synodic period of 3.73 ± 0.01 h. Peak-to-peak magnitude variation (*A*) was found to be 0.53 ± 0.02 mag.

6463 Isoda This is another main-belt object with no reported lightcurve or rotational period. The object was imaged 233 times over 3 nights. On two of the three nights, the total observing duration was greater than the reported period. The complex lightcurve shows two peaks and troughs of different amplitudes. The synodic period is 6.15 ± 0.04 h and *A* = 0.21 ± 0.04 mag.

Acknowledgements

I would like to thank Dr. Richard Miles of the British Astronomical Association for his invaluable support and advice on asteroid astrometry and photometry techniques. In particular, his assistance with 6463 Isoda enabled appropriate analysis of the data.

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A REVISED PERIOD FOR ASTEROID 1732 HEIKE

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The main-belt asteroid 1732 Heike has been reported to have a period of 3.90 h based on observations made in 2003. New photometric observations of the asteroid carried out over two nights at the Truman Observatory conclusively find the period is 4.742 ± 0.013 h.

1732 Heike is a main-belt asteroid belonging to the Eos family. Discovered in 1943, its rotation lightcurve was first observed by Alvarez-Candal et al. (2004). From their observations, carried out on two nights in 2003 September, they determined a rotation period of 3.338 ± 0.002 h. They devoted only 4.24 hours of total observation time to this asteroid, however, and their published light curve has a significant gap in coverage.

The rotation period was initially reported as 3.90 h in the database of asteroid light curve parameters maintained by Harris et al. (2008), which cited the observations of Alvarez-Candal et al. but included the note: “Rotation period ‘determined’ from published data, but not given by author(s) of original data.” The most recent version of the Asteroid Lightcurve Database (Warner et al., 2009) includes a period of 4.74 h attributed to Behrend (2009), but the lightcurve for 1732 Heike does not appear on the referenced web site as of 2009 October.

Unfiltered photometric observations of 1732 Heike were made at the Truman Observatory in Kirksville, Missouri, in 2008 October with a 0.35-m Meade LX-200GPS telescope, f/6.3 focal reducer, and an SBIG ST-7XME CCD camera. All of the data were analyzed using *MPO Canopus* (Bdw Publishing) which employs differential aperture photometry. The period analysis was also performed within *MPO Canopus* using the Fourier analysis algorithm developed by Harris (Harris et al., 1989). The asteroid was observed for 3.5 hours on the first night and 4 hours on the second, with sufficient overlap to provide complete phase coverage and establish a reliable period. Analysis of the data from the two nights revealed a bimodal light curve with a synodic period of 4.742 ± 0.013 h and an amplitude of 0.32 ± 0.02 mag.

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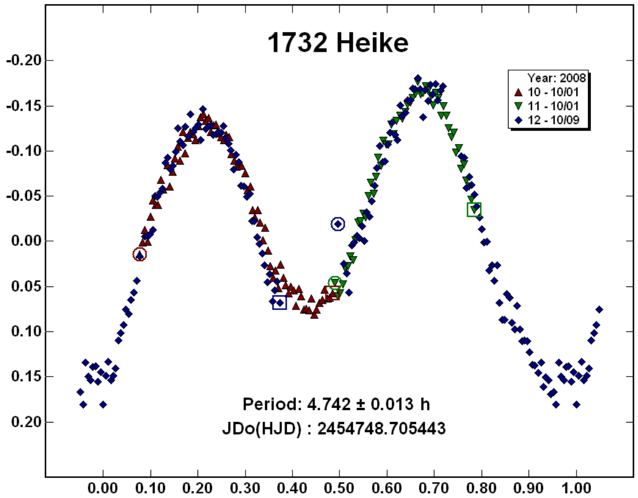

THE EXTREMELY LONG PERIOD OF 4524 BARKLAJDETOLLI

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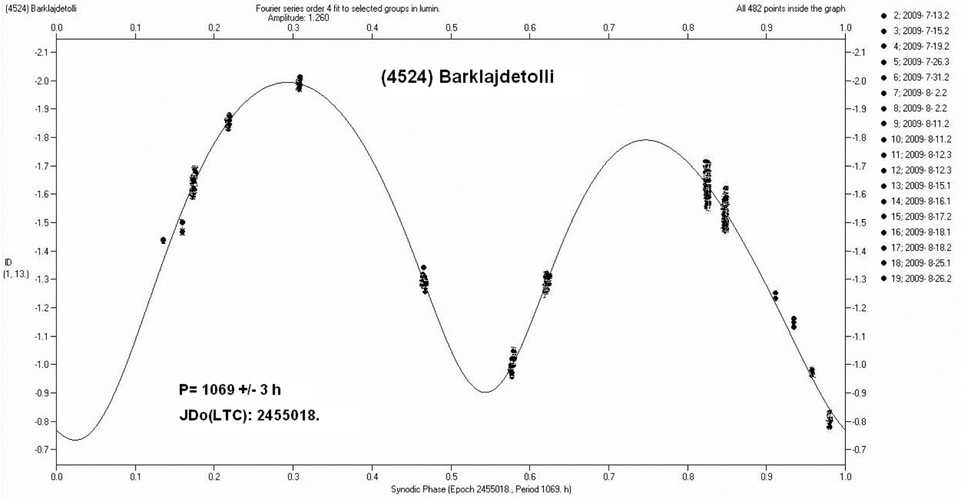
Observations of main-belt asteroid 4524 Barklajdetolli taken over 16 nights in 2009 June through September show the asteroid has an extremely long period. Our analysis found a synodic period of 1069 ± 3 h and a lightcurve amplitude estimate of 1.26 ± 0.05 mag.

Asteroid 4524 Barklajdetolli was chosen as a target as part of the Photometric Survey for Asynchronous Binary Asteroids (Pravec, 2009a). Once observations by Pray indicated the object had a longer period, Durkee joined the effort. Pray used an f/7.8, 0.35-m Schmidt Cassegrain (SCT) with an SBIG ST10XE CCD operating at a scale of 1.2 arc sec/pixel. Durkee also used a 0.35-m SCT with an SBIG ST10XE CCD camera working at a scale of 0.94 arcsec/pixel. Exposures at the Shed of Science were made through a Celestron UHC LPR filter and unguided. Both stations used *MPO Canopus* to perform differential photometry on the reduced images.

Due to the long period, we employed the same method to link our data on an internal magnitude scale. Once the initial data were taken, each star field was re-imaged at a later date in quick succession using the same exposure times as the original science images. Using *MPO Canopus*, the linkage images were measured using the same comparison stars as used in the original science images in order to find the internal average magnitude or "Delta-Comp" of each set of comparison stars. The new Delta-Comp value was then used to adjust the relative magnitudes of the corresponding science fields taken earlier. This simple method gives an approximate internal calibration for each station. Since we observed the asteroid simultaneously on Aug 2, this common point allowed both data sets to be merged.



This asteroid is among the slowest rotating asteroids ever measured (see table). We did not observe evidence of tumbling, that is, rotation in more than one axis. We cannot know for certain that this object is a primary axis rotator without repeated coverage of the lightcurve. Our result is rated PAR = 0 using the scale defined by Pravec et al. (2005). The resulting lightcurve is shown with a synodic period of 1069 ± 3h and an amplitude (*A*) estimate is 1.2 ± 0.05 mag.

Acknowledgements

Thanks go to Dr. Petr Pravec of Ondrejov Observatory for assistance with the period analysis of 4524 Barklajdetolli and for the use of his lightcurve plot. Partial funding for work at both Carbuncle Hill Observatory and the Shed of Science are provided by Gene Shoemaker NEO Grants from the Planetary Society.

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Long Period Asteroids		
Asteroid	Per (h)	Reference
1997 AE12	1880	Pravec 2009a
1235 Schorria	1365	Warner 2009
288 Glauke	1200	Ostro 2001
4524 Barklajdetolli	1069	This paper
9000 Hal	908	Galad 2009
2862 Vavilov	>800*	Pravec 2009b
* Estimated lower bound. Period likely > 1000 h.		

(35107) 1991 VH: AN APOLLO BINARY ASTEROID

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Lightcurves of (35107) 1991 VH, a known binary, revealed a primary orbital period P_{prim} = 2.6239 ± 0.0001 h with amplitude 0.15 ± 0.03 mag and an orbital period P_{orb} = 32.26 ± 0.01 h with primary and secondary minima of 0.16 ± 0.03 and 0.14 ± 0.03 mag. There were indications of a third period, possibly due to rotation of the secondary, but this was not confirmed.

During the 1997 apparition of the near-Earth Apollo-type binary asteroid (35107) 1991 VH, two intertwined lightcurves were reported (Pravec et al., 1998). Fourier analysis revealed a short-period lightcurve of period P_{prim} = 2.62385 ± 0.000072 h with amplitude A_{prim} = 0.09 mag and a long period P_{orb} = 32.688 ± 0.024 h with a primary and secondary minima of A_p = 0.19 ± 0.01 and A_s = 0.16 ± 0.01 mag. The interpretation of these data assumed a model consisting of two gravitationally bound bodies with a non-synchronous primary rotating at period P_{prim} and a secondary orbiting with the period P_{orb}. Occultations produced the long period lightcurve.

During the 2003 apparition the asteroid was found to have the same basic short and long period lightcurves with P_{prim} = 2.6236 ± 0.0001 h, A_{prim} = 0.08 mag, P_{orb} = 32.63 ± 0.05 h, and minima depths A_p = 0.17 ± 0.01 and A_s = 0.14 ± 0.01 mag (Pravec et al., 2006). However, a third period of P_{sec} = 12.836 ± 0.003 h and amplitude A_{sec} = 0.06 mag was also seen. A recheck of the 1997 data showed no such component. The suggested explanation for this period was a non-synchronous rotation of the secondary.

During the 2008 apparition photometric data were collected on 35107 at Stonegate Observatory using a 36-cm Celestron C-14, SBIG ST-10XME CCD camera, and clear filter. The camera was binned 2x2 with an image scale of 1.3 arc-seconds per pixel. Image exposures were 120 seconds at –15C. All photometric data were obtained and analyzed using *MPO Canopus* (Warner, 2008).

Observations were made on 8 nights from 2008 July 2 through July 31, resulting in 770 data points. Analysis of the data using the *MPO Canopus* "Dual Period Search" indicated a primary orbital period P_{prim} = 2.6239 ± 0.0001 h with amplitude A_{prim} = 0.15 ± 0.03 mag. The period agrees well with previous results but the amplitude was 0.06 mag higher. The secondary orbital period P_{orb} = 32.26 ± 0.01 h is 0.4 h shorter period than previously reported. The orbital amplitude A_p = 0.16 ± 0.03 and A_s = 0.14 ± 0.03 mag are within the error bars of the references. The residual period spectrum showed a low confidence periodicity at 14.30 ± 0.01 h but this is likely noise and does not correlate with the previous 2003 apparition secondary period, P_{sec} = 12.836 h.

Acknowledgments

The author appreciates the assistance and encouragement from Jean-Luc Margot and Petr Pravec and the continued help of Brian Warner in sorting out the "real from the imaginary" in period analysis.

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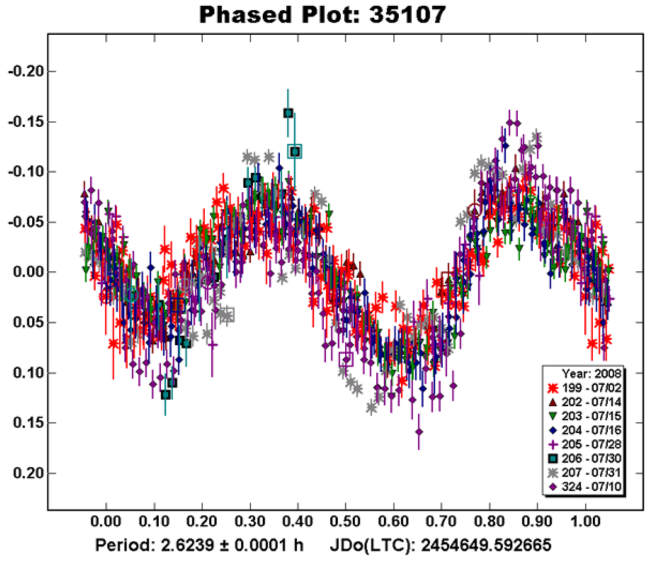

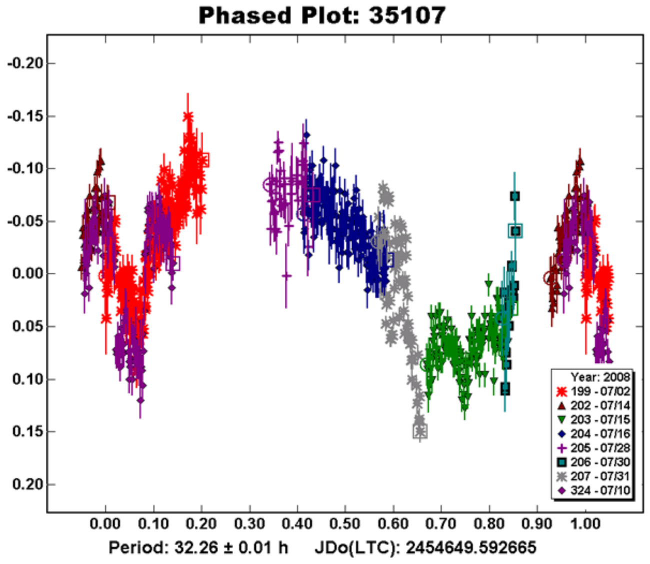

LIGHTCURVE PHOTOMETRY OPPORTUNITIES: 2010 JANUARY – MARCH

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With a New Year come new things. For this regular article it means an "In Focus" section at the top that highlights particular topics or calls extra attention to listed targets so that they don't get overlooked. We have trimmed the material in the standard text, keeping the essential elements and Internet web sites. For more background on the program details for each list, refer to previous issues, e.g., *Minor Planet Bulletin* **36**, 188.

In Focus

In the radar support list, we make particular mention of needed data to help with pole and shape modeling. Surprisingly, very few pole directions for near-Earth asteroids (NEAs) have been published – only 30 or so. There are hints that pole directions have preferred orientations, which can be evidence for drift due to the Yarkovsky effect (e.g., see Warner et al., *Icarus* **204**, 172-182). However, the lack of data prevents any definitive conclusions. Almost every lightcurve (those of sufficient quality) can help build the statistical pool for pole modeling. For many years, the lack of data prevented proper rotational rate studies. Now that we have rotational data on almost 3000 asteroids, the focus moves beyond (but not completely away from) rotation rates and onto pole orientations and, with even more data, shape modeling.

It is easy to bypass asteroids that have been well-observed over many apparitions. However, for NEAs and small asteroids in the inner main belt, "more data!" could be very important. As has been shown, some asteroids do not have a constant rotation rate (1862 Apollo, Kaasalainen et al., 2007. *Nature* **446**, 420-422; 54509 YORP, Taylor et al., 2007. *Science* **316**, 274-276). It's believed that the YORP effect, the thermal re-radiation from an asteroid, causes the rotation rate for some asteroids to change gradually, either slower or faster. This was determined by comparing precise data on at least three well-separated apparitions over many years. If an NEA or small, inner main belt asteroid becomes available, don't ignore it just because it's been well-worked. Your data could provide yet more evidence for the sunlight-induced spin up or down of asteroids. A potential target along these lines is 1627 Ivar, which will be available in February 2010 at V = 15.9, Dec +15°.

Note that 4486 Mithra in the radar targets list is a high priority. The radar observations have already been made, so the goal here is to obtain additional data to support those observations. Do try to coordinate efforts, either by working directly with Lance Benner or by messaging on the Minor Planet Mailing List: http://tech.groups.yahoo.com/group/mpml. The object has a long period and so collaboration among observers at different longitudes will be critical.

The Opportunities Lists

We present four lists of "targets of opportunity" for the period 2010 January-March. In the first three sets of tables, Dec is the declination, U is the quality code of the lightcurve, and α is the solar phase angle. See the asteroid lightcurve data base (LCDB) documentation for an explanation of the U code:

www.minorplanetobserver.com/astlc/LightcurveParameters.htm

Note that the lightcurve amplitude in the tables could be more, or less, than what's given. Use the listing only as a guide.

Objects with no U rating or *U* = 1 should be given higher priority when possible. ***We strongly urge that you do not overlook asteroids with U = 2 on the assumption that the period is sufficiently established.*** Regardless, do not let the existing period influence your analysis since even high quality ratings have been proven wrong at times.

The first list is those asteroids reaching <15m at brightest during the period and have either no or poorly constrained lightcurve parameters. The goal for these asteroids is to find a well-determined rotation rate.

The Low Phase Angle list includes asteroids that reach very low phase angles. Getting accurate, calibrated measurements (usually V band) at or very near the day of opposition can provide important information for those studying the "opposition effect."

The third list is of those asteroids needing only a small number of lightcurves to allow shape and spin axis modeling. Those doing work for modeling should contact Josef Durech at the email address above and visit the Database of Asteroid Models from Inversion Techniques (DAMIT) web site for existing data and models: *http://astro.troja.mff.cuni.cz/projects/asteroids3D.*

The fourth list gives a brief ephemeris for planned radar targets. Supporting optical observations made to determine the lightcurve period, amplitude, and shape are needed to supplement the radar data. High-precision work, 0.01-0.03 mag, is preferred. Those obtaining lightcurves in support of radar observations should contact Dr. Benner directly at the email given above.

Future radar targets:
http://echo.jpl.nasa.gov/~lance/future.radar.nea.periods.html
Past radar targets:
http://echo.jpl.nasa.gov/~lance/radar.nea.periods.html
Arecibo targets:
http://www.naic.edu/~pradar/sched.shtml
Goldstone targets:
http://echo.jpl.nasa.gov/asteroids/goldstone_asteroid_schedule.html

Once you have analyzed your data, it's important that you publish your results. Papers appearing in the *Minor Planet Bulletin* are indexed in the Astrophysical Data System (ADS) and so can be referenced by others in subsequent papers. It's also important to make the data available at least on a personal website or upon request.

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Lightcurve Opportunities

This list includes a few un-numbered objects reaching a favorable apparition that may not fit all the usual criteria but may not be seen for many years and so are higher-priority targets.

#	Name	Brightest Date	Mag	Dec	U	LCDB Data Period	Amp
3318	Blixen	1 02.4	14.9	+21	2+	6.45	0.20
	2005 MC	1 02.4	15.9	+11			
4156	Okadanoboru	1 02.1	14.7	+35			
581	Tauntonia	1 04.1	13.7	+23	2	16.54	0.06
	2002 CY25	1 04.6	15.9	+47			
6524	Baalke	1 05.4	14.8	+07			
40014	1998 HL124	1 06.9	15.0	+24			
1888	Zu Chong-Zhi	1 08.0	13.9	+15	2	15.9	0.50
34708	2001 OG95	1 11.9	14.9	+25			
2443	Tomeileen	1 13.9	14.1	+20	2	3.97	0.1
4690	Strasbourg	1 17.2	14.8	+20	2	109.0	0.80
189099	2001 RO	1 22.0	15.0	+01			
4024	Ronan	1 26.3	14.7	+33	1	18.9	0.5
1630	Milet	1 27.4	14.5	+25	2	32.55	0.37
5131	1990 BG	1 28.1	14.0	+59			
2960	Ohtaki	1 30.4	14.8	+18			
2881	Meiden	1 31.4	14.9	+11			
4000	Hipparchus	2 03.0	15.0	+17			
1737	Severny	2 04.2	14.7	+19	2	14.11	0.14
8062	Okhotsymskij	2 07.2	14.8	+20			
3851	Alhambra	2 20.9	15.0	+13	2	53.	0.35
1845	Helewalda	2 20.4	15.0	+13	2	7.39	0.20
2832	Lada	2 21.9	14.9	+09	2+	8.35	0.47
3458	Boduognat	2 25.4	14.6	+09			
2181	Fogelin	2 26.1	15.0	+23			
	2001 PT9	2 27.2	15.0	-31			
19651	1999 RC112	2 27.8	15.0	+00			
892	Seeligeria	2 27.7	13.7	-01	2	41.40	0.15
	1984 QY1	3 01.3	14.0	-05			
1415	Malautra	3 02.2	14.0	+06	1	> 12.	>0.03
616	Elly	3 03.7	13.7	+12	2	5.30	0.34
4283	Stoffler	3 04.5	14.7	-10	2-	98.	0.46
4486	Mithra	3 06.0	14.5	-04	2	100.	1.
1178	Irmela	3 07.8	13.9	+05	2	19.17	0.34
3068	Khanina	3 08.9	15.0	+11			
1194	Aletta	3 09.6	13.8	-09	2	19.7	0.32
5691	Fredwatson	3 14.6	15.0	+01			
996	Hilaritas	3 15.8	14.3	+02	2	7.20	0.69
33750	Davehiggins	3 15.0	15.0	+38			
1451	Grano	3 17.1	14.2	+02	2	5.10	0.06
22295	1989 SZ9	3 22.6	14.8	+00			
	2007 HE4	3 23.2	15.7	+02			

Low Phase Angle Opportunities

#	Name	Date	α	V	Dec	Period	Amp.	U
40014	1998 HL124	01 06.9	0.74	15.0	+24			
2271	Kiso	01 14.2	0.67	15.0	+19			
515	Athalia	01 19.9	0.08	14.8	+20			
749	Malzovia	01 20.0	0.66	14.5	+22			
2616	Lesya	01 28.8	0.35	14.9	+17			
2960	Ohtaki	01 30.4	0.23	14.9	+18			
4000	Hipparchus	02 03.0	0.18	15.0	+17			
828	Lindemannia	02 06.6	0.35	14.8	+17			
431	Nephele	02 17.1	0.35	13.8	+13	21.43	0.02 0.30	1
3458	Boduognat	02 25.4	0.21	14.7	+09			
1415	Malautra	03 02.2	0.65	14.1	+06	>12.	0.03	1
2004	Lexell	03 05.5	0.72	14.8	+08			
22295	1989 SZ9	03 22.6	0.27	14.9	+00			
1332	Marconia	03 28.8	0.14	14.9	-03			

Shape/Spin Modeling Opportunities

#	Name	Brightest Date	Mag	Dec	Per (h)	Amp.	U
38	Leda	1 01.	11.6	+28	12.838	0.05 0.16	3
47	Aglaja	1 01.	12.8	+21	13.178	0.02 0.17	3
51	Nemausa	1 01.	11.5	+04	7.783	0.10 0.25	3
173	Ino	1 01.	12.2	-09	6.163	0.04 0.15	3
225	Henrietta	1 01.	14.8	-03	7.360	0.16 0.29	2
238	Hypatia	1 01.	12.2	+04	8.86	0.17	3
263	Dresda	1 01.	14.6	+21	16.809	0.32 0.40	3
313	Chaldaea	1 01.	11.2	+01	8.392	0.08 0.24	3
334	Chicago	1 01.	13.5	+18	7.361	0.15 0.67	3
344	Desiderata	1 01.	13.1	+15	10.77	0.18	3
137	Meliboea	1 11.4	13.5	+04	25.676	0.11 0.20	3
354	Eleonora	1 26.1	9.5	+11	4.277	0.12 0.52	3
804	Hispania	1 29.0	12.4	+32	14.845	0.19 0.24	3
10	Hygiea	2 07.2	9.7	+12	27.623	0.09 0.33	3
323	Brucia	2 07.7	13.5	+39	9.46	0.19 0.36	3
505	Cava	2 11.1	11.7	+26	8.1789	0.15 0.27	3
85	Io	2 11.9	12.2	+00	6.875	0.05 0.17	3
113	Amalthea	2 15.9	11.1	+16	9.935	0.20	3
50	Virginia	2 20.9	13.4	+09	14.315	0.07 0.20	3
60	Echo	2 23.2	10.1	+06	25.208	0.07 0.22	3
537	Pauly	2 27.9	13.9	+16	16.25	0.18	2
674	Rachele	3 04.4	11.1	+24	30.962	0.16	2
852	Wladilena	3 09.2	14.1	+29	4.6134	0.30 0.32	3
1180	Rita	3 18.4	15.0	+10	14.902	0.29	3

Radar-Optical Opportunities

Use the ephemerides to judge your best chances for observing. Note that the intervals in the ephemerides are not always the same and that *geocentric* positions are given. Use the web sites below to generate updated and *topocentric* positions. In the ephemerides, E.D. and S.D. are, respectively, the Earth and Sun distances (AU), V is the V magnitude, and α is the phase angle.

Minor Planet Center: *http://cfa-www.harvard.edu/iau/mpc.htm*
JPL Horizons: *http://ssd.jpl.nasa.gov/?horizons*

4486 Mithra (2010 Feb)

Recent radar studies (Brozovic et al., submitted to *Icarus*) indicate this is a contact binary with a period of approximately 67 h. The data fit both principal axis and non-principal axis (tumbling) rotation. A look at the viewing aspects during the apparition show that the amplitude of the lightcurve could be significant as the asteroid pulls away from closest approach. The sense of rotation (prograde or retrograde) is ambiguous. Lightcurves may be able to help determine the rotation period and, possibly, the spin sense – prograde or retrograde.

This is a priority target to support radar observation and so photometry is strongly urged.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
02/10	13 00.85	+02 43.9	0.452	1.312	15.95	36.6
02/13	13 12.66	+02 13.8	0.413	1.281	15.73	37.7
02/16	13 26.16	+01 40.1	0.375	1.251	15.51	39.0
02/19	13 41.81	+01 01.5	0.340	1.220	15.30	40.9
02/22	14 00.20	+00 16.6	0.307	1.190	15.08	43.3
02/25	14 22.10	-00 36.4	0.276	1.159	14.89	46.5
02/28	14 48.35	-01 39.0	0.249	1.129	14.72	50.7

2002 AJ129 (2010 Feb)

This isn't a radar target until 2018, however apparitions favorable for photometry are few and far between; February 2010 is one of those opportunities, though it will take a larger telescope (at least 0.5 meter) to work the 630-meter NEA effectively. Given the large range of phase angles, then under ideal circumstances it might be possible to get a preliminary model from this one apparition.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
02/01	12 26.75	-00 15.3	0.184	1.102	16.80	46.6
02/03	11 50.73	+04 54.1	0.191	1.135	16.64	35.7
02/05	11 17.66	+09 27.1	0.205	1.166	16.57	25.8
02/07	10 48.42	+13 12.6	0.223	1.197	16.54	17.3
02/09	10 23.23	+16 11.0	0.246	1.227	16.56	10.4
02/11	10 01.87	+18 28.9	0.271	1.257	16.62	5.7
02/13	9 43.91	+20 14.5	0.300	1.286	16.86	5.2
02/15	9 28.87	+21 35.3	0.330	1.314	17.25	7.9
02/17	9 16.27	+22 37.2	0.363	1.342	17.62	10.9
02/19	9 05.72	+23 24.8	0.396	1.369	17.96	13.7

11066 Sigurd (2010 Feb-Mar)

The period for this contact binary is well-defined (8.496 h). The primary objectives (in order) for this apparition are to determine the pole direction and shape.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
02/15	11 37.79	+37 34.7	0.715	1.631	16.53	19.8
02/18	11 25.30	+37 08.3	0.716	1.643	16.49	18.1
02/21	11 12.75	+36 33.0	0.718	1.655	16.47	16.7
02/24	11 00.36	+35 49.0	0.724	1.667	16.47	15.8
02/27	10 48.35	+34 56.8	0.733	1.678	16.49	15.3
03/02	10 36.90	+33 57.6	0.745	1.690	16.54	15.3

2000 CO101 (2010 Feb-Mar)

There are no lightcurve parameters in the Lightcurve Database (LCBD, Warner et al, 2009). Radar observations at Arecibo in 2009 September showed that this is a binary system but the size ratio of secondary to primary is so small that it's unlikely that occultations or eclipses ("mutual events") can be found photometrically. The radar data are also consistent with a rotation period of < 3 h but this must be confirmed.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
02/24	10 47.03	+61 51.8	0.132	1.075	16.53	46.8
02/27	10 17.64	+56 58.9	0.129	1.080	16.40	43.5
03/02	9 54.85	+51 22.8	0.128	1.084	16.31	40.7
03/05	9 37.45	+45 20.3	0.128	1.089	16.27	38.5
03/08	9 24.27	+39 08.4	0.131	1.093	16.28	37.4
03/11	9 14.39	+33 03.0	0.135	1.097	16.36	37.3
03/14	9 07.09	+27 16.2	0.141	1.102	16.49	38.0

2001 FM129 (2010 Mar)

This 1-km NEA will require some larger instruments to get good photometry. There are no known lightcurve parameters.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
03/10	2 45.73	+04 01.2	0.117	0.925	17.50	122.2
03/13	4 04.65	+07 11.0	0.106	0.961	16.23	105.1
03/16	5 30.11	+09 37.7	0.109	0.996	15.52	86.4
03/19	6 42.76	+10 40.5	0.125	1.030	15.34	70.8
03/22	7 35.74	+10 46.5	0.150	1.063	15.47	60.1
03/25	8 12.89	+10 30.0	0.181	1.095	15.73	53.1
03/28	8 39.47	+10 07.3	0.214	1.127	16.04	48.6

2005 YU55 (2010 Apr)

There are no lightcurve parameters in the LCDB for this 120-meter NEA. Given its small size, there is a chance that it may be a fast rotator, meaning it may be spinning faster than the ~2.2 h spin barrier. Here again, a larger telescope will help keep the SNR high for a fast-moving object.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
04/11	13 09.95	-04 38.1	0.068	1.070	16.55	3.7
04/12	13 03.10	-03 44.7	0.060	1.062	16.41	6.1
04/13	12 54.41	-02 36.6	0.053	1.055	16.26	9.3
04/14	12 43.04	-01 07.2	0.046	1.048	16.09	13.2
04/15	12 27.66	+00 53.9	0.039	1.040	15.90	18.4
04/16	12 05.96	+03 43.9	0.033	1.033	15.70	25.4
04/17	11 33.77	+07 49.5	0.027	1.025	15.53	35.2
04/18	10 43.87	+13 41.0	0.022	1.018	15.47	49.7
04/19	9 27.04	+20 56.5	0.019	1.010	15.73	70.3
04/20	7 46.27	+26 30.7	0.018	1.003	16.59	94.9

IN THIS ISSUE

This list gives those asteroids in this issue for which physical observations (excluding astrometric only) were made. This includes lightcurves, color index, and H-G determinations, etc. In some cases, no specific results are reported due to a lack of or poor quality data. The page number is for the first page of the paper mentioning the asteroid. EP is the "go to page" value in the electronic version.

16404	1985 CM1	9	9
20614	1999 SN3	24	24
21607	Robel	19	19
26916	1996 RR2	24	24
29665	1998 WD24	1	1
31867	2000 EG94	18	18
32209	2000 OW9	24	24
35107	1991 VH	36	36
39828	1998 BH4	9	9
44060	1998 FU42	9	9
46818	1998 MZ24	24	24
46953	1998 SB121	9	9
50879	2000 GT32	9	9
56367	2000 EF	9	9
77799	2001 QV88	24	24
88161	2000 XK18	18	18
90698	1984 EA	9	9
96178	1987 SA4	9	9
120928	1998 SP109	9	9
154244	2002 KL6	9	9
	1995 UX1	9	9
	2007 PU11	23	23

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The deadline for the next issue (37-2) is January 15, 2010. The deadline for issue 37-3 is April 15, 2010.