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PHOTOMETRIC MEASUREMENTS OF 343 OSTARA AND OTHER ASTEROIDS AT HOBBS OBSERVATORY

Lyle Ford, George Stecher, Kayla Lorenzen, and Cole Cook
Department of Physics and Astronomy
University of Wisconsin-Eau Claire
Eau Claire, WI 54702-4004
fordla@uwec.edu

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We observed 343 Ostara on 2008 October 4 and obtained R and V standard magnitudes. The period was found to be significantly greater than the previously reported value of 6.42 hours. Measurements of 2660 Wasserman and (17010) 1999 CQ72 made on 2008 March 25 are also reported.

We made R band and V band photometric measurements of 343 Ostara on 2008 October 4 using the 0.6 m "Air Force" Telescope located at Hobbs Observatory (MPC code 750) near Fall Creek, Wisconsin. Sixty second 2x2 binned exposures were taken with an Apogee Alta U55 camera. Additional details on the telescope can be found in Stecher et al. (1999). Images were dark-subtracted and flat-fielded. Photometric transforms were found using Landolt standard stars from the LONEOS catalog and first order extinction coefficients were determined using the modified Hardie method as described in Warner (2006). Data were analyzed using *MPO Canopus* version 9.3.1.0 (Warner 2007).

The V data for 343 Ostara are shown in Figure 1. The R data are similar but with larger errors. The magnitude of 343 Ostara varied between about 13.67 and 13.87 in V and 13.22 and 13.43 in R. No extrema were evident in the lightcurve, indicating that its period is significantly longer than the 8.4 hours of our observing run. This finding is in contradiction with the period of 6.42 hours reported by Binzel (1987).

We also report measurements of 2660 Wasserman and (17010) 1999 CQ72 made on 2008 March 25. Measurements of 2660 Wasserman indicated an average R magnitude of 15.05 and an average V magnitude of 14.47. The variation was small compared to the scatter in the data, which was about 0.1 magnitudes. Over a 2.6 hour stretch, (17010) 1999 CQ72 exhibited a 0.5 magnitude variation in both V and R, with average values of 15.62 in V and 15.07 in R.

Our data can be obtained from http://www.uwec.edu/physics/asteroid/.

Acknowledgements

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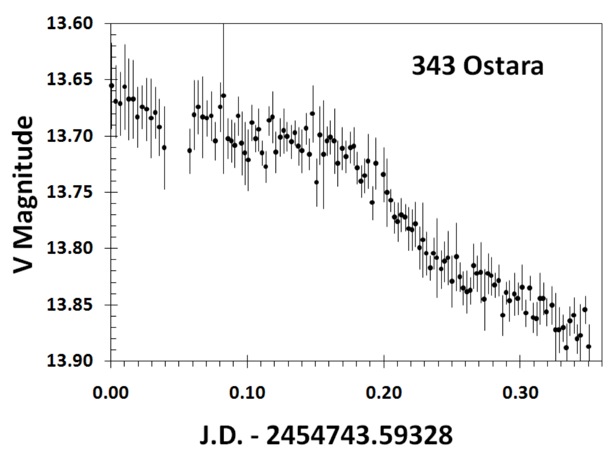

Figure 1. V magnitude partial lightcurve of 343 Ostara. Times have not been adjusted for light travel.

GENERAL REPORT OF POSITION OBSERVATIONS BY THE ALPO MINOR PLANETS SECTION FOR THE YEAR 2008

Frederick Pilcher
4438 Organ Mesa Loop
Las Cruces, NM 88011 USA
pilcher@ic.edu

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Observations of positions of minor planets by members of the Minor Planets Section in calendar year 2008 are summarized.

During the year 2008 a total of 1514 positions of 439 different minor planets were reported by members of the Minor Planets Section. Of these 99 are CCD images (denoted C), and all the rest are approximate visual positions.

The summary lists minor planets in numerical order, the observer and telescope aperture (in cm), UT dates of the observations, and the total number of observations in that period. The year is 2008 in each case.

Positional observations were contributed by the following observers:

Observer, Instrument	Location	Planets	Positions
Bookamer, Richard E. 41 cm reflector	Sebastian, Florida USA	88	288
Faure, Gerard 20 cm Celestron, 35 cm SCT	Col de L'Arzelier, France	112	347 (99C)
Garrett, Lawrence 32 cm f/6 reflector	Fairfax, Vermont, USA	6	12
Harvey, G. Roger 74 cm Newtonian	Concord, North Carolina, USA	171	590
Hudgens, Ben 32 cm f/4.8 Dobsonian 30 cm f/10 Cassegrain 25 cm f/5 Dobsonian 41 cm f/4.5 Dobsonian 33 cm f/4.5 Dobsonian	Stephenville, Texas, USA	94	197
Pryal, Jim 20 cm f/10 SCT 12 cm f/8.33 refractor	Federal Way, WA USA and environs	26	54
Watson, William W. 20 cm Celestron	Tonawanda, NY USA and vicinity.	8	26

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2008)	NO. OBS.
4 Vesta	Pryal, 12	Oct 27-Dec 4	2
5 Astraea	Pryal, 20 Watson, 20	Apr 12 Apr 30-Jun 7	2 7
7 Iris	Pryal, 20	May 2-4	2
11 Parthenope	Pryal, 20	Aug 4	2
24 Themis	Pryal, 20	Jan 26	2
31 Euphrosyne	Pryal, 20	May 2-4	2
32 Pomona	Pryal, 20	Oct 28	2
41 Daphne	Pryal, 20	Apr 12	2
48 Doris	Pryal, 20	Mar 5-6	3
50 Virginia	Pryal, 20	Sep 29	2
52 Europa	Pryal, 20	Sep 7-8	2
79 Eurynome	Pryal, 20	Sep 7-8	2
82 Alkmene	Pryal, 20	Apr 12	2
94 Aurora	Harvey, 73	Aug 14	3
104 Klymene	Watson, 20	Oct 7	2
128 Nemesis	Pryal, 20	Aug 4	2
130 Elektra	Pryal, 20	Sep 7-8	2
152 Atala	Bookamer, 41	Oct 3	3
155 Scylla	Bookamer, 41	Nov 19	3
190 Ismene	Faure, 20	Apr 26	5C
199 Byblis	Faure, 20	Apr 25	6C
214 Aschera	Garrett, 32	Aug 27	2
216 Kleopatra	Pryal, 20	Sep 7-8	2
224 Oceana	Pryal, 20	Sep 7-8	2
229 Adelinda	Bookamer, 41	Jul 26	3
238 Hypatia	Pryal, 20	Sep 7-8	3
250 Bettina	Pryal, 20	Sep 7-8	2
252 Clementina	Bookamer, 41	Aug 30	3
259 Aletheia	Watson, 20	Apr 30-May 1	2
260 Huberta	Bookamer, 41	Nov 4	3
263 Dresda	Garrett, 32	Aug 27	2
264 Libussa	Watson, 20	Oct 31-Nov 6	3
272 Antonia	Bookamer, 41	Jan 10	4
275 Sapientia	Pryal, 20 Watson, 20	Apr 12 Mar 25-Apr 7	2 3
290 Bruna	Bookamer, 41	Apr 10	3
306 Unitas	Pryal, 20	Sep 7-8	2
327 Columbia	Bookamer, 41	Apr 27	3
333 Badenia	Bookamer, 41	Aug 30	3
335 Roberta	Faure, 20	Apr 26	7C
343 Ostara	Bookamer, 41	Oct 27	3
347 Pariana	Watson, 20	Apr 3-7	2
358 Apollonia	Pryal, 20	Oct 1	2
409 Aspasia	Faure, 20	Feb 5	3
439 Ohio	Faure, 20	Aug 29	2
440 Theodora	Bookamer, 41	Jan 30	3
469 Argentina	Pryal, 20	Mar 6	2
495 Eulalia	Bookamer, 41	Nov 15	2
496 Gryphia	Bookamer, 41	Apr 1	3
497 Iva	Bookamer, 41	Nov 6	3
513 Centesima	Bookamer, 41	Oct 29	3
518 Halawe	Bookamer, 41	Oct 29	3
527 Euryanthe	Bookamer, 41	Jun 7	3
568 Cheruskia	Bookamer, 41	Oct 27	2
576 Emanuela	Pryal, 20	Aug 4	2
577 Rhea	Bookamer, 41	Apr 11	3
588 Achilles	Faure, 20	Sep 8-9	2
590 Tomyris	Bookamer, 41	Nov 30	4
594 Mireille	Hudgens, 41	Feb 13	2

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2008)	NO. OBS.
598 Octavia	Faure, 20	Jun 27	2
627 Charis	Bookamer, 41	Sep 22	3
658 Asteria	Faure, 20	Dec 8	8C
673 Edda	Bookamer, 41	Dec 7	3
687 Tinette	Bookamer, 41	Oct 27	4
692 Hippodamia	Bookamer, 41	Feb 5	3
732 Tjilaki	Bookamer, 41	Mar 4	3
746 Marlu	Bookamer, 41	Aug 2	3
750 Oskar	Faure, 20	Feb 9	2
751 Faïna	Watson, 20	Oct 7	2
765 Mattiaca	Faure, 20	Feb 3	2
766 Moguntia	Faure, 20	Dec 8	7C
768 Struveana	Bookamer, 41	Nov 17	3
769 Tatjana	Bookamer, 41	Mar 28	3
775 Lumière	Bookamer, 41	Jan 11	3
783 Nora	Bookamer, 41	Sep 27	3
787 Moskva	Pryal, 20	Sep 29	2
791 Ani	Bookamer, 41	Jul 21	3
795 Fini	Bookamer, 41	Mar 1-4	5
796 Sarita	Pryal, 20	Oct 1	2
819 Barnardiana	Bookamer, 41	Jul 27	3
832 Karin	Hudgens, 33	Sep 26	2
835 Olivia	Faure, 20	Sep 28-29	2
840 Zenobia	Faure, 20	Apr 4	2
847 Agnia	Bookamer, 41	Sep 22	3
860 Ursina	Bookamer, 41	Aug 2	3
861 Aida	Bookamer, 41	May 31	3
889 Erynia	Bookamer, 41	Oct 3	3
898 Hildegard	Bookamer, 41	May 2-Jun 1	7
	Hudgens, 41	Jun 1	2
899 Jokaste	Bookamer, 41	Nov 22	3
904 Rockefellia	Bookamer, 41	Feb 11	3
914 Palisana	Faure, 20	Nov 27	4
	Hudgens, 33	Oct 31-Nov 1	2
923 Herluga	Bookamer, 41	Nov 6	4
926 Imhilde	Bookamer, 41	Apr 3	3
936 Kunigunde	Bookamer, 41	May 29	3
956 Elisa	Bookamer, 41	Aug 6	3
1005 Arago	Bookamer, 41	Nov 16	4
1017 Jacqueline	Bookamer, 41	Feb 8	3
1022 Olympiada	Bookamer, 41	Apr 3	3
1031 Arctica	Bookamer, 41	Mar 3	3
1043 Beate	Garrett, 32	Aug 23	2
1047 Geisha	Bookamer, 41	Nov 23	4
1056 Azalea	Bookamer, 41	May 24	4
1063 Aquilegia	Bookamer, 41	Apr 12	3
1066 Lobelia	Hudgens, 33	Oct 19-20	2
1068 Nofretete	Harvey, 73	Feb 7	3
1088 Mitaka	Bookamer, 41	Jun 5	3
1089 Tama	Hudgens, 41	May 3	2

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2008)	NO. OBS.
1096 Reunerta	Bookamer, 41	Oct 17	3
1098 Hakone	Bookamer, 41	Nov 22	4
1102 Pepita	Bookamer, 41	Sep 27	3
1117 Reginita	Bookamer, 41	Jun 8	3
1122 Neith	Faure, 20	Sep 29	2
	Hudgens, 33	Oct 31	2
1126 Otero	Bookamer, 41	Feb 26	3
1132 Hollandia	Bookamer, 41	Jul 5	3
1157 Arabia	Bookamer, 41	May 29	3
1165 Imprinetta	Faure, 20	Jul 5	2
1177 Gonnessia	Hudgens, 41	Aug 3	2
1188 Gothlandia	Bookamer, 41	Nov 27	3
1199 Geldonia	Faure, 20	Apr 26	7C
1217 Maximiliana	Hudgens, 41	May 3	2
1252 Celestia	Bookamer, 41	Feb 5	3
1294 Antwerpia	Bookamer, 41	Nov 8	3
1300 Marcelle	Faure, 20	Feb 9	2
1303 Luthera	Bookamer, 41	Jan 15	3
1326 Losaka	Hudgens, 41	Jul 27-30	2
1349 Bechuana	Faure, 20	Sep 27	2
1365 Henyey	Bookamer, 41	Mar 9	3
	Faure, 20	Mar 14	2
1368 Numidia	Faure, 20	Sep 8-27	4
1379 Lomonosowa	Faure, 20	Mar 29	2
1382 Gerti	Faure, 20	Apr 4	2
1385 Gelria	Faure, 20	Jul 4-5	3
1393 Sofala	Hudgens, 41	May 3	2
1403 Idelsonia	Bookamer, 41	Oct 19-Nov 4	4
	Hudgens, 33	Oct 31-Nov 1	2
1449 Virtanen	Bookamer, 41	May 26	3
	Faure, 20	Jun 27	3
1479 Inkeri	Bookamer, 41	Feb 11	4
	Faure, 20	Mar 29	2
1488 Aura	Hudgens, 41	Feb 8	2
1528 Conrada	Faure, 20	Apr 5	2
1554 Yugoslavia	Hudgens, 33	Oct 26	2
1558 Järnefelt	Hudgens, 41	Jul 10	2
1560 Strattonia	Bookamer, 41	Nov 27	3
1596 Itzigsohn	Bookamer, 41	Dec 7	4
1598 Paloque	Hudgens, 41	Jul 3	2
1605 Milankovitch	Bookamer, 41	Jan 10	2
1620 Geographos	Hudgens, 41	Feb 29	3
1638 Ruanda	Bookamer, 41	Jun 1	3
1642 Hill	Bookamer, 41	Feb 7	3
1645 Waterfield	Faure, 20	Aug 31	2
	Garrett, 32	Aug 29	2
1650 Heckmann	Hudgens, 41	May 3	2
1655 Comas Solá	Bookamer, 41	Nov 30	6
1672 Gezelle	Hudgens, 33	Oct 31-Nov 1	2
1679 Nevanlinna	Faure, 20	Jun 27-28	3
	Hudgens, 41	Jun 3	2
1685 Toro	Bookamer, 41	Jan 26	4
	Hudgens, 41	Feb 8	2

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2008)	NO. OBS.
1706 Dieckvoss	Hudgens, 41	Jun 3	2
1710 Gothard	Faure, 20	Sep 27	2
1712 Angola	Bookamer, 41	Apr 25	3
1724 Vladimir	Faure, 20	Mar 30	2
1727 Mette	Bookamer, 41	Jan 28	4
1763 Williams	Faure, 20	Sep 29	2
1791 Patsayev	Faure, 20	Sep 9	2
1794 Finsen	Faure, 20	Mar 29	2
1796 Riga	Hudgens, 41	Feb 10	2
1805 Dirikis	Faure, 20	Feb 3	2
	Hudgens, 41	Feb 8	2
1810 Epimetheus	Hudgens, 41	Jan 30	2
1836 Komarov	Bookamer, 41	Jul 6	3
	Hudgens, 41	Jul 3	2
1855 Korolev	Faure, 20	Apr 4	2
1868 Thersites	Faure, 20	Aug 31	2
1875 Neruda	Harvey, 73	Oct 3	3
1914 Hartbeespoortdam	Hudgens, 41	Jun 27	2
1929 Kollaa	Hudgens, 41	Feb 8	2
1930 Lucifer	Faure, 20	Aug 30-Sep 9	4
1947 Iso-Heikkilä	Faure, 20	Mar 30	3
1951 Lick	Hudgens, 41	Jul 26	2
1973 Colocolo	Harvey, 73	Sep 20	3
2000 Herschel	Bookamer, 41	Oct 20	4
2001 Einstein	Bookamer, 41	Mar 9	4
	Hudgens, 41	Mar 5	2
2052 Tamriko	Faure, 20	Feb 8	2
2065 Spicer	Faure, 20	Sep 29	2
	Hudgens, 33	Oct 19-20	2
2066 Palala	Hudgens, 41	Jun 1	2
2080 Jihlava	Faure, 20	Feb 9	2
2116 Mtskheta	Faure, 20	Aug 30	2
2157 Ashbrook	Hudgens, 41	May 3	2
2178 Kazakhstania	Harvey, 73	Sep 20	3
2186 Keldysh	Harvey, 73	Oct 5	3
2199 Klet	Faure, 20	Mar 30	2
2232 Altaj	Hudgens, 41	Aug 3	2
2253 Espinette	Bookamer, 41	Sep 6	3
2269 Efremiana	Hudgens, 41	Feb 8	2
2345 Fu•ik	Hudgens, 32	Jan 6	2
2353 Alva	Harvey, 73	Oct 27	3
2397 Lappajärvi	Hudgens, 41	Jan 30	2
2399 Terradas	Hudgens, 41	Jul 26	2
2411 Zellner	Hudgens, 41	Aug 3	2
2431 Skovoroda	Hudgens, 41	Jul 27-29	2
2436 Hatshepsut	Harvey, 73	Feb 9	3
2448 Sholokhov	Bookamer, 41	Mar 27	3
2509 Chukotka	Faure, 20	Sep 27	2
	Harvey, 73	Sep 19	3
2511 Patterson	Hudgens, 41	Jun 27	2
2517 Orma	Harvey, 73	Nov 26	3
2524 Budovicium	Hudgens, 41	Jul 3	2
2527 Gregory	Faure, 20	Aug 31	2
2543 Machado	Hudgens, 33	Oct 20-21	2
2598 Merlin	Faure, 20	Sep 28	2
2606 Odessa	Bookamer, 41	Mar 9	3
	Faure, 20	Mar 14	2
2612 Kathryn	Faure, 20	Feb 8	2
2669 Shostakovich	Harvey, 73	Oct 4	3
2670 Chuvashia	Faure, 20	Feb 9-10	2
2761 Eddington	Harvey, 73	Feb 8	3
2771 Polzunov	Faure, 20	Jul 4	2
2811 St•emchoví	Harvey, 73	Jan 1	3
2911 Miahelena	Faure, 20	Mar 30	2
2962 Otto	Hudgens, 41	Jun 1	2
3017 Petrovi•	Faure, 20	Mar 29	2
	Hudgens, 41	Feb 8	2
3085 Donna	Harvey, 73	Nov 24	3
3086 Kalbaugh	Harvey, 73	Feb 8	3
3198 Wallonia	Faure, 20	Apr 5	2
3209 Buchwald	Harvey, 73	Feb 28	3
3247 Di Martino	Faure, 20	Feb 9	2
	Harvey, 73	Feb 8	3
3288 Seleucus	Faure, 20	Feb 8	4
3401 Vanphilos	Faure, 20	Mar 29	2
	Hudgens, 41	Feb 10	2
3404 Hinderer	Harvey, 73	Jan 15	3
3428 Roberts	Faure, 20	Apr 4	2
	Hudgens, 41	Feb 29	2
3446 Combes	Faure, 20	Apr 5-27	12(10C)
3506 French	Harvey, 73	Dec 30	3
3578 Carestia	Faure, 20	Sep 27	2
3609 Liloketai	Harvey, 73	Nov 24	3
3633 Mira	Harvey, 73	Feb 7	3
3675 Kemstach	Faure, 20	Feb 9	2
3709 Polypoites	Faure, 20	Sep 9	2
3752 Camillo	Harvey, 73	Feb 7	6
3761 Romanskaya	Hudgens, 41	Jul 3	2
3794 Stenelos	Faure, 20	Sep 27-28	2
3831 Pettengill	Hudgens, 41	Jul 26	2
3861 Lorenz	Faure, 20	Apr 4	2
	Hudgens, 41	Feb 29	2
3919 Maryanning	Harvey, 73	Aug 9	3
3924 Birch	Faure, 20	Feb 3	2
3928 Randa	Faure, 20	Aug 30	2
3970 Herran	Harvey, 73	Oct 28	3
3982 Kastel	Hudgens, 41	Jun 3	2
4000 Hipparchus	Faure, 20	Sep 29	2
4076 Dörffel	Harvey, 73	Jan 1	3
4119 Miles	Harvey, 73	Mar 3	3
4160 Sabrina-John	Harvey, 73	Apr 30	3
4169 Celsius	Faure, 20	Sep 29	2
4264 Karl Josephine	Harvey, 73	Nov 24	6

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2008)	NO. OBS.
4332 Milton	Hudgens, 33	Oct 26	2
4340 Dence	Harvey, 73	Apr 24	3
4375 Kiyomori	Harvey, 73	Mar 2	3
4424 Arkhipova	Hudgens, 41	Feb 8	2
4446 Carolyn	Harvey, 73	Aug 4-5	3
4450 Pan	Bookamer, 41	Feb 10	6
	Faure, 20	Feb 3	2
	Harvey, 73	Feb 3	6
	Hudgens, 41	Feb 10	2
4480 Nikitibotania	Harvey, 73	Oct 27	3
4484 Sif	Harvey, 73	Jan 2	3
4497 Taguchi	Faure, 20	Feb 3	2
4512 Sinuhe	Bookamer, 41	Jan 10	3
	Faure, 20	Jan 26	2
4520 Dovzhenko	Harvey, 73	Oct 4	3
	Hudgens, 33	Oct 26	2
4533 Orth	Hudgens, 41	Mar 5	2
4543 Phoinix	Faure, 20	Oct 4-5	3
4686 Maisaca	Faure, 20	Sep 9	2
4790 Petrpravec	Faure, 20	Apr 25	2C
	Harvey, 73	Feb 28	3
4801 Ohre	Harvey, 73	Feb 28	3
4844 Matsuyama	Harvey, 73	Aug 4-5	3
	Hudgens, 41	Jul 10	2
4859 Fralmpo	Hudgens, 41	Feb 8	2
4937 Lintott	Faure, 20	Aug 23	4
	Harvey, 73	Aug 9	3
4961 Timherder	Harvey, 73	Oct 2-20	6
4981 Sinyavskaya	Harvey, 73	Oct 28	3
5002 Marnix	Harvey, 73	Jun 7	3
5056 Rahua	Harvey, 73	Dec 3	3
5062 Glennmiller	Harvey, 73	Oct 28	3
5093 Svirelia	Harvey, 73	Oct 21	3
5100 Pasachoff	Harvey, 73	Feb 28	3
5138 Gyoda	Harvey, 73	Feb 7	3
5184 Cavaillé-Coll	Harvey, 73	Mar 10	3
5226 Pollack	Harvey, 73	Dec 4	3
5231 Verne	Faure, 20	Feb 9	2
5236 Yoko	Harvey, 73	Nov 24	3
5262 Brucegoldberg	Hudgens, 41	May 3	2
5290 Langevin	Harvey, 73	Aug 9	3
5295 Masayo	Harvey, 73	Mar 2	3
5313 Nunes	Harvey, 73	Jun 7	3
	Hudgens, 41	Jun 1	2
5331 Erimomisaki	Faure, 20	Feb 8	2
5397 Vojislava	Harvey, 73	Oct 2	3
5444 Gautier	Harvey, 73	Mar 2	3
5468 Hamatonbetsu	Hudgens, 41	Apr 7	2
5474 Ginghsen	Harvey, 73	Feb 11	3
5481 Kiuchi	Harvey, 73	Mar 10	3
5518 Mariobotta	Faure, 20	Jun 28	2
	Hudgens, 41	Jun 27	2
5521 Morpurgo	Harvey, 73	Nov 24	3
5526 Kenzo	Harvey, 73	Oct 3	3
5559 1990 MV	Faure, 20	Apr 27	3C
5614 Yakovlev	Harvey, 73	Sep 20	3
5650 Mochihito-o	Faure, 20	Feb 8	2
	Harvey, 73	Jan 1	3
5661 Hildebrand	Hudgens, 41	Jul 27-29	2
5671 Chanal	Faure, 20	Feb 10	2
5713 1982 FF3	Harvey, 73	Jan 14	3
5741 1989 XC	Harvey, 73	Oct 28	3
5749 1991 FV	Hudgens, 41	Jul 3	2
5784 1991 CY	Harvey, 73	Feb 7	3
5806 Archieroy	Hudgens, 41	Feb 8	2
5849 1990 HF1	Hudgens, 41	Jul 26	2
5858 Borovitskia	Harvey, 73	Feb 28	3
5905 Johnson	Faure, 20	Jul 4	3
5917 1991 NG	Faure, 20	Aug 23	2
5921 1992 UL	Faure, 20	Sep 28	2
5931 Zhvanetskij	Harvey, 73	Nov 26	3
5942 Denzilrobert	Harvey, 73	Dec 3	3
5955 Khromchenko	Harvey, 73	Feb 7	3
5976 Kalatajean	Harvey, 73	Mar 3	3
5985 1942 RJ	Faure, 20	Aug 30-Sep 9	4
6000 United Nations	Hudgens, 33	Oct 31-Nov 1	2
6024 Ochanomizu	Harvey, 73	Jan 2	3
6039 Parmenides	Faure, 20	Sep 28	2
6113 Tsap	Harvey, 73	Oct 3	3
6146 Adamkrafft	Hudgens, 41	Jul 27-30	2
6212 1993 MS1	Hudgens, 41	May 30-Jun 1	2
6295 Schmoll	Harvey, 73	Oct 28	3
6296 Cleveland	Harvey, 73	Jan 1	3
6310 Jankonke	Harvey, 73	Jan 14	3
6321 Namuratakao	Harvey, 73	Feb 10	3
6349 Acapulco	Hudgens, 41	Feb 10	2
6368 1983 RM3	Harvey, 73	Feb 7	3
6372 Walker	Hudgens, 41	Jun 1	2
6403 Steverin	Faure, 20	Aug 23	2
6422 Akagi	Hudgens, 41	Jul 27-29	2
6541 Torahiko	Harvey, 73	Oct 27	3
6542 Jacquescousteau	Faure, 20	Nov 27-Dec 7	18(15C)
6560 Pravdo	Harvey, 73	Feb 8	3
6590 Barolo	Harvey, 73	Jan 15	3
6602 Gilclark	Harvey, 73	Oct 27	3
6665 Kagawa	Harvey, 73	Jan 1	3
6670 Wallach	Faure, 20	Jul 5	2
	Hudgens, 41	Jul 10	2
6690 Messick	Hudgens, 41	Aug 3	2
6729 Emiko	Harvey, 73	Dec 30	3
6838 Okuda	Faure, 20	Dec 8	5C
6896 1987 RE1	Harvey, 73	Oct 21	3
6967 1991 VJ3	Harvey, 73	Dec 30	3

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2008)	NO. OBS.
6972 Helvetius	Faure, 20	Feb 10	2
	Harvey, 73	Feb 7	3
7032 Hitchcock	Harvey, 73	Dec 30	3
7043 Godart	Faure, 20	Aug 30-31	6
	Harvey, 73	Sep 19	3
7175 1988 TN	Faure, 20	Aug 23	2
7182 Robinvaughan	Harvey, 73	Nov 1	3
7225 Huntress	Hudgens, 32	Jan 6	2
7267 1943 DF	Faure, 20	Mar 14-30	4
	Harvey, 73	Feb 7	3
	Hudgens, 41	Mar 5	2
7462 Grenoble	Faure, 20	Dec 8	9C
7514 1986 ED	Harvey, 73	Apr 30	3
7516 Kranjc	Harvey, 73	Jun 7	3
7572 Znokai	Faure, 20	Sep 29	2
7574 1989 WO1	Harvey, 73	Nov 1	3
7593 1992 WP4	Harvey, 73	Oct 4	3
7663 1994 RX1	Faure, 20	Mar 14	2
	Harvey, 73	Mar 13	3
7748 1987 TA	Harvey, 73	Sep 20	3
7759 1990 QD2	Hudgens, 41	Aug 3	2
7778 Markrobinson	Faure, 20	Jun 28	2
	Harvey, 73	Jun 7	3
	Hudgens, 41	Jun 3	2
7811 Zhaojiuzhang	Harvey, 73	Jan 15	3
7824 Lynch	Hudgens, 33	Oct 20-21	2
7851 Azumino	Hudgens, 41	Jul 10	2
7875 1991 ES1	Harvey, 73	Feb 8	3
7965 Katsuhiko	Hudgens, 41	Jul 27-29	2
8059 Deliyannis	Faure, 20	Apr 5-26	11(9C)
	Harvey, 73	Mar 10	3
8141 Nikolaev	Harvey, 73	Nov 1	3
8195 1993 UC1	Harvey, 73	Aug 5	3
	Hudgens, 41	Aug 3	2
8270 Winslow	Harvey, 73	Mar 10	3
8296 Miyama	Harvey, 73	Feb 28	3
8320 Van Zee	Harvey, 73	Oct 4	3
8356 Wadhwa	Harvey, 73	Oct 3	3
8374 Horohata	Harvey, 73	Dec 4	3
8567 1996 HW1	Bookamer, 41	Sep 6	3
	Faure, 20	Jun 29	3
	Garrett, 32	Aug 27	2
	Harvey, 73	Aug 9	3
	Hudgens, 33	Oct 31-Nov 1	2
	Watson, 20	Sep 7	5
8694 1993 CO	Harvey, 73	Feb 11	3
8994 Kashkashian	Harvey, 73	Nov 1	3
9000 Hal	Harvey, 73	Aug 9	3
9117 Aude	Faure, 20	Feb 9	2
	Hudgens, 41	Jan 30	2
9219 1995 WO8	Faure, 20	Feb 9-10	2
9292 1982 UE2	Harvey, 73	Oct 21	3
9356 Elineke	Faure, 20	Dec 8	2C
9671 Hemera	Harvey, 73	Feb 7	3
9873 1992 GH	Harvey, 73	Oct 20	3
10987 1967 US	Harvey, 73	Dec 8	3

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2008)	NO. OBS.
11398 1998 YP11	Faure, 20	Mar 14	5
	Harvey, 73	Feb 15	6
	Hudgens, 41	Mar 5	2
11978 Makotomasako	Harvey, 73	Nov 2	3
12738 Satoshimiki	Harvey, 73	Jan 1	3
13166 1995 WU1	Harvey, 73	Mar 13	3
13405 Dorisbillings	Harvey, 73	Mar 2	3
13919 1984 SO4	Harvey, 73	Oct 4	3
14495 1995 AK1	Harvey, 73	Jan 15	3
15012 1998 QS92	Hudgens, 41	Aug 3	2
16272 2000 JS55	Harvey, 73	Nov 26	3
16960 1998 QS52	Faure, 20	Sep 27	6
	Harvey, 73	Sep 30	6
	Hudgens, 33	Oct 25	2
17770 Baume	Harvey, 73	Oct 4	3
18070 2000 AC205	Hudgens, 33	Oct 20-21	2
18078 2000 FL31	Harvey, 73	Jan 1	3
18108 2000 NT5	Harvey, 73	Aug 9	3
19774 2000 OS51	Hudgens, 41	Jul 3	2
19982 Barbaradoore	Harvey, 73	Jan 15	5
20014 1991 RM29	Harvey, 73	Dec 3	3
20439 1999 JM28	Harvey, 73	Nov 12	3
21766 1999 RW208	Harvey, 73	Oct 20	3
22262 1980 PZ2	Harvey, 73	Feb 10	3
22275 1982 BU	Harvey, 73	Jan 15	3
22449 1996 VC	Harvey, 73	Feb 10	3
22464 1997 AG14	Harvey, 73	Dec 22	6
22870 Rosing	Harvey, 73	Oct 20	3
24114 1999 VV23	Harvey, 73	Feb 7	3
24611 1978 SH3	Harvey, 73	Oct 28	3
26382 1999 LT32	Harvey, 73	Dec 8	3
26514 2000 CH48	Harvey, 73	Jan 2	3
27135 1998 XB12	Harvey, 73	Oct 27	3
27259 1999 XS136	Harvey, 73	Jan 15	3
29566 1998 FK5	Harvey, 73	Oct 3	3
30767 Chriskraft	Harvey, 73	Nov 2	3
31828 1999 VU199	Harvey, 73	Jun 7	3
32479 2000 SL312	Harvey, 73	Aug 9	3
32497 2000 XF18	Harvey, 73	Aug 9	3
35107 1991 VH	Harvey, 73	Jul 2	6
37384 2001 WU1	Faure, 20	Apr 5	3
43084 1999 WQ1	Harvey, 73	Dec 30	3
43100 1999 XV15	Harvey, 73	Nov 1-2	3
49548 1999 CP83	Harvey, 73	Mar 13	3
70453 1999 TS19	Harvey, 73	Jan 1	3
72396 2001 CU20	Hudgens, 32	Jan 6	2
134340 Pluto	Harvey, 73	Jul 2	3
137032 1998 UO1	Faure, 20	Oct 4	5
153591 2001 SN263	Bookamer, 41	Jan 29	3
	Faure, 20	Jan 26	3
	Garrett, 32	Feb 29	2
	Hudgens, 41	Feb 10	2

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2008)	NO. OBS.
162361 2000 AF6	Harvey, 73	Dec 23	6
162900 2001 HG31	Harvey, 73	Oct 21	3
164400 2005 GN59	Faure, 20	Aug 30	2
	Harvey, 73	Sep 18	6
170891 2004 TY16	Faure, 20	Feb 8-9	6
	Harvey, 73	Feb 3	6
179806 2002 TD66	Harvey, 73	Feb 28	6
187026 2005 EK70	Harvey, 73	Feb 21	6
199003 2005 WJ56	Bookamer, 41	Jan 8	8
	Harvey, 73	Jan 12	6
	Hudgens, 32, 30, 25	Jan 6-12	7
2005 WY3	Harvey, 73	Mar 10	3
2006 DU62	Harvey, 73	Feb 15	6
2006 SZ217	Harvey, 73	Nov 24	6

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2008)	NO. OBS.
2006 VB14	Harvey, 73	Dec 8	6
2007 TU24	Bookamer, 41	Jan 29-30	8
	Faure, 20	Feb 3	5
	Harvey, 73	Feb 3	6
	Hudgens, 41	Jan 30	3
2008 CL1	Harvey, 73	Mar 2	6
	Hudgens, 41	Mar 5	3
2008 CN1	Harvey, 73	Feb 15	6
2008 EV5	Harvey, 73	Dec 22	6
2008 ED8	Harvey, 73	Mar 10	6
2008 QS11	Harvey, 73	Oct 1	6
2008 TT26	Harvey, 73	Oct 21	6
2008 UE7	Faure, 20	Dec 8	4C
	Harvey, 73	Dec 4	6

LIGHTCURVE ANALYSIS OF 1125 CHINA

Kenneth T. Menzies
Tigh Speuran Observatory
Framingham, MA, USA
kenmenstar@gmail.com

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Asteroid 1125 China was observed photometrically from Tigh Speuran Observatory in 2009 February. The synodic period of the lightcurve was found to be 5.367 ± 0.002 h and the amplitude 0.38 ± 0.02 mag. Also found were the absolute magnitude, *H* = 11.26 ± 0.19, and phase slope parameter, *G* = 0.018 ± 0.25.

The asteroid 1125 China was selected for study on the basis of no record of previous lightcurves according to Harris and Warner (2009). Observations were collected over four evenings during 2009 February 14-18 resulting in six data sets and 498 data points. An additional set of data was collected on 2009 March 4 to expand the phase angle for calculation of H and G parameters (absolute magnitude and phase slope parameter, respectively). Images were taken using an f/4 0.2-m Schmidt-Newtonian and SBIG ST7 XME CCD camera operating at -30º C. Exposures were 120 seconds using a Schuler Clear filter. Target S/N ratios ranged from 37-55. Images were calibrated in *CCDSoft V5* using bias, dark and flat frames. Phased lightcurves and periods were generated using the Fourier Transform tool in *MPO Canopus V9.5.0.8*. H-G parameters were calculated using the tool provided in *Canopus*.

Two *Canopus* sessions were created to include images collected on either side of the meridian during a given night. An astrometric auto-match was conducted, which identified the asteroid target and many comparison stars from the *UCAC2* catalog. The target magnitude was calculated on the basis of *2MASS* catalog stars that yielded acceptable photometric residual errors (< ± 0.2). This magnitude is not directly comparable to a standard system but is relatively accurate as a result of comparison to multiple known stars of various color indices. The *Canopus* lightcurve wizard was used to generate a lightcurve for all images in each of six sessions. Since each session may have a slightly different zero point due to the use of different comparison stars, the curves were adjusted to yield similar differential magnitudes, with a comp adjust, for identical portions (i.e., maximum light) of the lightcurve. After each session lightcurve was aligned, the *Canopus* period analysis tool, using the Fourier algorithm (FALC), (Harris *et al*. 1989), was used. This procedure was run iteratively to reduce the range of assumed periods through reduction of the period interval size, and increase of the number of period steps. The phased period plot facilitated the refinement of the period analysis. The synodic period was determined to be 5.367 ± 0.002 h. The amplitude was found to be 0.38 ± 0.02 mag.

The H-G system of absolute magnitude (*H*) and phase slope (*G*) parameters (Bowell et al. 1989) were also tabulated using the *Canopus* H-G calculator. The *H* value is the standard Johnson V magnitude of the asteroid when moved to a hypothetical unity distance from both the Sun and Earth and viewed at 0º phase angle. The standard V magnitude for a similar lightcurve point (i.e., maximum) from each session was calculated by using the Quick Binzel tool in *MPO PhotoRed*. Three selected images from each session were used for this calculation. The target and three standard *2MASS* V comparison stars were identified. By using known color transforms previously determined for the system's clear filter and an assumed V-R color index of 0.45 for asteroids, a standard V magnitude for 1125 China was determined for each session. The eight standard V magnitudes were entered into the H/G tool in *Canopus*. The tool calculates asteroid distances to the Sun (R) and Earth (r) as well as phase angle on the basis of MPCORB elements. The standard V magnitudes are transformed to reduced unity magnitudes on the basis of $V_r = V_s - 5.0 \log (Rr)$. The value of *H* was determined using the FAZ algorithm (Bowell et al., 1989) implemented in the *Canopus* H-G tool. The absolute magnitude *H* was determined to be 11.26 ± 0.19, which is statistically identical to the value of 11.2 reported by the Minor Planet Center.

The phase slope parameter (*G*) was also calculated using the reduced magnitude and phase angle data. The *G* value models the asteroid's brightness with decreasing phase angle, including the "opposition effect" which is a non-geometric brightening near opposition. Initially, an assumed value of *G* (0.15) is used to calculate *H*. If data are available from both small phase angles (<7º) as well as larger phase angles, an actual value of *G* can be calculated. The measured value of *G* was determined to be 0.018 ± 0.25. The error is clearly large compared to the actual value, and is indicative of the use of a clear filter and the difficulty of selecting identical lightcurve points and appropriate comparison stars for conversion to standard magnitudes. It is also indicative of the need to collect sufficient data points for small phase angles (<7º).

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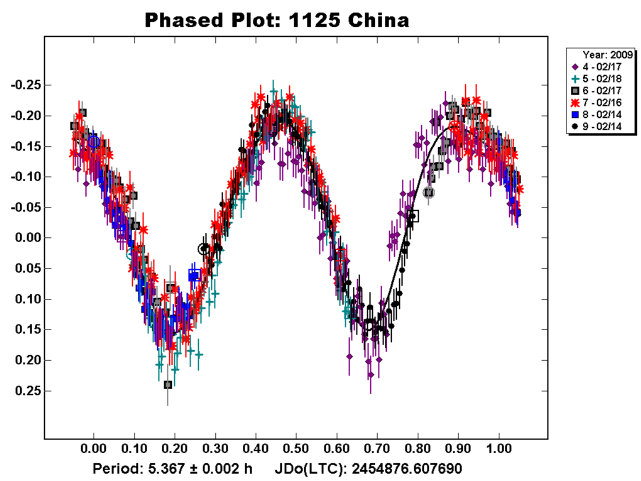

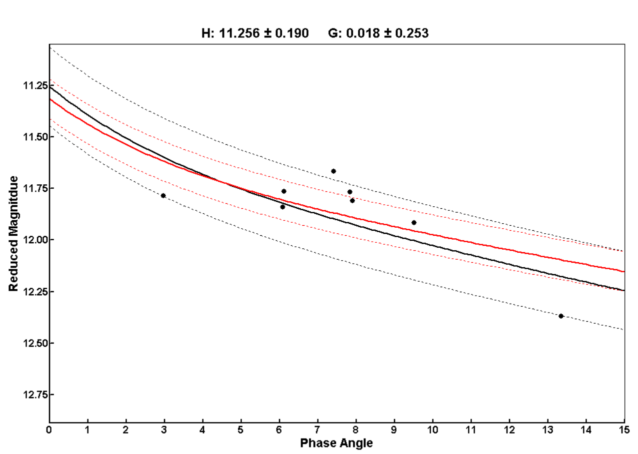

Reduced V magnitudes for 1125 China are plotted against phase angle to determine its absolute magnitude (*H*) and phase slope parameter. The red lines represent the solution and error envelope for *G* = 0.15. The black lines represent the free-floating solution of *G* = 0.018 and its error envelope.

LIGHTCURVES OF ASTEROIDS 358 APOLLONIA, 734 BENDA, AND 8356 WADHWA

Robert K. Buchheim
Altimira Observatory
18 Altimira, Coto de Caza, CA 92679 USA
rbuchheim@earthlink.net

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The rotation periods and lightcurve amplitudes for three asteroids have been determined by CCD differential photometry: 358 Apollonia, *P* = 50.6 ± 0.1 h, *A* = 0.15 mag; 734 Benda, *P* = 7.106 ± 0.005 h, *A* = 0.3 mag; and 8356 Wadhwa, *P* = 3.04 ± 0.01 h, *A* = 0.1 mag.

This article reports on asteroid photometry studies conducted at Altimira Observatory during 2007 and 2008. Altimira Observatory is located in southern California. It is equipped with a 0.28-m Schmidt-Cassegrain telescope (Celestron NexStar-11) operating at F/6.3) and CCD imager (ST-8XE NABG) with Johnson-Cousins filters. Details of the equipment and instrument characterization are available at the observatory's website (http://www.geocities .com/oca_bob). CCD images were reduced in the standard way with bias, dark, and flat frames using *CCDSoft*. Asteroid brightness variations were determined by differential photometry, with an ensemble of 2 to 5 comparison stars in the same CCD field of view as the target asteroid, using the lightcurve analysis routines of *MPO Canopus*.

358 Apollonia. Wetterer et al. (1999) observed this object for one night. After finding a negligible change in brightness during a 7-hour observing run, they suggested that this asteroid has a long rotation period. This asteroid turned out to be a difficult target because its slow rotation is nearly synchronous with our diurnal cycle and its lightcurve amplitude is low. A total of 14 nights spanning 2 months (2008 Sept. and Oct.) were devoted to creating its lightcurve in V- and R-bands. The R-band lightcurve is shown in Figure 1. It displays a typical two-peak curve, with period *P* = 50.6 ± 0.1 h and amplitude *A* = 0.15 mag. This is the first known report of a reliable rotation period and complete lightcurve for this asteroid. The V-band lightcurve (not shown) had the same period and shape as the R-band curve. There was no evidence of color variation as the asteroid rotates.

The determination of this lightcurve was greatly aided by a feature of *MPO Canopus*: the "comp star selector" that identifies candidate comp stars whose color indices are roughly comparable to typical asteroid colors, and provides their magnitudes on the standard system (B, V, R) to good accuracy (roughly ± 0.05 mag). This greatly simplifies the challenge of linking multiple nights (using different comp stars) to create an integrated lightcurve.

734 Benda. A total of 10 nights were devoted to this object, in order to take advantage of its near-zero phase angle in 2007 October to determine its phase curve. Most of these nights were adversely affected by unstable extinction conditions, so the following procedure was used. Each night, the imaging sequence was VV-RR-VV... Then, on a photometric night in 2007 December, each field of view from the "lightcurve" nights was imaged in the V and R bands (near culmination, typical air mass ≈ 1.1), and Landolt standard fields were taken at several air masses to determine the atmospheric extinction. This night provided a calibration of the comp stars in each field, which in

turn enabled determination of the asteroid's magnitude and color by reference to these now-calibrated comp stars.

The resulting lightcurve, shown in Figure 2, displays a rotation period of P = 7.106 ± 0.005 h and A = 0.3 mag. This is consistent with the period P = 7.11 h reported by Behrend (2008). The asteroid's color is (V-R) = 0.43 ± 0.03, and there is no evidence of color change with rotational phase. Benda's phase curve is shown in Figure 3. The best fit parameters are H = 9.9 ± 0.05, G = 0.10 ± 0.05. However, this value of the slope parameter is indistinguishable from the "default" value of G = 0.15, as illustrated in the figure. This is slightly fainter than the value H = 9.7, G = 0.15 reported by Tholen (2007).

8356 Wadhwa. This asteroid was observed on four consecutive nights in 2008 October. Unfiltered ("C" band) images were used for differential photometry of this faint object in order to get a signal-to-noise ratio of at least 100:1 in each image. The result, shown in Figure 4, is a low-amplitude double-peaked lightcurve displaying a rotation period of P = 3.04 ± 0.01 h and A = 0.1 mag.

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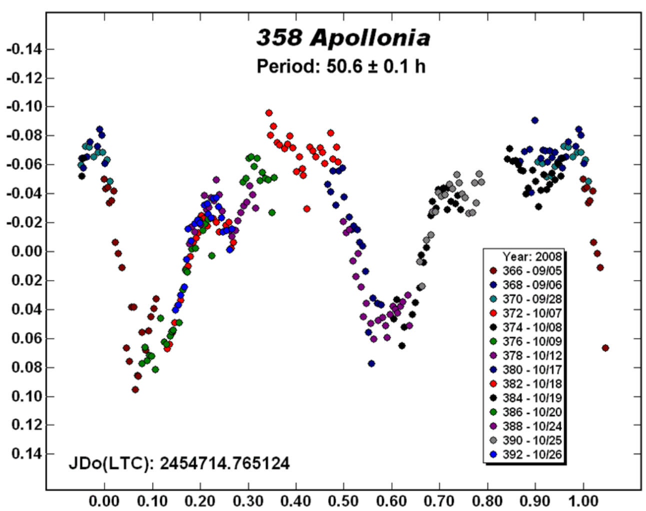

Figure 1: Lightcurve of 358 Apollonia, phased to P = 50.6 hours

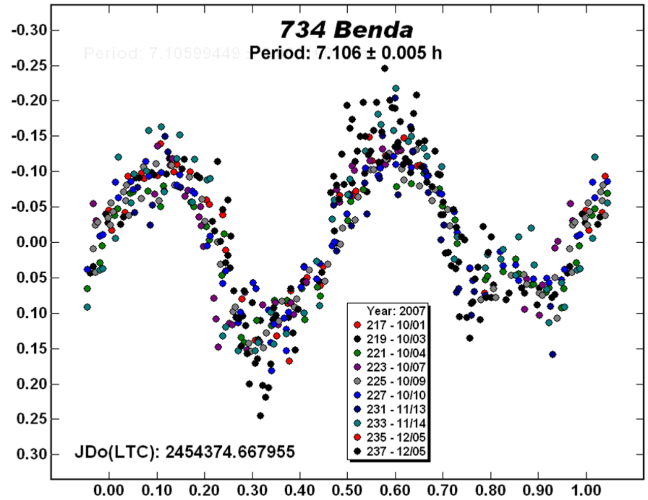

Figure 2: Lightcurve of 734 Benda, phased to P = 7.106 h.

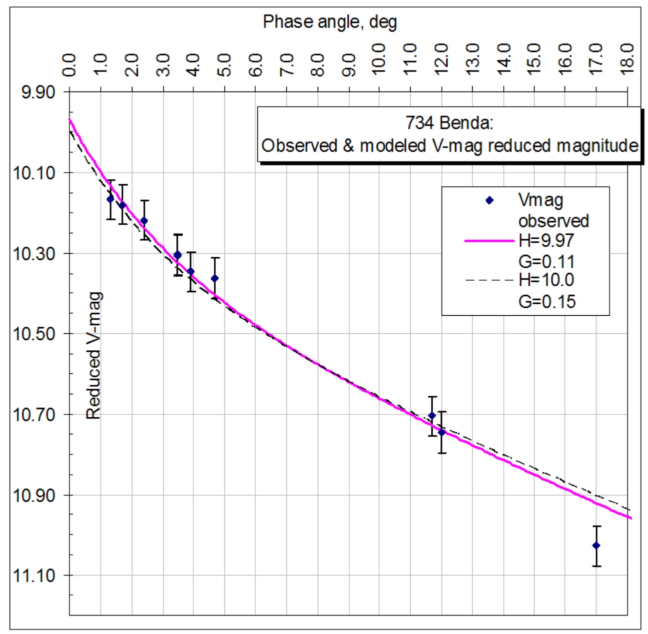

Figure 3: Phase curve of 734 Benda; 2007 October apparition.

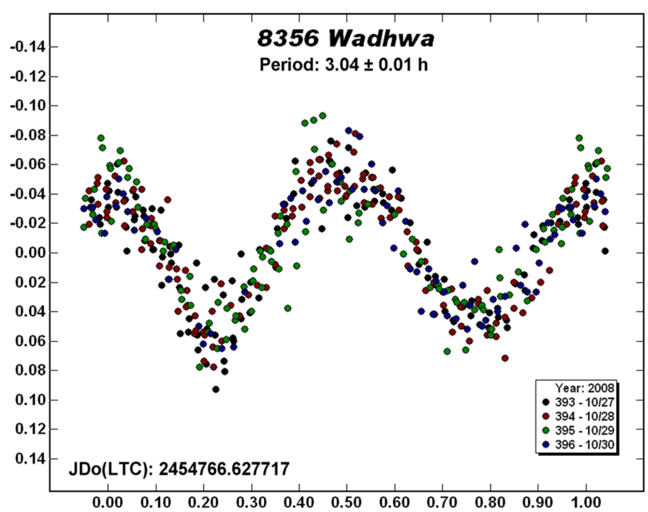

Figure 4: Lightcurve of 8356 Wadhwa, phased to P = 3.04 h.

CCD LIGHTCURVE ANALYSIS OF 40 HARMONIA

Kevin B. Alton
UnderOak Observatory
70 Summit Ave
Cedar Knolls, NJ 07927

(Received: 2009 Mar 15)

Filtered (Ic) CCD images for 40 Harmonia were obtained over six sessions from 2009 February to March. A folded lightcurve was produced and the synodic period estimated by Fourier analysis to be 8.9091 h.

First discovered in 1856, 40 Harmonia (107.2 km) is an S-type main belt asteroid. More recent investigations on this minor planet include those by Lagerkvist et al. (1986), McCheyne et al. (1985), Gallardo and Tancredi (1987), Mellilo (1995), and López-González and Rodríguez (1999) and Tedesco et al. (2004).

For this study, the equipment included a focal reduced (f/6.3) 0.2-m Schmidt-Cassegrain telescope with a thermoelectrically cooled (5°C) SBIG ST 402ME CCD camera mounted at the Cassegrain focus. Filtered (Ic) imaging was conducted on six nights with exposures automatically taken every 45 seconds. Image acquisition (raw lights, darks and flats) was performed by *CCDSoft 5* (SBIG) while calibration and registration were accomplished with *AIP4WIN* (Berry and Burnell, 2006). Further data reduction with *MPO Canopus* (Warner, 2008) used at least four non-varying comparison stars to generate lightcurves by differential aperture photometry. Data were light-time corrected but not reduced to standard magnitudes.

A total of 1407 photometric values were generated over 25 days. Relevant aspect parameters for 40 Harmonia taken at the mid-point from each session are tabulated below. *MPO Canopus* provided a period solution for the folded data sets using Fourier analysis (Harris, 1989). The calculated synodic period, P = 8.9091 ± 0.0005 h, is in good agreement with the most recent value for 40 Harmonia published by López-González and Rodríguez (1999) as well as that found at the JPL Solar System Dynamics website. The peak amplitude was estimated at 0.33 ± 0.02 mag. Phased data are available by request at http://underoakobservatory.com.

Acknowledgement

Special thanks are due to the NASA Astrophysics Data System hosted by the Computation Facility at the Harvard-Smithsonian Center for Astrophysics.

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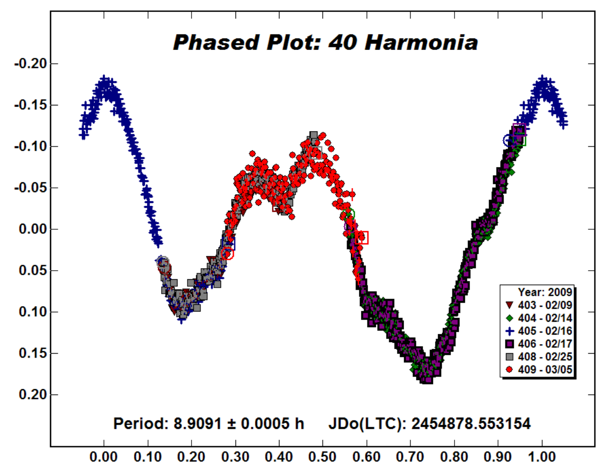

UT Date (2009)	No. Obs.	Phase Angle	L_{PAB}	B_{PAB}
Feb 9	175	14.1	112.8	2.4
Feb 14	270	16.1	113.2	2.5
Feb 16	249	16.8	113.3	2.5
Feb 17	266	17.1	113.4	2.6
Feb 25	239	19.7	114.4	2.7
Mar 06	208	21.9	115.7	2.8

Observational circumstances for 40 Harmonia.

LIGHTCURVES OF 494 VIRTUS, 556 PHYLLIS, 624 HEKTOR, 657 GUNLOD, 1111 REINMUTHIA, 1188 GOTHLANDIA, AND 1376 MICHELLE

Hiromi Hamanowa, Hiroko Hamanowa
Hamanowa Astronomical Observatory
4-34 Hikarigaoka Nukazawa Motomiya Fukushima Japan
hamaten@poplar.ocn.ne.jp

(Received: 2009 Mar 19)

Lightcurves for seven asteroids were obtained at the Hamanowa Astronomical Observatory from 2008 March to 2009 February. Synodic rotation periods and amplitudes have been found for 494 Virtus 5.570 ± 0.003 h, 0.033 ± 0.005 mag; 556 Phyllis 4.2909 ± 0.0003 h, 0.222 ± 0.005 mag; 624 Hektor 6.9210 ± 0.0001 h, 0.590 ± 0.005 mag; 657 Gunlod 15.6652 ± 0.0001 h, 0.193 ± 0.003 mag; 1111 Reinmuthia 4.0075 ± 0.0001 h, 0.945 ± 0.003 mag; 1188 Gothlandia 3.4915 ± 0.0001 h, 0.776 ± 0.005 mag; 1376 Michelle 5.9748 ± 0.0002 h, 0.199 ± 0.003 mag.

The observations reported here were made with the 40-cm telescope of the Hamanowa Astronomical Observatory (MPC D91). The CCD imager was a SBIG ST-8E featuring a 1530x1020 array of 9-micron pixels. All observations were made with R-band filter (UBVRI) at 2x binning yielding an image scale of 2.0 arc seconds per pixel. All images were dark and flat-field corrected. Images were measured using *Stella Image* v5 (Astro Arts) and *IRAF*. The data were light-time corrected. The period analysis was done with *Cycrocode*, which was developed by B. Dermawan (2003). The results are summarized in the table below and include average phase angle information across the observational period. Individual lightcurve plots along with additional comments, as required, are also presented.

494 Virtus. Our period is consistent with those in the asteroid lightcurve database (LCDB, Harris et al., 2007), which listed reported periods of 5.57 h and 5.570 h, but our amplitude, A = 0.033 mag., is smaller than the A = 0.12 mag reported previously, most likely indicating a different viewing aspect.

556 Phyllis. Data were collected from 2008 October 13 through November 14 resulting in 4 data sets. A period of 4.2909 ± 0.0003 h was determined. This result is nearly consistent with those in the LCDB.

624 Hektor. Lightcurve observations of the Trojan asteroid 624 Hektor were obtained from 2008 December 29 through 2009 January 28 resulting in 11 data sets. A period of 6.9210 ± 0.0001 h with two un-symmetrical peaks and amplitude of 0.590 ± 0.005 mag were determined. These agree with previous results.

657 Gunlod. Data were collected from 2008 December 1 through 2009 January 1 resulting in 9 data sets. A period of 15.6652 ± 0.0001 h was determined. This result is consistent with Pilcher (1980).

1111 Reinmuthia. A period of 4.0075 ± 0.0001 h was derived from 6 nights of photometric observations. The only previous lightcurve of Reinmuthia was reported to have a period of 4.02 h (Binzel, 1987). Our observations from 2009 January through February 14 found a period of 4.0074 ± 0.0001 h.

1188 Gothlandia. Data were collected from 2008 December 10 through 2009 January 7 resulting in 7 data sets. A period of 3.4915 ± 0.0001 h was determined. The only previous lightcurve of Gothlandia was reported to have a period of 3.493 h (Di Martino et al., 1994).

1376 Michelle. Data were collected from 2008 December 1 through October 21 resulting in 5 data sets. A period of 5.9748 ± 0.0002 h was determined. The only previous lightcurve of Michelle was reported to have a period of 6.0 h (Wisniewski et al., 1997).

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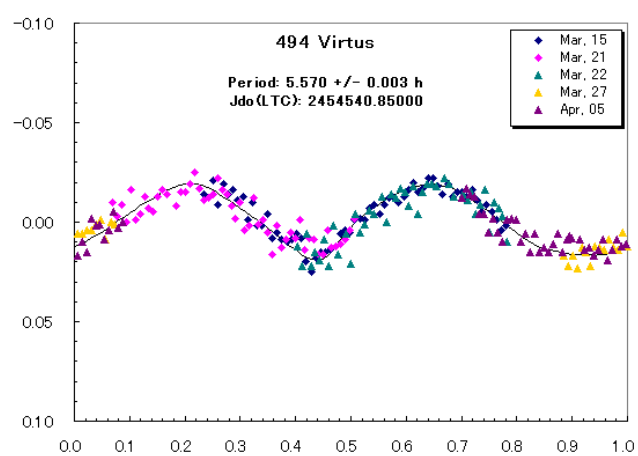

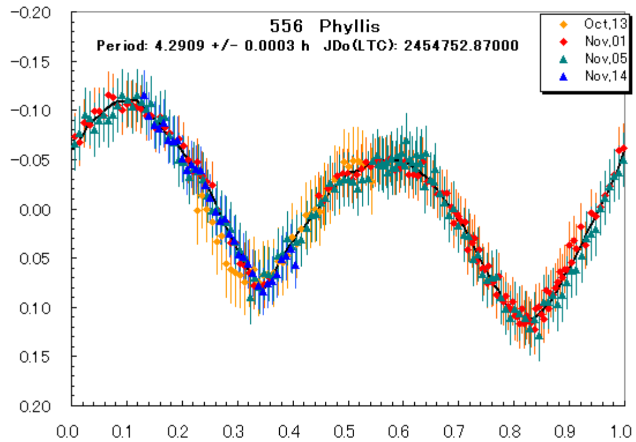

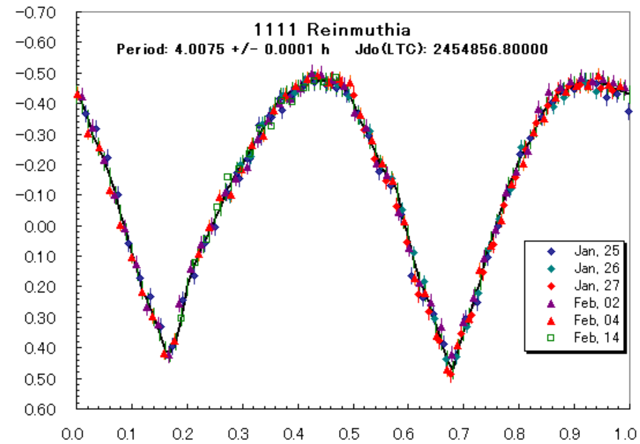

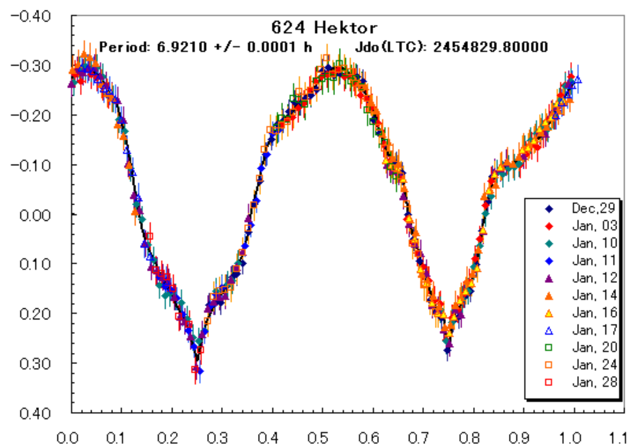

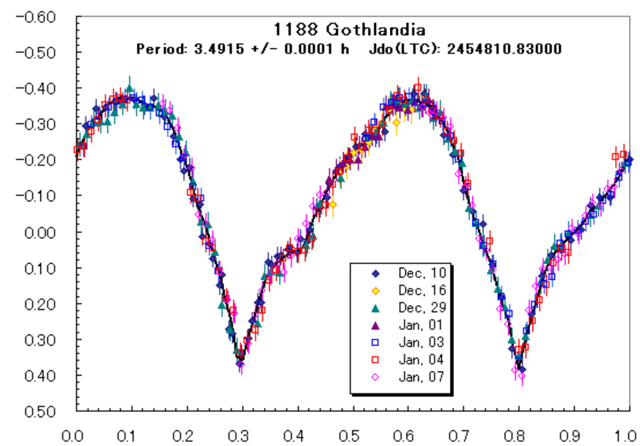

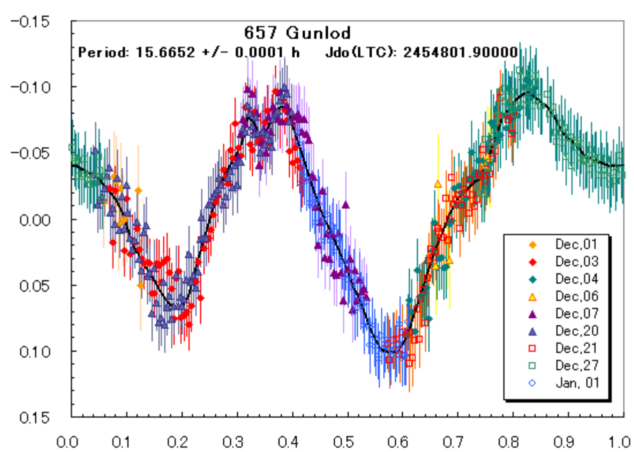

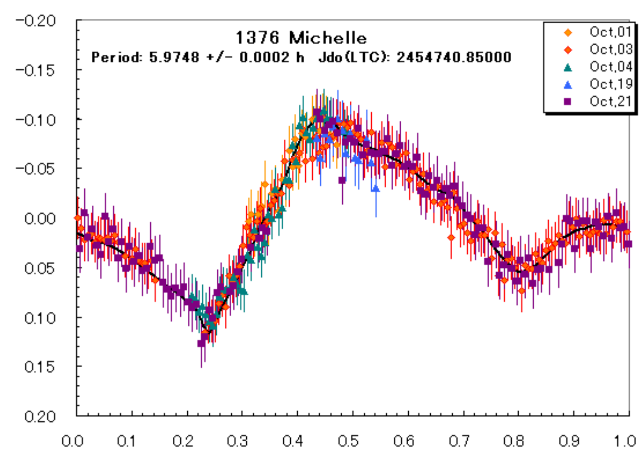

#	Name	Date Range (yyyy/mm/dd)	Phase	L-PAB	B-PAB	Per (h)	PE	Amp (mag)	AE
494	Virtus	2008/03/15-2008/04/05	5.9	166.7	7.1	5.570	0.003	0.033	0.005
556	Phyllis	2008/10/13-2008/11/14	7.6	31.3	6.3	4.2909	0.0003	0.222	0.005
624	Hektor	2008/12/29-2009/01/28	15.4	20.2	12.5	6.9210	0.0001	0.590	0.005
657	Gunlod	2008/12/01-2009/01/01	6.2	87.7	6.9	15.6652	0.0001	0.193	0.003
1111	Reinmuthia	2009/01/25-2009/02/14	9.0	107.8	-1.6	4.0075	0.0001	0.945	0.003
1188	Gothlandia	2008/12/10-2009/01/07	14.2	74.7	6.6	3.4915	0.0001	0.776	0.005
1376	Michelle	2008/10/01-2008/10/21	8.8	5.3	-2.4	5.9748	0.0002	0.199	0.003

5905 JOHNSON: A HUNGARIA BINARY

Brian D. Warner
Palmer Divide Observatory/Space Science Institute
17995 Bakers Farm Rd., Colorado Springs, CO USA 80908
brian@MinorPlanetObserver.com

Alan. W. Harris
Space Science Institute, La Canada, CA USA

Petr Pravec
Astronomical Institute, Academy of Sciences
Ondřejov, CZECH REPUBLIC

Walter R. Cooney, Jr., John Gross, Dirk Terrell
Sonoita Research Observatory, Sonoita, AZ USA

Julian Oey
Leura Observatory, Leura, NSW, AUSTRALIA

Jozef Vilagi, Stefan Gajdos
Modra Observatory
Dept. of Astronomy, Physics of the Earth and Meteorology
Bratislava, SLOVAKIA

James W. Brinsfield
Via Capote Observatory, Thousand Oaks, CA USA

Joseph Pollock
Physics and Astronomy Dept., Appalachian State Univ.
Boone, NC USA

Daneil Reichart, Kevin Ivarsen, Josh Haislip, Aaron LaCluyze, Melissa Nysewander
PROMPT, UNC-Chapel Hill, NC USA

Franck Marchis, Minjin Baek
SETI Institute & Univ. of California at Berkeley, CA USA

(Received: 2009 Apr 7)

The Hungaria asteroid, 5905 Johnson, was previously confirmed to be a binary system. Follow up observations were obtained by the authors during a 2008 campaign in order to further define the system. The data from this second campaign found the rotation of the primary P_1 = 3.7826 ± 0.0002 h. The orbital period was P_{orb} = 21.78 ± 0.01 h.

Lightcurve observations in 2005 obtained by several observers and analyzed by Pravec (Warner et al., 2005a) determined that the Hungaria asteroid, 5905 Johnson, was binary with P_1 = 3.7824 ± 0.0002 h, P_{orb} = 21.7850 ± 0.0005 h, A_1 = 0.11 ± 0.01 mag, and Ds/Dp = 0.40 ± 0.04 (Warner et al., 2005b). Additional analysis of the 2005 data found Ds/Dp = 0.38 ± 0.02. A similar observing campaign was staged by the authors in 2008 to verify and refine the original findings.

Observations were obtained from 2008 May through June. During the six-week observing run, the viewing aspect was essentially constant. Several mutual events (occultations or eclipses) were recorded, which affirmed the binary status. As before, analysis of the data was conducted by Pravec. In brief, the analysis involves the dissection of the data into at least two linear, additive Fourier curves due to the rotation of the bodies in the system. Eclipses and occultations ("mutual events") are seen as attenuations superimposed on the combined curves (see Pravec et al., 2006).

His results for the 2008 campaign are posted in the Table 1. In 2008, some deviations from the P_1/P_{orb} model indicated the possibility of a third period, which – if real – could be interpreted as the rotation of the satellite or, less likely, the rotation of a third body in the system. However, a careful examination of the data showed no consistent signal and the deviations may just be noise. A second look of the 2005 data shows no signs of a third period.

Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grant NNG06GI32G, National Science Foundation grant AST-0607505, and by a Gene Shoemaker NEO Grant from the Planetary Society. The work at Ondřejov was supported by the Grant Agency of the Czech Republic, Grant 205/05/0604.

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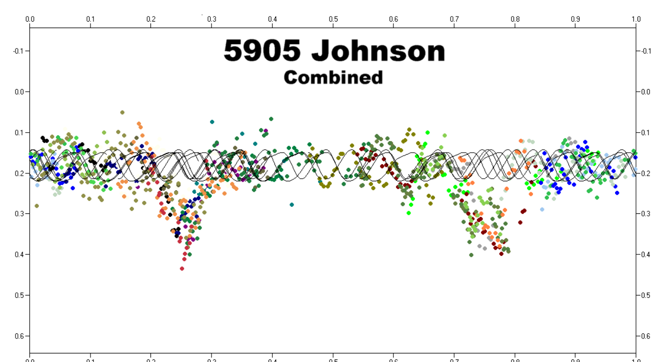
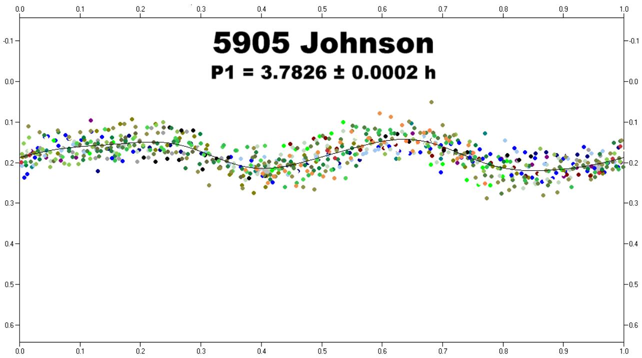
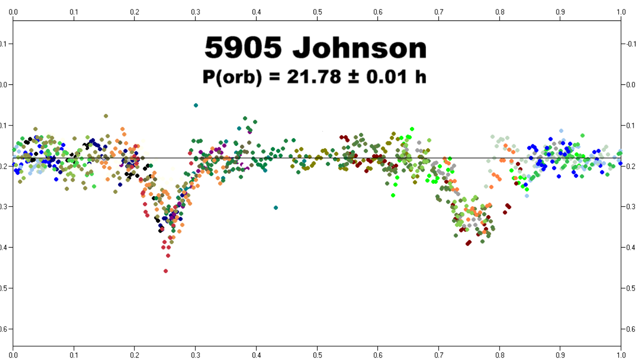
5905 Johnson (2008 Results)		
P1	3.7826	± 0.0002 h
P(orb)	21.78	± 0.01 h
A1	0.08	± 0.01 mag
A(events)	0.15	- 0.22 mag
Ds/Dp	0.38	± 0.02
H	14.0	± 0.2 (Warner 2005a)

Table 1. Summary of results for 5905 Johnson (2008).







LIGHTCURVE ANALYSIS OF HUNGARIA ASTEROID 4440 TCHANTCHES

Brian D. Warner
Palmer Divide Observatory / Space Science Institute
17995 Bakers Farm Rd., Colorado Springs, CO 80908 USA
brian@MinorPlanetObserver.com

David Higgins
Hunters Hill Observatory, Ngunnawal, Canberra 2913
AUSTRALIA

(Received: 2009 Feb 25)

We report on lightcurve observations made on the Hungaria asteroid, 4440 Tchantches, in 2009 January. We found parameters of $P = 2.7883 \pm 0.0002$ h and $A = 0.21 \pm 0.02$ mag. Previous observations in 2005 indicated the possibility that the asteroid might be binary. We found no evidence of such during this apparition.

The Hungaria asteroid, 4440 Tchantches, has been previously observed by Warner (2003), who found a period of 6.83 h. This was clearly incorrect, as shown by Behrend (2009) and Warner et al. (2005), the latter of which found a period of 2.7883 h. During that apparition around 2005 October, some observations indicated the possibility of mutual events – eclipses or occultations – that would be evidence of the asteroid being binary. However, the data were inconclusive and the authors suggested follow up observations.

Those follow up observations were obtained by the authors in 2009 January. Data were obtained at the Palmer Divide Observatory using 0.35-m Schmidt-Cassegrain (SCT) with SBIG STL-1001E CCD camera. The 240-s exposures were with a clear filter and guided. Flats and darks were created and merged with the raw data frames in *MPO Canopus*. The same software was used to measure the images employing differential photometry with up to five comparison stars. At Hunters Hill Observatory, Higgins used a 0.35-m SCT with SBIG ST-8E for 120-s guided exposures with a clear filter. Flats, Darks and Bias frames were created and merged in *MPO Canopus*. Period analysis on the combined data set was also done in *MPO Canopus* using the FALC Fourier analysis algorithm developed by Harris (Harris et al. 1989).

We found a synodic period of $P = 2.7883 \pm 0.0002$ h and a lightcurve amplitude of $A = 0.21 \pm 0.02$ mag. While there were a couple of sessions that showed small deviations, there was nothing reasonably suggestive of the asteroid being binary. It should be noted that at the time of the 2009 observations, the phase angle bisector longitude was ~ 117°. In 2005, the longitude was ~ 42°, or almost at right angles to one another. Assuming that the plane of the orbit of any satellite would be nearly perpendicular to the spin axis of the primary, then if the spin axis is tilted sufficiently towards the line of sight, it is *possible* that the different viewing aspects would allow for mutual events at one apparition and not the other. However, based on the evidence in hand, we conclude that the asteroid is very likely *not* a binary. If nothing else, observations at upcoming apparitions can provide additional data for spin axis modeling as well as to remove any remaining doubts.

Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grants NNG06GI32G and NNX09AB48G, by National Science Foundation grant AST-0607505, and by a Gene Shoemaker NEO Grant from the Planetary Society. Funding for observations at Hunters Hill is provided in part by a Gene Shoemaker NEO Grant from the Planetary Society.

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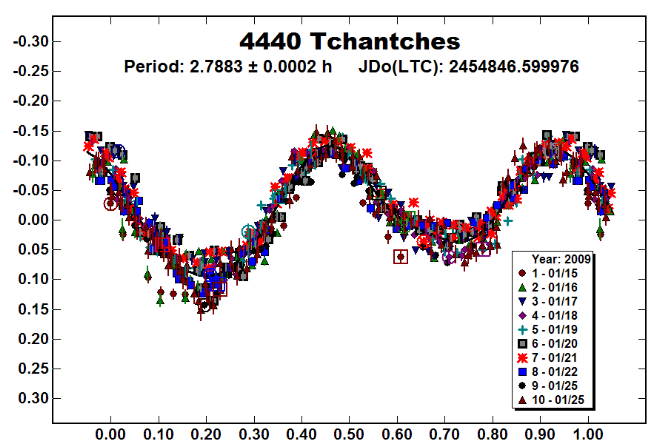

ASTEROID LIGHTCURVE ANALYSIS AT THE OAKLEY SOUTHERN SKY OBSERVATORY AND OAKLEY OBSERVATORY: 2008 SEPTEMBER AND OCTOBER

Landry Carbo, Katherine Kragh, Jonathan Krotz,
Andrew Meiers, Nelson Shaffer, Steven Torno, Jason Sauppe,
Richard Ditteon
Rose-Hulman Institute of Technology CM 171
5500 Wabash Ave., Terre Haute, IN 47803
ditteon@rose-hulman.edu

(Received: 2009 Feb 6 Revised: 2009 Feb 14)

Photometric data for 22 asteroids were collected over 14 nights of observing during 2008 September and October at the Oakley Southern Sky Observatory and Oakley Observatory. The asteroids were: 618 Elfriede, 1032 Pafuri, 1041 Asta, 1129 Neujmina, 1428 Mombasa, 1595 Tanga, 1732 Heike, 1792 Reni, 2617 Jiangxi, 2829 Bobhope, 4058 Cecilgreen, 4959 Niinoama, 5385 Kamenka, 5855 Yukitsuna, 6247 Amanogawa, 6801 Strekov, 7131 Longtom, 7818 Muirhead, 16528 Terakado, (16556) 1991 VQ1, (16773) 1996 VO1, and (23255) 2000 YD17.

Twenty-two asteroids were observed from the Oakley Southern Sky Observatory in New South Wales, Australia, and the Oakley Observatory in Terre Haute, IN, on the nights of 2008 September 8-12, 19, 23-30, and October 3. From the data, we were able to find lightcurves for 17 asteroids. Out of that group, 10 were previously unrecorded results, 4 were reasonably close to previously published periods, and 3 disagreed with previously published periods. The five remaining asteroids produced no repeatable data.

Our selection of asteroids was 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 hope that we would be able to improve previous results. For the southern hemisphere asteroids, a 20-inch Ritchey-Chretien optical tube assembly (OTA) mounted on a Paramount ME was used with a Santa Barbara Instrument Group (SBIG) STL-1001E CCD camera and a clear filter. The image scale was 1.2 arcseconds per pixel at f/8.4. The northern hemisphere asteroids were observed with a 14-inch Celestron OTA mounted on a Paramount ME with an SBIG STL-1001E CCD camera and a clear filter. The image scale was 1.9 arcseconds per pixel at f/7. Exposure times varied between 90 and 240 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, our period results are the first reported for the following asteroids: 1041 Asta, 1595 Tanga, 1792 Reni, 4058 Cecilgreen, 5385 Kamenka, 6247 Amanogawa, 6801 Strekov, 16528 Terakado, (16773) 1996 VO1, and (23255) 2000 YD17. No repeatable pattern was found for the following asteroids: 1032 Pafuri, 1428 Mombasa, 7131 Longtom, 7818 Muirhead, and (16556) 1991 VQ1. Our data for these asteroids were too noisy for us to determine periods, so we are reporting the magnitude variations only. Results from all of the asteroids are listed in the table below. Additional comments have been included as needed.

618 Elfriede. Our data are consistent with the period of 14.801 ± 0.001 h found by Warner (2006).

1129 Neujmina. Our data are inconsistent with the period of 7.61 ± 0.10 h found by Binzel (1987).

1732 Heike. Our data are inconsistent with the period of 3.338 ± 0.001 h found by Alvarez-Candal et al. (2004).

2617 Jiangxi. Our data are consistent with the period of 11.3 ± 0.7 h found by Behrend (2008).

2829 Bobhope. Our data are inconsistent with the period of 6.0888 ± 0.0007 h found by Behrend (2008).

4959 Niinoama. Our data are consistent with the period of 4.725 ± 0.002 h found by Behrend (2008).

Number	Name	Dates 2008 mm/dd	Data Points	Period	P. E. (h)	Amp (mag)	A. E. (mag)
618	Elfriede	09/08-10	101	14.85	0.01	0.12	0.02
1032	Pafuri	09/08-12	115	-	-	0.24	0.04
1041	Asta	09/29-30, 10/03	105	7.99	0.02	0.12	0.02
1129	Neujmina	09/19, 23-24	203	5.089	0.004	0.29	0.02
1428	Mombasa	09/08, 10-12	87	-	-	0.26	0.03
1595	Tanga	09/29-30, 10/03	85	11.05	0.02	0.32	0.04
1732	Heike	09/29-30, 10/03	148	4.74	0.01	0.32	0.04
1792	Reni	09/29-30, 10/03	90	15.95	0.02	0.54	0.06
2617	Jiangxi	09/08-10, 12	122	11.79	0.02	0.34	0.04
2829	Bobhope	09/19, 23-24	67	5.013	0.003	0.46	0.08
4058	Cecilgreen	09/08-10, 09/12	123	7.34	0.01	0.22	0.02
4959	Niinoama	09/29-30, 10/03	94	4.73	0.01	0.27	0.04
5385	Kamenka	09/08, 10, 12	83	6.683	0.008	0.2	0.01
5855	Yukitsuna	09/24-26, 28	107	19.04	0.04	0.8	0.1
6247	Amanogawa	09/24-26, 28	111	12.38	0.02	0.48	0.04
6801	Strekov	09/29-30, 10/03	86	6.173	0.008	0.17	0.01
7131	Longtom	09/24, 26, 28	108	-	-	0.1	0.03
7818	Muirhead	09/24-26, 28	118	-	-	0.1	0.02
16528	Terakado	09/24-26, 28	132	23.38	0.02	0.55	0.05
16556	1991 VQ1	09/08-12	118	-	-	0.17	0.04
16773	1996 VO1	09/08-10, 12	122	5.345	0.005	0.45	0.03
23255	2000 YD17	09/08-10, 12	113	13.56	0.04	0.35	0.04

5855 Yukitsuna. Our data are consistent with the period of 19.2 h found by Behrend (2008).

Acknowledgement

Construction of the Oakley Southern Sky Observatory was funded by a grant from the Oakley Foundation and by a generous donation made by Niles Noblitt. This research was partially supported by a grant from NASA administered by the American Astronomical Society.

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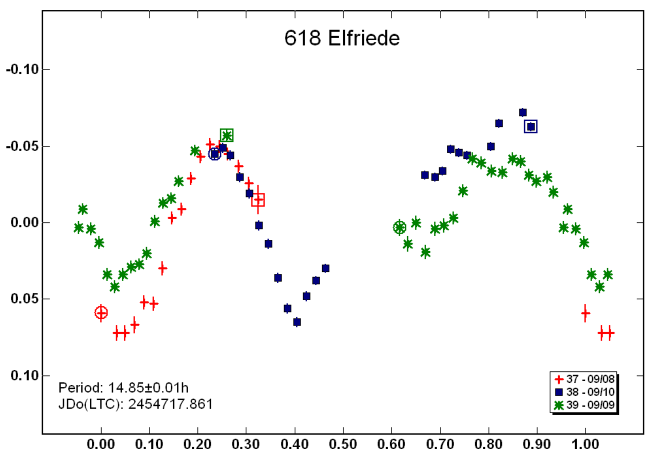
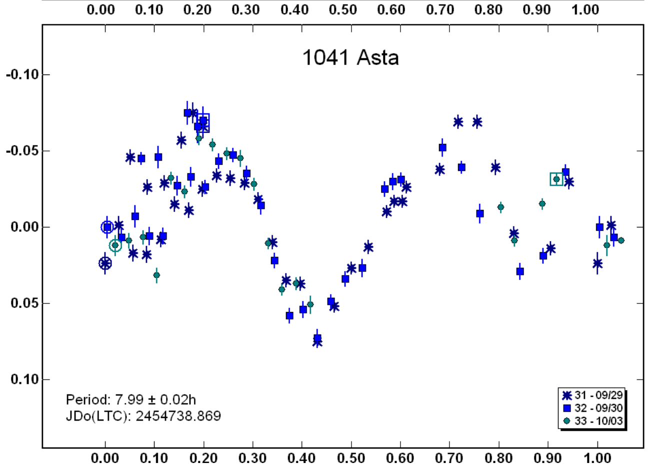
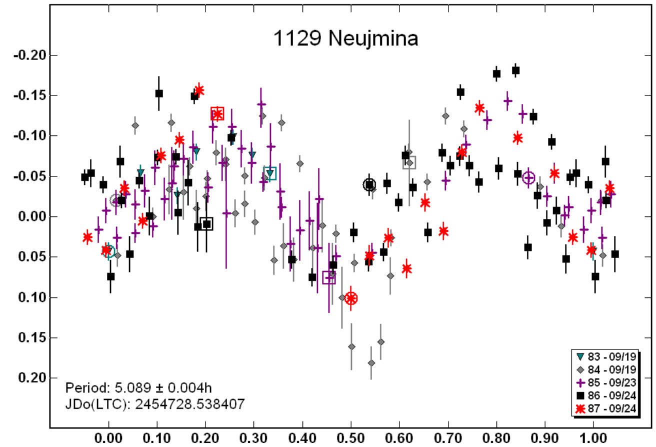
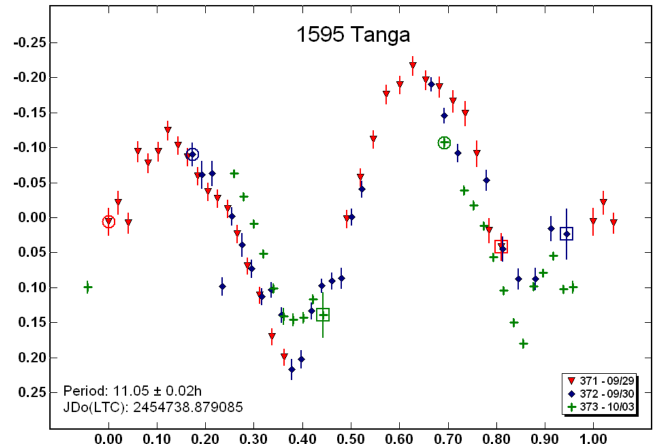
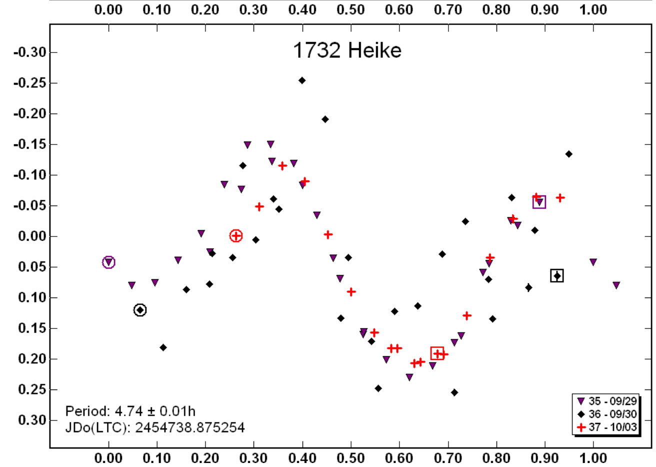
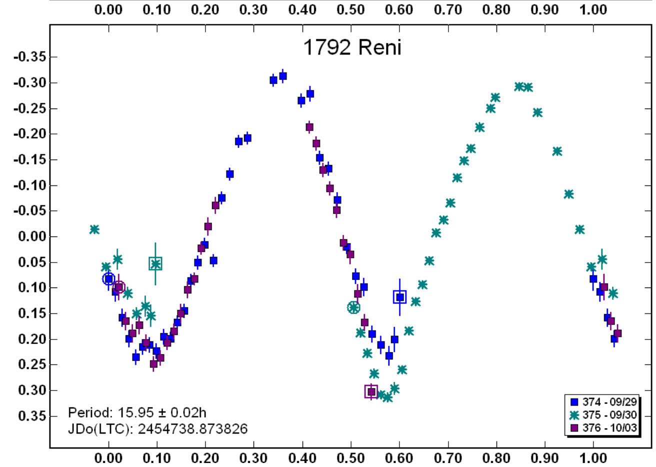


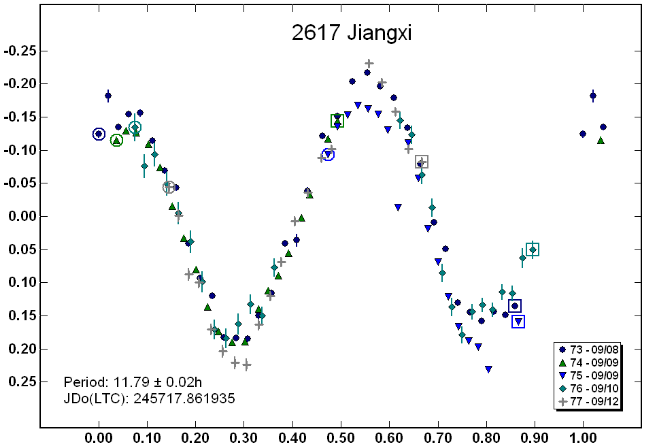


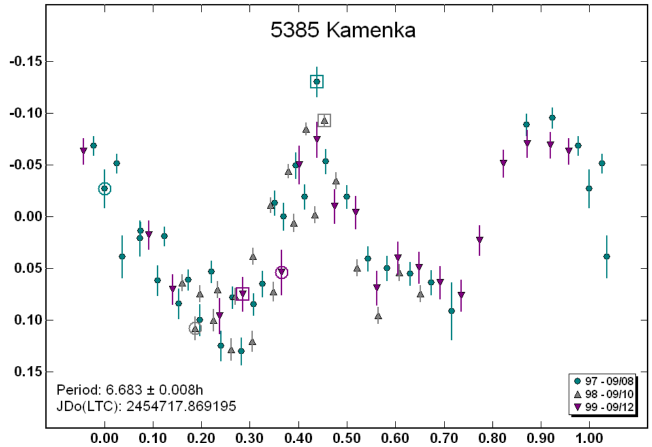


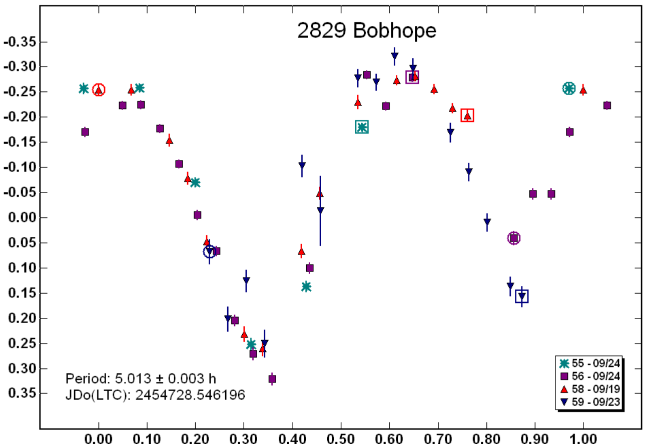


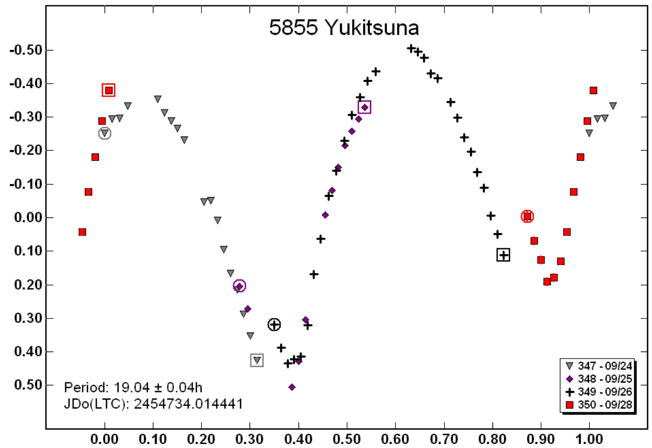


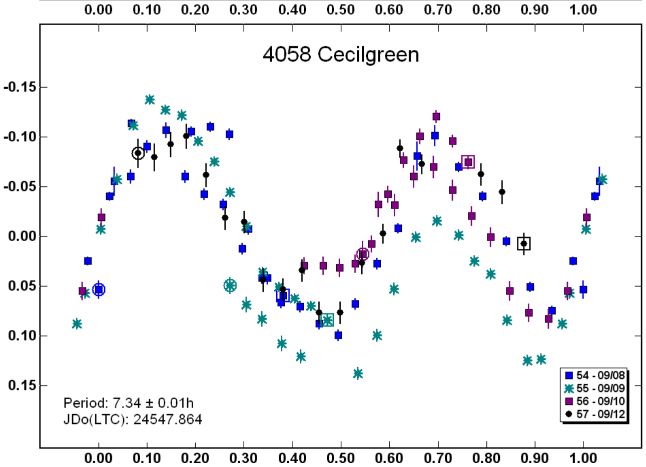


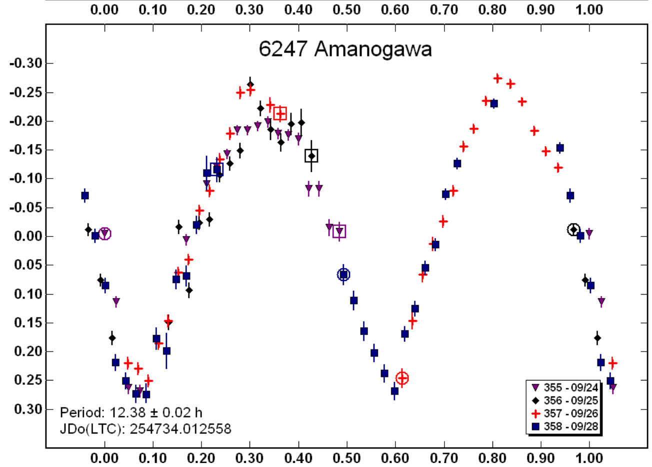

2617 Jiangxi
Period: 11.79 ± 0.02h
JDo(LTC): 245717.861935
73 - 09/08
74 - 09/09
75 - 09/09
76 - 09/10
77 - 09/12


5385 Kamenka
Period: 6.683 ± 0.008h
JDo(LTC): 2454717.869195
97 - 09/08
98 - 09/10
99 - 09/12


2829 Bobhope
Period: 5.013 ± 0.003 h
JDo(LTC): 2454728.546196
55 - 09/24
56 - 09/24
58 - 09/19
59 - 09/23


5855 Yukitsuna
Period: 19.04 ± 0.04h
JDo(LTC): 2454734.014441
347 - 09/24
348 - 09/25
349 - 09/26
350 - 09/28


4058 Cecilgreen
Period: 7.34 ± 0.01h
JDo(LTC): 24547.864
54 - 09/08
55 - 09/09
56 - 09/10
57 - 09/12


6247 Amanogawa
Period: 12.38 ± 0.02 h
JDo(LTC): 254734.012558
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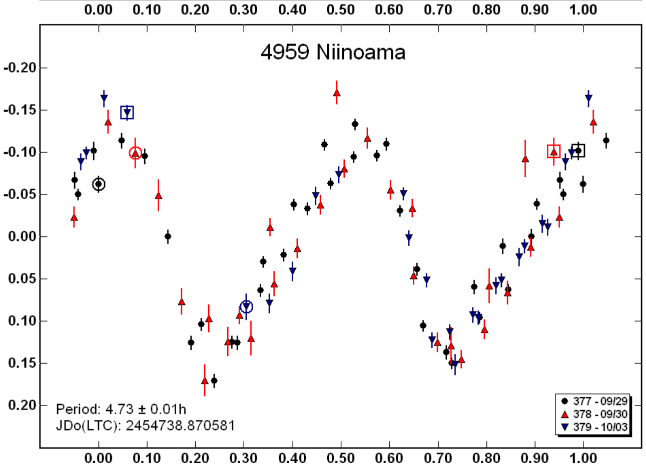
356 - 09/25
357 - 09/26
358 - 09/28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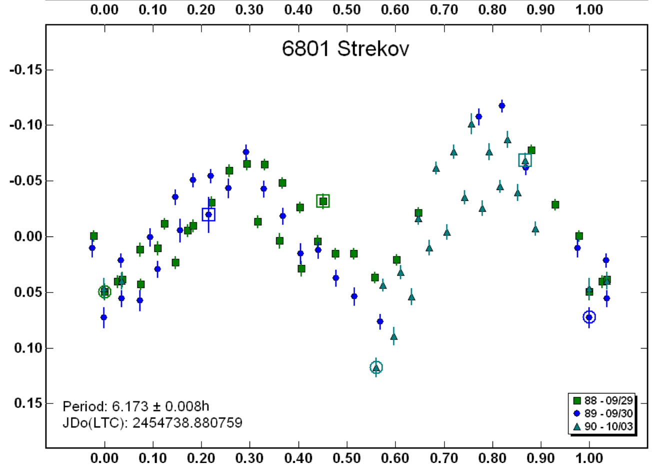
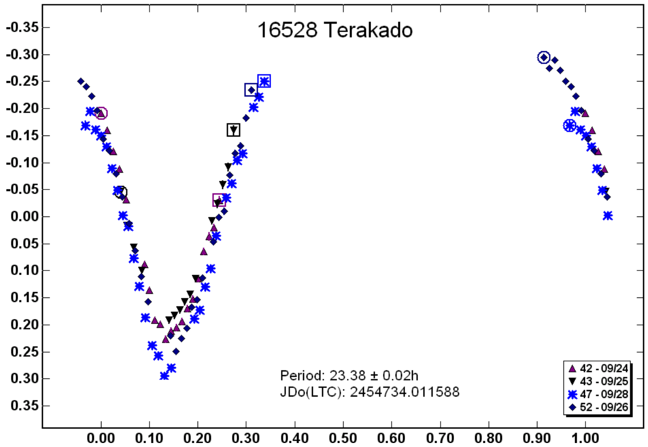
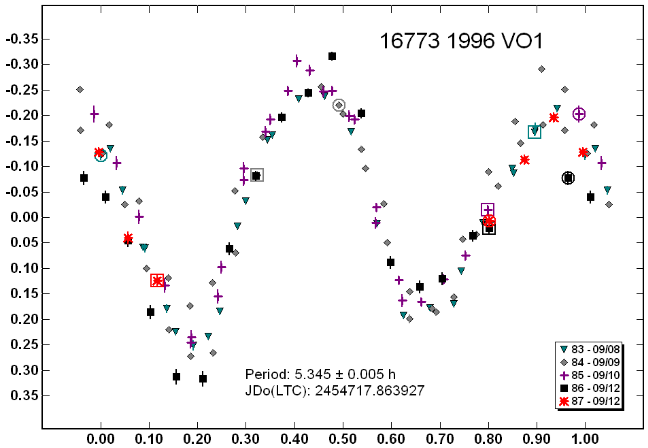
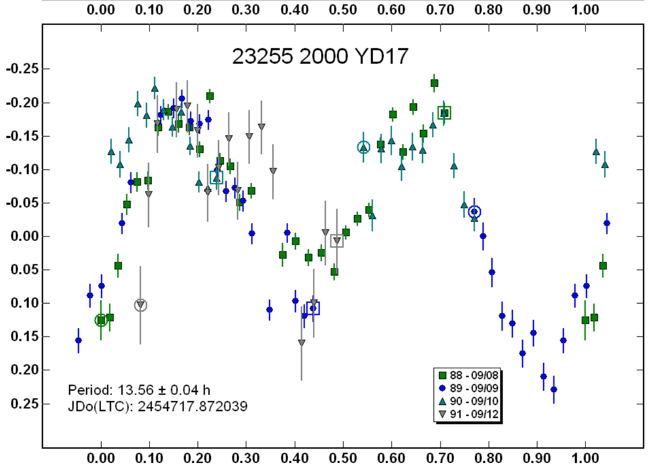
Period: 4.73 ± 0.01h
JDo(LTC): 2454738.870581
377 - 09/29
378 - 09/30
379 - 10/03


6801 Strekov
Period: 6.173 ± 0.008h
JDo(LTC): 2454738.880759
88 - 09/29
89 - 09/30
90 - 10/03







OBSERVATIONS OF V-TYPE BINARY NEAR-EARTH ASTEROIDS 2006 VV2 AND 2008 BT18

Alberto Silva Betzler[1,2], Alberto Brum Novaes[1]
1 – Projeto "Descobrindo o Céu"
Departamento de Física da Terra e do Meio Ambiente
Instituto de Física, Universidade Federal da Bahia (IF-UFBA)
Salvador, Estado da Bahia, BRASIL
a_betzler@yahoo.com

2 – Projeto "Astronomia no Campus", Departamento de Física, Instituto Federal da Bahia (IFBA), Salvador, Estado da Bahia, BRASIL

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The near-Earth asteroids 2006 VV2 and 2008 BT18 were observed by the authors in 2007 April and 2008 July to determine their basic physical parameters. The absolute magnitude (*H*) and slope parameter (*G*) are 2006 VV2: $H = 16.6 \pm 0.2$, $G = 0.2 \pm 0.2$; and 2008 BT 18: $H = 18.2 \pm 0.2$, $G = 0.2 \pm 0.1$. The linear phase coefficients are $\beta = 0.03 \pm 0.01$ and 0.030 ± 0.005 mag/deg. The synodic period for 2008 BT18 was determined to be $P = 2.726 \pm 0.007$ h with a lightcurve amplitude of $A = 0.045 \pm 0.002$ mag. For 2006 VV2, we revise our previous results for color indices, finding B-V = 0.84 ± 0.06 and V-R = 0.39 ± 0.02.

The near-Earth asteroids 2006 VV2 and 2008 BT18 belong to the Apollo dynamic group and were observed by Arecibo and Goldstone stations in 2007 March/April and 2008 July, respectively. At that time, physical observations of both objects were requested with the aim to complement the radar data. Therefore, the "Discovering the Sky" Project carried out observations at Salvador (Bahia, Brazil) using a 0.3-m LX200 GPS Meade telescope, operating at f/3.3, combined with a CCD SBIG ST-7XME detector and B, V, R and I Bessell filters. Our goal was to estimate, if possible, the B-V and V-R color indices, rotation synodic periods, lightcurve amplitudes, absolute magnitude (*H*), and diameter. To improve the SNR of the asteroids and comparison stars, we summed images using routines in the IRIS V. 5.52 program. Photometric calibration was done using 2MASS stars in the asteroid's field. The 2MASS J-K field star color indices were converted to the equivalent B-V and V-R indices of Johnson-Cousins system using the transformation equations from Warner (2007). Only stars with near solar characteristics were used to calculate the asteroid color index and obtain their apparent magnitudes.

2006 VV2. Radar observations made from Goldstone and Arecibo in 2007 March and April gave evidence to the binary nature of 2006 VV2 (Benner et al., 2007). Based on IR data obtain by NASA IRTF, Howell et al. (2008) classified this object as taxonomic type V. Several observers determined the object's synodic period with the most recent determination of $P = 2.42 \pm 0.02$ h (Hergenrother et al., 2009) in excellent agreement with our previously reported period (Betzler et al., 2008). A difference of 0.19 mag between our V-R determination (V-R = 0.64 ± 0.07) from 2007 and the more recent Hergenrother et al. value lead us to revisit the reduction process in our earlier work.

Using the Aladin Sky Atlas (http://aladin.u-strasbg.fr/), which can superimpose images with entries from astronomical catalogues or databases such as 2MASS, we found that one of our two Tycho calibration stars had two close companions, which probably contaminated our results. We then switched to using two stars of near solar color that were in the asteroid field. This, in turn, lead to new results of B-V = 0.84 ± 0.06 and V-R = 0.39 ± 0.02, which are in much better agreement with Hergentrother et al. Based on the V-R value, the apparent magnitude on 2007 April 1 at 01:04 UT was V = 10.17 ± 0.02. This value agrees with the Minor Planet Center (MPC) ephemeredes to within 0.8%. This small difference could be justified partially by the $G = 0.15$ value used in the object magnitudes calculation. A two-color diagram using the B-V and V-R values suggests that 2006 VV2 may be of type V or Q (see Dandy et al., 2003). When using the Hergenrother et al. (2009) color indices and same method, 2006 VV2 may be classified as a T type.

Assuming an average value of V-R = 0.42, we converted R magnitude values published in the MPC circulars (Casali et al., 2007, Helin et al., 2006) to V in order to find the absolute magnitude (H) and phase slope parameter (G) of the asteroid. The computed V magnitudes were entered into the H-G calculator in *MPO Canopus*, which uses the FAZ routine by Alan Harris. If the MPC default of $G = 0.15$ is used, the result is $H = 16.5 \pm 0.2$. This is consistent with a value of $H = 16.8 \pm 0.5$ reported on the JPL Small-Body Database Browser. If we use $G = 0.36$, the value for Vesta found by Hollis (2002), we find $H = 16.7 \pm 0.1$. When both values are allowed to "float", the results are $H = 16.6 \pm 0.2$ and $G = 0.2 \pm 0.2$ (Figure 1). From these, we estimate the diameter of 2006 VV2 to be $D = 1.06 \pm 0.05$ km when using the albedo for Vesta, $p_V = 0.36$ (Hollis, 2002).

2008 BT18. The binary nature of 2008 BT18 was reveled during radar observations on 2008 July 6 and 7 from the Arecibo observatory. The primary has a diameter of 600 meters and the secondary has a diameter of > 200 meters (Benner et al., 2008). Reddy et al (2008), based on a Near-IR spectrum from NASA IRTF, suggested a classification of type V and reported a synodic rotation period of 2.57h. We observed the asteroid on 2008 July 24-26 UT, gathering 452 images of 30-s exposure in V filter. Each observation session had a typical duration of 4 hours. The short exposure times were necessary to keep the asteroid profile somewhat "stellar" despite its rapid sky motion. All images were corrected with bias, dark, and flat-field frames. The period search using Fourier series was performed using FALC routine of *MPO Canopus*. We found a synodic period of $P = 2.726 \pm 0.007$ h with a lightcurve amplitude of $A = 0.045 \pm 0.002$ mag (Figure 2). We tried to reduce the noise of the original data by binning three consecutive data points into one. This produced RMS = 0.04 mag, but the noise remained to be significant in relation to the total amplitude. Using V-R = 0.41, typical of V type asteroids (Dandy et al., 2003), we converted R magnitudes published in the MPC circulars (Young et al., 2008; Matson et al., 2008) to V magnitudes. This dataset was combined with our V magnitudes from July 24 and 26, phase angle > 30°, to find $H = 18.7 \pm 0.3$ with $G = 0.15$. This just fits with the $H = 18.2 \pm 0.5$ given in the JPL Small-Body Database Browser. If G is forced to 0.36, $H = 19.0 \pm 0.2$. If both values are allowed to "float", we find $H = 18.2 \pm 0.2$ and $G = 0.2 \pm 0.1$ (Figure 3). If the last values are used, we calculate a diameter of $D = 0.510 \pm 0.05$ km, which is in good agreement with the radar-derived diameter.

Including no opposition effect in the calculations, the linear phase coefficient for 2006 VV2 and 2008 BT18 are estimated to be $\beta = 0.03 \pm 0.01$ and $= 0.030 \pm 0.005$ mag/deg, respectively (Figure 4). The phase angle variation is nearly the same in both values. From this, we conclude that both asteroids have approximately the same linear coefficient and large-scale roughness. This roughness is probably similar to that of 2 Vesta (0.021 mag/deg; Rock and Hollis, 1990) or 2511 Patterson (0.028±0.001 mag/deg; Juarez et al., 2005), a Vesta family member.

Acknowledgments

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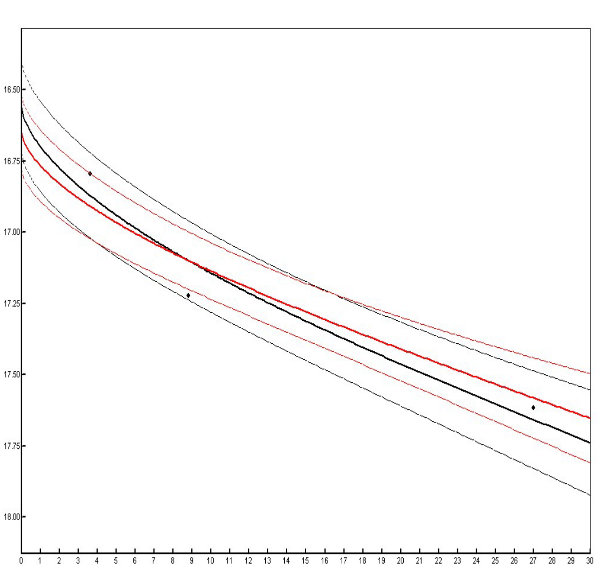

Figure 1. Plot of the reduced magnitude of 2006 VV2 versus phase angle. The solid black line is corresponding to a curve with G = 0.2 ± 0.2 and the red line to G = 0.4 (0.36) ± 0.2. The reduced magnitude error is < 0.1 mag.

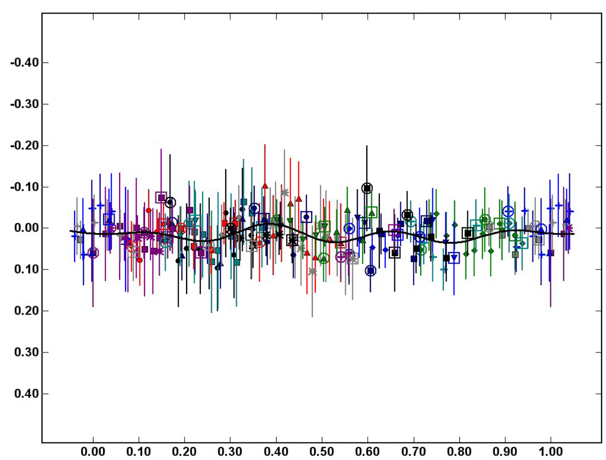

Figure 2. 2008 BT18 lightcurve adjusted in a period of 2.726 ± 0.007 h. Zero phase corresponds to JDo(LTC) 2454671.549222. The black solid line is the best adjust to data a 4th harmonic Fourier series.

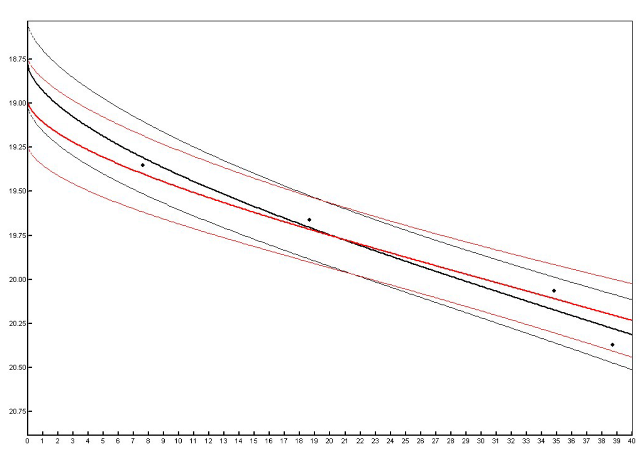

Figure 3. Plot of the reduced magnitude of 2008 BT18 versus phase angle. The solid black line corresponds to a curve with G = 0.2 ± 0.1 and the red line to G = 0.40(0.36) ± 0.2.

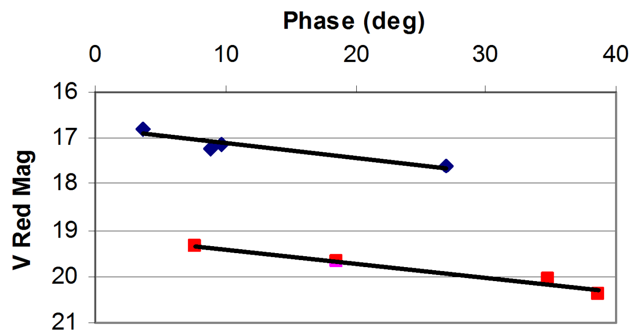

Figure 4. Linear phase functions of 2006 VV2 (blue dots) and 2008 BT18 (red dots). The solid line is the best linear fit obtained with the least squares method. The magnitude error is < 0.1 mag.

LIGHTCURVE ANALYSIS OF 566 STEREOSKOPIA AND 823 SISIGAMBIS

Michael Fauerbach, Scott A. Marks
Egan Observatory
Florida Gulf Coast University
10501 FGCU Blvd.
Fort Myers, FL 33965
mfauerba@fgcu.edu

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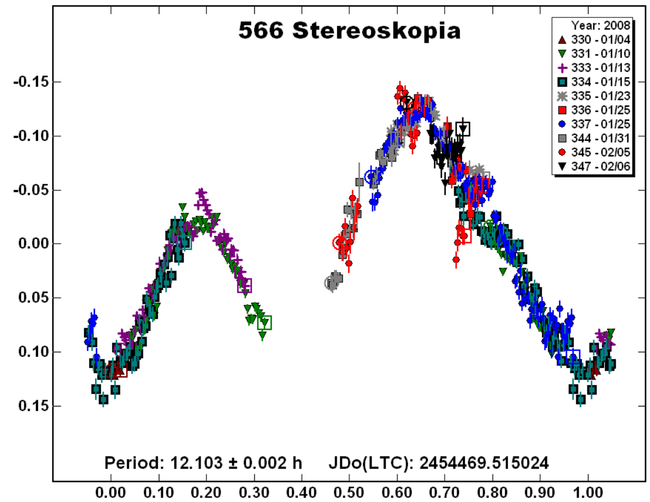
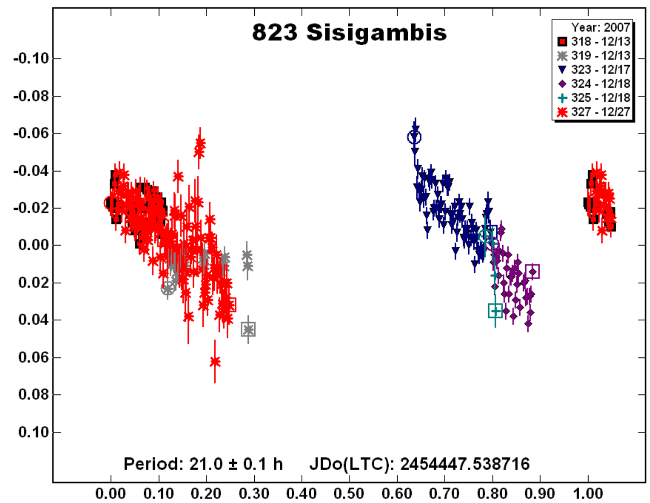
We report the lightcurve period for the 566 Stereoskopia for which two very different periods had been previously published, our results being 12.103 ± 0.002 h. Unfortunately, we are able to provide only a very tentative result of 21.0 ± 0.1 h for 823 Sisigambis.

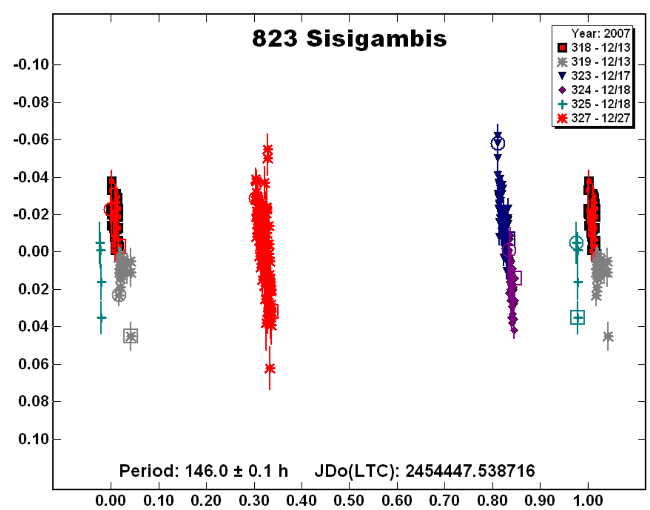
The Evelyn L. Egan Observatory is located on the campus of Florida Gulf Coast University in Fort Myers, Florida. Details on the equipment and experimental methods can be found in Fauerbach and Bennett (2005). The data were analyzed with *MPO Canopus* version 9, which employs differential aperture photometry to determine the values used for analysis. The targets were chosen by comparing well-placed asteroids to the list of known lightcurve parameters maintained by Harris and Warner (2008). We focused our observations on two large and bright asteroids for which a high uncertainty in the actual rotational period existed.

566 Steroskopia. Previously published periods for this asteroid, based on sparsely populated lightcurves, ranged from 9.685 h by Blanco et al. (2000) to 17.76 h by Behrend (2008). Our densely populated lightcurve, derived over 10 nights and spanning just longer than a month, fits neither of those previous periods. Instead, we find a stable solution for a period of 12.103 ± 0.002 h.

823 Sisigambis. Previously published periods for this asteroid, based on sparsely populated lightcurves, ranged from greater than 24 h by Barucci et al. (1994) as well as Wisniewski et al. (1997) to 146.2 h by Behrend (2008). Despite observing the asteroid exclusively for six nights over a two-week period, we were unable to find a high-quality solution. This is mainly due to the very low amplitude variations observed over an entire night, which typically spanned 5-6 h of observational time. A similar trend was observed by Wisniewski et al. (1997). They show a single night lightcurve for 823 Sisigambis that covers approximately 3 h and is basically flat. Barucci et al. (1994) reported a drop of ~0.2 mag over a 5 h period. When Wisniewski et al. (1997) observed the asteroid during the same night, with a 30-minute overlap, they found the lightcurve to be flat. We were unable to observe a maximum during the 6 nights of observations, which would have helped in predicting the period. Bowing to Occam's Razor, we present here a possible solution with a period of 21.0 h. We also show a lightcurve with a period of 146.2 h as predicted by Behrend (2008). It should be pointed out that since we used differential photometry, the absolute location of the individual nights on this plot is arbitrary and could be shifted up or down. Further data for this large and bright asteroid are clearly needed.







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#	Name	Date Range (yyyy mm/dd)	Data Pts	Phase	LPAB	BPAB	Per (h)	PE
566	Stereoskopia	2008 01/03-02/05	554	12.4,17.6	65	-0.5	12.103	0.002
823	Sisigambis	2007 12/12-12/26	292	13.2,19.5	58	0.7	21.0	0.1

A TRIO OF WELL-OBSERVED ASTEROID OCCULTATIONS IN 2008

Brad Timerson
International Occultation Timing Association (IOTA)
623 Bell Rd., Newark, NY, USA
btimerson@rochester.rr.com

J. Durech, Astronomical Institute of the Charles University

S. Aguirre, L. Benner, D. Blanchette, D. Breit, S. Campbell, T. Campbell, R. Carlisle, E. Castro, D. Clark, J. Clark, A. Correa, K. Coughlin, S. Degenhardt, D. Dunham, R. Fleishman, R. Frankenberger, P. Gabriel, B. Harris, D. Herald, M. Hicks, G. Hofler, A. Holmes, R. Jones, R. Lambert, G. Lucas, G. Lyzenga, C. MacDougal, P. Maley, W. Morgan, G. Mroz, R. Nolthenius, R. Nugent, S. Preston, C. Rodriguez, R. Royer P. Sada, E. Sanchez, J. Sanford, B. Sorensen, R. Stanton, R. Venable, M. Vincent, R. Wasson, E. Wilson.
IOTA

B. Owen, J. Young
Jet Propulsion Laboratory

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During 2008, IOTA observers in North America recorded observations for about 100 asteroidal occultation events. Of these, three events were notable for producing well-defined profiles as a result of a large number of well-spaced observation sites at each event. Detailed profiles are presented for three events having the most extensive observations: 9 Metis on 2008 September 12, an irregular ellipse measuring 176.1 ± 3.1 x 161.1 ± 10.5 km; 19 Fortuna on 2008 June 18, an irregular ellipse measuring 229.7 ± 1.7 x 193.6 ± 1.7 km; 135 Hertha on 2008 December 11, an irregular ellipse measuring 101.0 ± 2.1 x 59.3 ± 2.1 km.

Historical Background and Introduction

The first observed asteroidal occultation involved 2 Pallas recorded photoelectrically in 1961 (Sinvhal et al. 1962). An earlier claim of a visual observation of an occultation by 3 Juno in 1958 in Malmo, Sweden is doubtful (Taylor 1962). The path of that occultation passed over the Arctic Ocean north of Greenland, according to an ephemeris calculated from backwards propagation of accurate modern orbital elements of Juno and the position of the star in 1958 computed with the Tycho 2 catalog data. The closest approach at Malmo was 3”, whereas astrometric observations of Juno made that year agree with the new ephemeris to within their 1” accuracy. The magnitude drop of the 1958 occultation was less then 0.5, which would be difficult to observe visually. Successful predictions (Preston 2009) and observations have increased dramatically since then, especially since 1997, aided by high-accuracy star catalogs and asteroid ephemerides (Dunham et al. 2002). With equipment ranging from simple visual techniques to time-inserted video, observers worldwide are regularly measuring the size and shape of asteroids as they watch these occultations. Recently observers have made use of smaller, portable instruments teamed with low-light video cameras to set up unattended stations at multiple locations (Degenhardt 2009).

The techniques and equipment needed to make these observations are outlined in the IOTA manual (Nugent 2007). Observations are reported to a regional coordinator who gathers these observations and uses a program called *Occult4* (Herald 2008) to produce a profile of the asteroid at the time of the event. These asteroidal occultation data are officially deposited and archived, and made available to the astronomical community through the NASA Planetary Data System (Dunham et. al. 2008). Additional tools such as asteroidal lightcurves (e.g. Warner 2008) and asteroidal models derived from inversion techniques (e.g. Durech 2009) can be combined with occultation results to yield high resolution profiles. A widely used asteroid lightcurve inversion method was developed by Kaasalainen and Torppa (2001) and Kaasalainen et al. (2001). It enables one to derive asteroid shape, spin axis direction, and rotation period from its lightcurves observed over several apparitions. The shape is usually modeled as a convex polyhedron. When the shape model and its spin state are known, its orientation with respect to an observer (sky plane projection) can be easily computed. Such a predicted silhouette can then be compared with the occultation chords and scaled to give the best fit. Finally, planning software called *OccultWatcher* allows observers to space themselves across the predicted path of the occultation to gather as many unique chords as conditions allow (Pavlov 2008).

Occultation Results in 2008

<u>9 Metis.</u> On 2008 September 12, from 6:20 UT to 6:23 UT, asteroid 9 Metis occulted the V mag. 6.0 star HIP 14764 (SAO 93320) in Aries, during which time the asteroid rotated about 3 degrees. The maximum predicted duration for this event was 48.3 seconds. A total of 21 different observers set up 35 stations for this event, most of them in southern California. Video recording was employed at 26 stations, 8 were visual, and one was a drift scan. The 14 northernmost stations all reported no occultation. The predicted centerline with central event time is shown as the dotted line labeled 14 in Figure 1. The Metis event was unique in that for the first time, four observers successfully ran one or more remote stations including their tended equipment. One observer, Degenhardt, ran 11 remote stations all of which recorded misses. One of his misses, chord one, served to constrain the shape on the north edge.

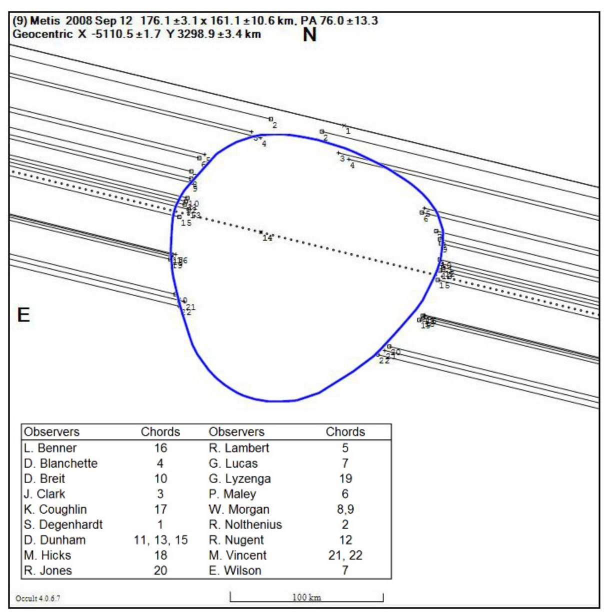

Figure 1. Observed occultation profile for 9 Metis on 2008 September 12 UT with lightcurve inversion model (blue).

Figure 1 shows the predicted orientation of Metis provided by J. Durech (Durech 2009) using the results of Torppa (2003) superimposed over the observed chords as created in *Occult4* (Herald 2008). For the sake of clarity, only the nearest, constraining miss chord is included. (Detailed results with maps showing the locations of all observers are posted on the IOTA *Asteroid Occultation Results for North America* webpage; Timerson 2009). A maximum duration of 42.61 seconds was recorded at station 19, about 11% shorter than predicted. The predicted path was in excellent agreement with the observations and the predicted time was just a few seconds late. The profile produced using *Occult4* and its least squares fit routine shows an ellipse with dimensions of 176.1 ± 3.1 x 161.1 ± 10.6 km. Fitting Durech's irregular shape model to the observations by least-squares gives 168 ± 10 km for the mean diameter of the shape model.

<u>19 Fortuna.</u> On 2008 June 18, from 7:17 UT until 7:24 UT, asteroid 19 Fortuna occulted the V magnitude 8.8 star TYC 6276-01878-1 (SAO 186418) in Sagittarius, during which time the asteroid rotated 5.6 degrees. Maximum duration for this event was predicted to be 19.3 seconds. Twenty observers, located in Texas, Florida, and Mexico, recorded this event, 14 using video techniques and six visual. Events were detected by 15 observers while five reported no occultation. The predicted centerline with central event time appears as the dotted line labeled 10 in Figure 2.

Figure 2 shows the observed chords from *Occult4* (Herald 2008) along with the superimposed lightcurve inversion model (Torppa et al. 2003). Visual observations at stations 17 and 18 were removed to produce a least squares profile of an ellipse measuring 229.7 ± 6.7 x 193.6 ± 6.2 km. The Durech least-squares diameter is 210 ± 12 km and gives the mean diameter of the irregular shape model determined from lightcurve observations. Maximum duration recorded via video was 18.31 seconds at station 12, about 5% less than the predicted value of 19.3 seconds. The predicted path was in excellent agreement with the observations and the predicted time was just a few seconds late.

<u>135 Hertha.</u> On 2008 December 11 between 7:42 and 7:44 UT, asteroid 135 Hertha occulted the V magnitude 9.2 star HIP 13021 (SAO 93103) in Aries, during which time the asteroid rotated one degree. Maximum duration was predicted to be 15.2 seconds. For this event, 11 observers at 23 sites from Oklahoma to California recorded 21 chords across the profile of the asteroid. At 21 sites video was used to record the event while two stations used drift scan. The two northernmost stations reported no occultation. S. Degenhardt set up an unprecedented 14 stations, all of which recorded events.

Figure 3 shows the resulting chords from *Occult4* (Herald 2008) along with the superimposed lightcurve inversion model (Torppa et al. 2003). These chords produce a smooth ellipse with dimensions of 101.0 ± 2.1 x 59.3 ± 2.1 km. Direct measurement of the irregular profile yields dimensions of 89.4 km wide by 88.1 km. The Durech least-squares diameter is 77 ± 7 km and gives the mean diameter of the irregular shape model determined from lightcurve observations. A lightcurve from the archives of the Palmer Divide Observatory (Warner 2008) for this asteroid is shown in Figure 4 to further support the apparent irregular and elongated shape. The maximum occultation duration of 16.49 seconds occurred at station 18 and is 8% longer than predicted, likely because of the orientation of the asteroid at the time of the occultation. The observed path exhibited a south shift from the prediction and was a few seconds late. The orientation of the asteroid at the time of the observation leads to the irregular shape.

Conclusions

Combining observations from a variety of independent sources provides reveals shape and orientation information for asteroids at the time of their observation. Future articles will also include previous occultation results in which multiple chords were observed. These observations are provided by the NASA PDS (Dunham et. al. 2008).

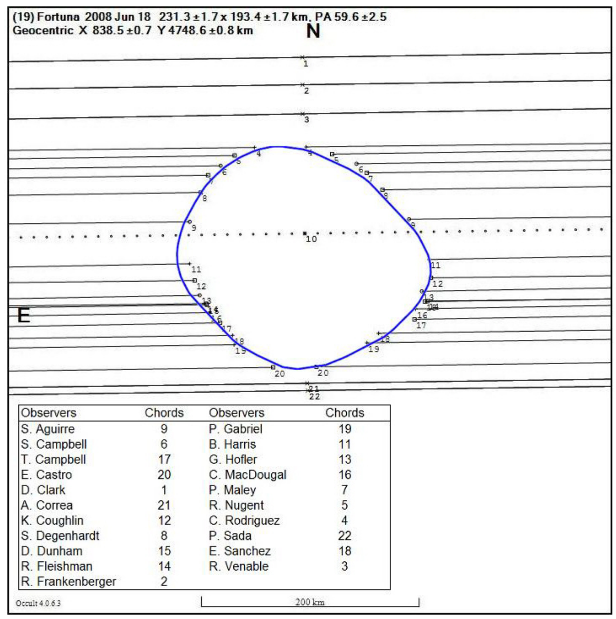

Figure 2. Observed occultation outline for 19 Fortuna on 2008 June 18 UT with lightcurve inversion model (blue).

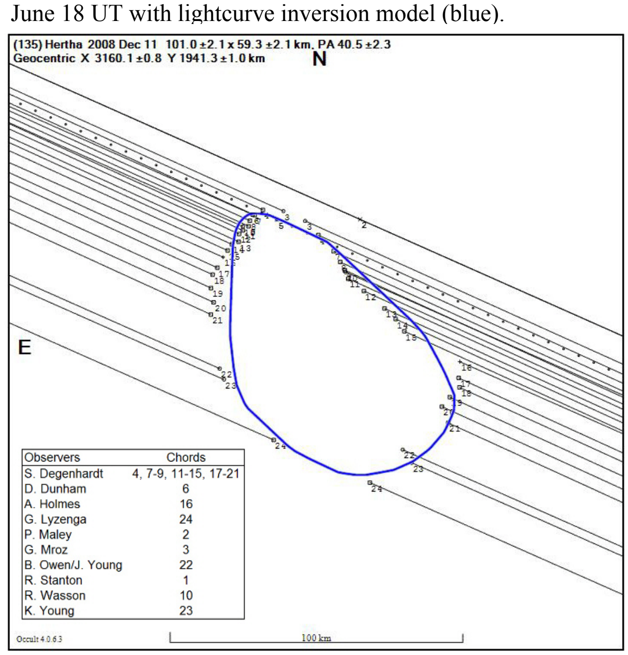

Figure 3. Observed occultation outline for 135 Hertha on 2008 December 11 UT with lightcurve inversion model (blue).

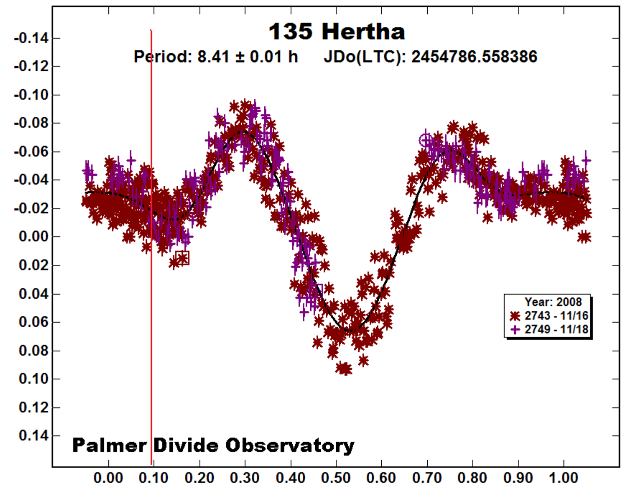

Figure 4. Lightcurve of 135 Hertha, with the rotation phase at the time of occultation indicated by the vertical line. Data are from Brian D. Warner, Palmer Divide Observatory (Warner 2008).

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ROTATION PERIOD DETERMINATIONS FOR 120 LACHESIS, 131 VALA, 157 DEJANIRA, AND 271 PENTHESILEA

Frederick Pilcher
4438 Organ Mesa Loop
Las Cruces, NM 88011 USA
Pilcher@ic.edu

(Received: 2009 Mar 22 Revised: 2009 Mar 24)

Synodic rotation periods and amplitudes have been found for 120 Lachesis 46.551 ± 0.002 h, 0.14 ± 0.02 mag; 131 Vala 5.1812 ± 0.0001 h, 0.28 ± 0.03 mag; 157 Dejanira 15.825 ± 0.001 h, 0.38 to 0.48 mag; and 271 Penthesilea 18.787 ± 0.001h, 0.32 ± 0.04 mag.

Observations of four main-belt asteroids were made in early 2009 at the Organ Mesa Observatory. Equipment consisted of a Meade 35-cm LX200 GPS Schmidt-Cassegrain, and SBIG STL 1001-E CCD camera. Exposures were 60 seconds and unguided using a clear filter, except for 120 Lachesis for which an R filter was used. *MPO Canopus* was used for image measurement using differential aperture photometry and lightcurve analysis. 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, except again for 120 Lachesis in which the even larger number of data points have been binned in sets of five with a maximum interval ten minutes.

120 Lachesis. Bembrick and Allen (2005) obtained lightcurves on nine nights 2005 Mar. 14-28 and found a period of 45.84 h and amplitude 0.22 mag. New observations on 26 nights from 2008 Dec. 23 – 2009 Mar. 17 show a period of 46.551 ± 0.002 h and amplitude 0.14 ± 0.02 mag. With a period slightly less than 2 days, lightcurves on successive nights show opposite rotation

angles and those on alternate nights nearly the same phase in the lightcurve, with a slow circulation toward the right (increasing phase). New all-night observations of both sides of the lightcurve were obtained every 4 to 8 days to achieve complete coverage with abundant overlap. The most prominent feature is a single deep minimum near phase 0.23. As the rotational phase presented during the observable part of the night slowly circulated, three sets of observations of this feature were obtained that served to anchor the period determination; however the 46.551 hour period also fits the shallow features well. The possibility that the period might be twice as long was investigated and can be ruled out entirely. On a lightcurve phased to 93.11 h, the two halves looked very similar to each other and to the lightcurve phased to 46.551 h. A shape sufficiently irregular to produce this lightcurve yet invariant over a 180-degree rotation is unlikely for real asteroids. An approximately 93-hour period is compatible with the 0.22 mag amplitude lightcurve obtained by Bembrick and Allen (2005) only if there are four maxima and minima per cycle. While such a curve is possible, even with amplitudes of about 0.2 mag, they are rare and require extraordinary evidence. Such evidence is lacking in this case.

131 Vala. Pilcher (2008) published a symmetric bimodal lightcurve phased to 10.359 h based on observations obtained 2007 October and November that showed an amplitude 0.09 ± 0.02 mag. However, the result was not considered secure since the high degree of symmetry and small amplitude suggested a pole-on viewing aspect with a period near 5.18 h and monomodal lightcurve. Investigation at the following opposition was recommended to resolve the ambiguity. The first night of observation, 2009 Feb. 7, confirmed the pole-on hypothesis, showing a bimodal lightcurve bimodal with P = 5.18 h. Lightcurves for the 2007 and 2009 observations are presented here with the 2007 data phased to a period of 5.179 ± 0.001 h. The new observations on five nights 2009 Feb. 7 – Mar. 14 show a period 5.1812 ± 0.0001 h, amplitude 0.28 ± 0.03 mag.

If one obtains a nearly symmetric bimodal lightcurve of small amplitude, for which the two halves look almost the same, there is a good possibility that the target asteroid is in near-polar aspect with a rotation period half that of the bimodal lightcurve. If possible the object should be observed at a future opposition at which the phase angle bisector longitude is at near right angles to the original observations. If the two lightcurves show significantly different amplitudes, then the viewing aspect for the apparition with the lower amplitude was very probably pole-on.

157 Dejanira. Warner (2005) obtained lightcurves on six nights 2005 Apr. 22-May 13 and found a period of 15.819 h, amplitude 0.52 mag. One set of new observations was obtained on five nights, 2008 Dec. 21 – 2009 Jan. 8, at phase angles 24.4° to 19.7° with full phase coverage and showed a synodic period 15.817 ± 0.001 h, amplitude 0.48 ± 0.02 mag., in excellent agreement with Warner (2005). A second set of observations on three nights 2009 Feb. 11–23 at phase angles 9.9° to 11.4°, also with full phase coverage, showed a synodic period 15.828 ± 0.001 h, amplitude 0.38 ± 0.02 mag. This smaller amplitude at smaller phase angle is usually encountered for asteroids because of less shadowing. A synodic period increase on the later dates when the prograde rate of motion of the phase angle bisector is much smaller than in December/January implies retrograde rotation. Because real errors in rotation periods are often several times larger than formal errors, this suggestion should be considered provisional. The observations on all eight nights evaluated as a single set produce a mean synodic period of 15.825 ± 0.001 h.

271 Penthesilea. Harris et al. (2008) list no previous photometric measurements. Observations on seven nights 2009 Jan. 1 – Feb. 17 show a period of 18.787 ± 0.001 h, amplitude 0.32 ± 0.04 mag.

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The author thanks Alan W. Harris for helpful suggestions on the data analysis for 157 Dejanira.

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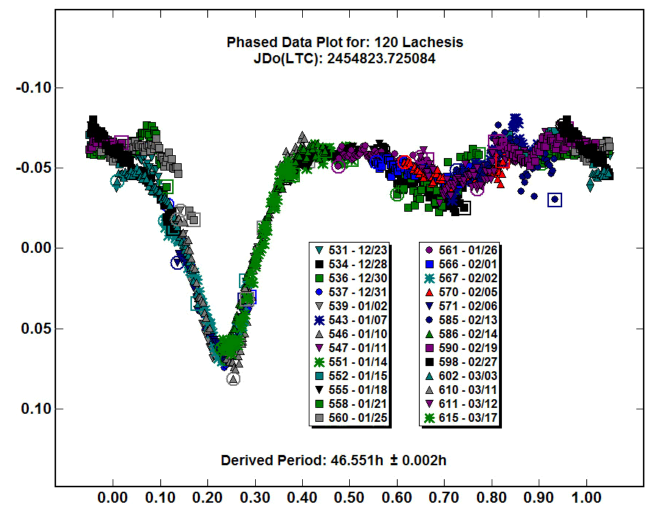

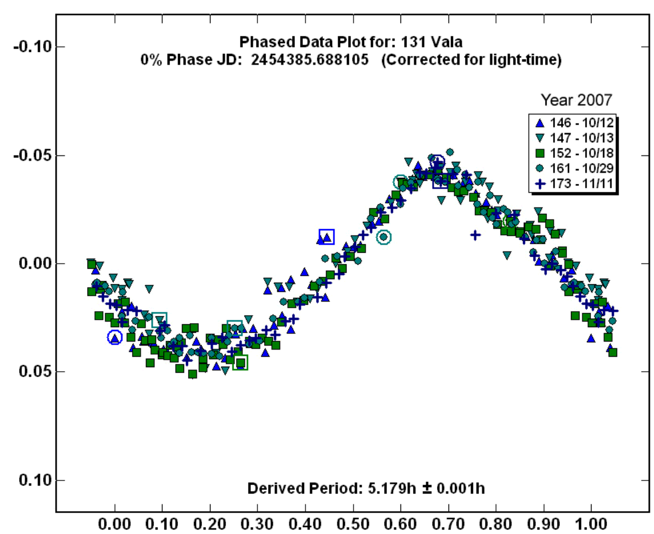

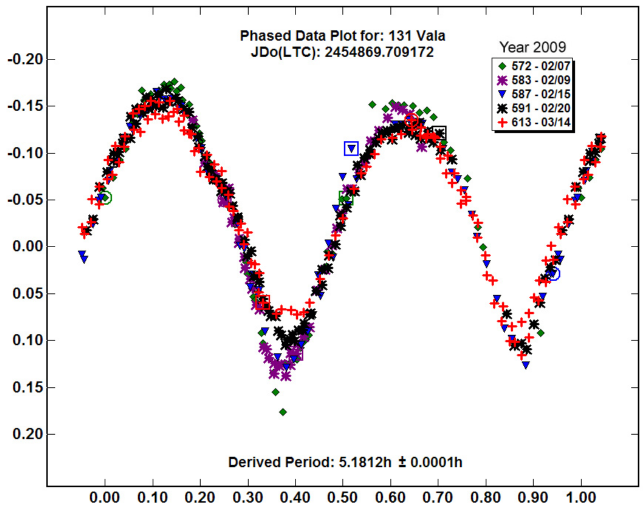

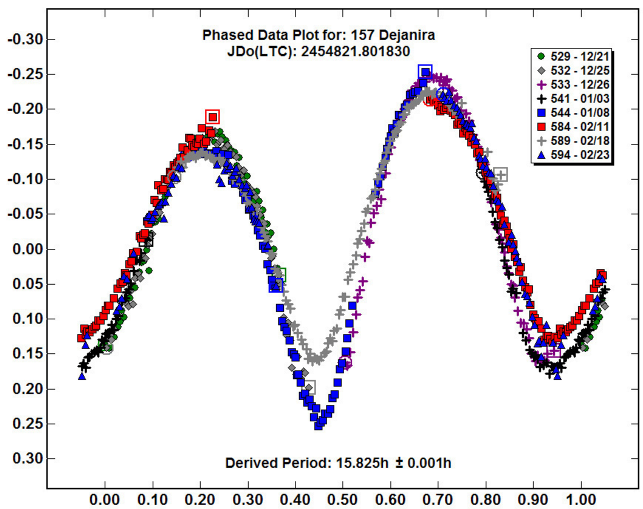

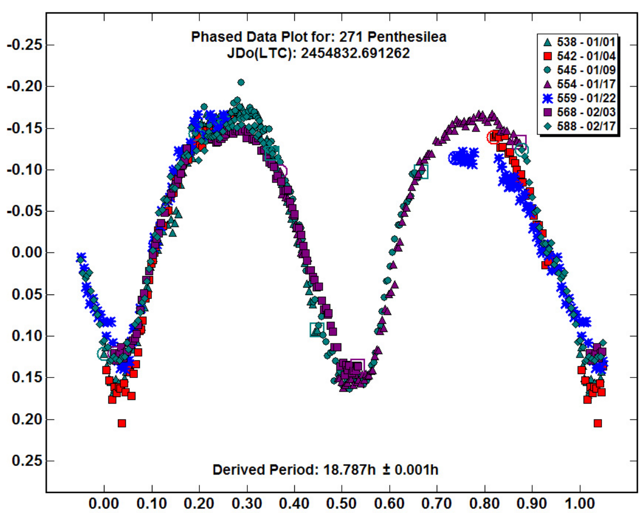

THE LIGHTCURVE FOR THE LONG-PERIOD HUNGARIA ASTEROID 1235 SCHORRIA

Brian D. Warner
Palmer Divide Observatory/Space Science Institute
17995 Bakers Farm Rd., Colorado Springs, CO 80908 USA
brian@MinorPlanetObserver.com

Robert D. Stephens
Goat Mountain Asteroid Research Station (GMARS)
Landers, CA USA

(Received: 2009 Mar 25)

The Hungaria asteroid, 1235 Schorria, was observed in 2009 February through April. The synodic period was determined to be approximately 1265 ± 80 h (about 51.7 days) with a lightcurve amplitude of 1.4 ± 0.05 mag. This makes the asteroid among the slowest rotators known. Despite an expected tumbling damping time many times greater than the age of the Universe, no significant evidence of tumbling was found.

Observations of the Hungaria asteroid, 1235 Schorria, were made by the authors from 2009 Feb 15 through Apr 5. The combined data set consisted of almost 2000 data points. Most of the Palmer Divide Observatory observations were made using a 0.35-m Schmidt-Cassegrain (SCT) with focal reducer (f/5) with SBIG ST-9MXE CCD camera. A 0.5-m Ritchey-Chretien with SBIG STL-1001E was used on two occasions. Exposures were 180 s and guided. A clear filter was used most of the time but when the moon was near full, a Cousins R filter was used to reduce the sky background. Observations at GMARS used a 0.35-m SCT with SBIG STL-1001E CCD camera. Exposures were also 180 s with a clear filter. All images were measured in MPO Canopus using differential aperture photometry. Period analysis was also done with Canopus which implements the FALC algorithm (Harris et al., 1989).

Night-to-night calibration of the data was done by using the using 2MASS magnitudes for field stars from the 2MASS (Neugebaur and Leighton, 1969) or UCAC2 catalog (Zacharias et al., 2004) with the J-K magnitudes converted to Johnson-Cousins BVRI using formulae by Warner (2007). See Stephens (2008) for more details on the calibration process using these magnitudes. It is important to use some form of calibration, even if on an internal system, in order to assure that the data are properly interpreted. Figure 1 shows the data from a single session on 2009 February 20. The data shows the slightest hint of increasing over the night but is dominated by noise on the order of ± ~0.02 mag. Figure 2 shows the same data on the same scale of the final lightcurve (Figure 3). It would be very tempting to conclude from any given session that the lightcurve was essentially flat and try to find a period within the noise. It is only after two or three sessions that it became apparent that, after removing the effects of changing geometry and phase angle, the asteroid's brightness was slowly increasing or decreasing over time.

Our data set covering more than a month showed a symmetrical bimodal curve with a period of 1265 ± 80 h – the total error being the quadratic sum of the formal and sidereal-synodic errors (see below) – and amplitude of 1.40 ± 0.05 mag. Initially, when the data just covered a half-cycle (assuming a bimodal curve), we searched for a half-period in order to estimate the full period. As more data were acquired, we were able to refine the suspected full, bimodal lightcurve period. The period of 1265 ± 80 h is the second longest currently known, exceeded only by (162058) 1997 AE_{12} (1880 h) and coming in just ahead of 288 Glauke (1200 h). Assuming an equatorial view and triaxial ellipsoid, the 1.4 mag amplitude implies an a/b ratio ~3.6:1.

Since the 2MASS conversion formulae have error bars on the order of ± 0.05 mag, the night-to-night calibration is not perfect and we had to make minor adjustments to get the data to fit the Fourier curve. For this reason, combined with a changing sidereal-synodic period difference, which was approximately 75 h at maximum (Pravec et al., 2005), and the effects of changing geometry and phase angle, we cannot say with certainty that the asteroid is not tumbling (also called non-principal axis rotation, NPAR). This is important because, given the size (~9 km) and rotation period, the asteroid should almost certainly be in a tumbling state based on the formula

$$T = (P/17)^3 / D^2 \qquad (1)$$

Where T is the tumbling damping time, in Gy, P is the period in hours, and D is the diameter in km (see Harris, 1994; Pravec et al., 2005). In this case, T is on the order of ~5000 Gy, or about 350 times the age of the Universe! It would be worth observing the asteroid again, using only Landolt fields or other means of accurately calibrating the data, to see if it is possible to determine the true status of rotation. If it can be shown that the asteroid is not tumbling or just barely so, that would make 1235 Schorria an interesting subject for the theorists.

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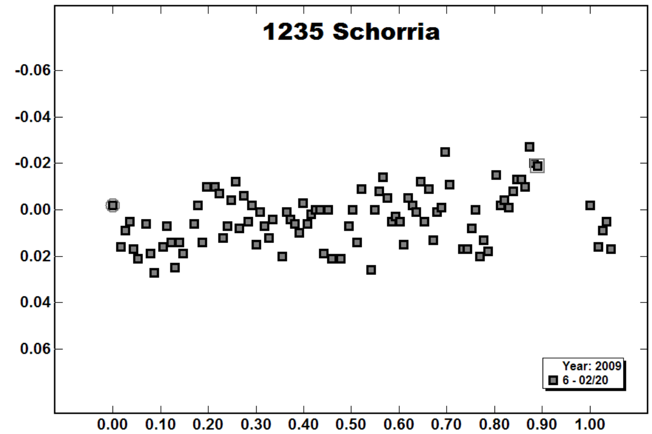

Figure 1. Single session of 1235 data with a floating scale.

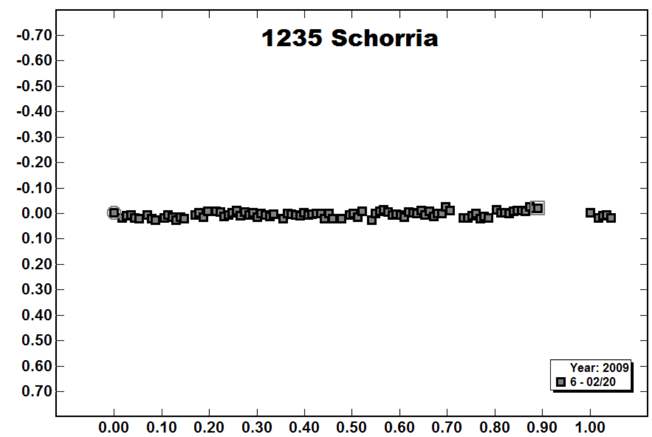

Figure 2. Figure 1 data on same vertical scale as full lightcurve.

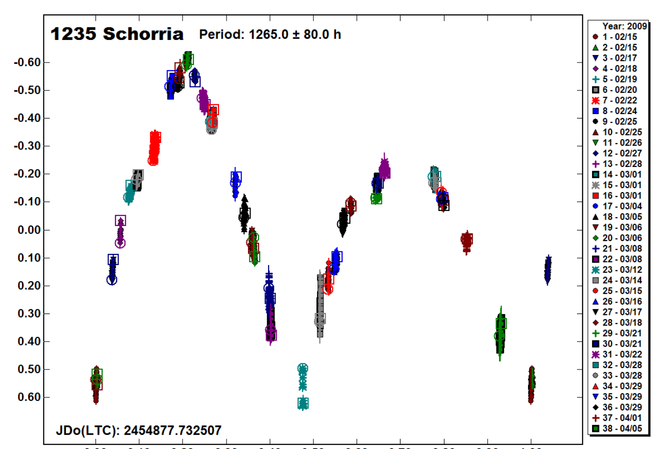

Figure 3. Lightcurve of 1235 Schorria phased to period of 1265 h.

LIGHTCURVES AND SPIN PERIODS FROM THE WISE OBSERVATORY: 2008 AUGUST – 2009 MARCH

David Polishook
The Wise Observatory and
the Department of Geophysics and Planetary Sciences
Tel-Aviv University, Tel-Aviv 69978, Israel
david@wise.tau.ac.il

(Received: 2009 Mar 29)

Some random asteroids travel through the field of view of Wise Observatory's telescopes while observing other targets. We report here the lightcurves and period analysis of those "secondary" asteroids for which we could find secure results.

Photometry of asteroids has been done at the Wise Observatory since 2004. We observed near-Earth asteroids (Polishook and Brosch, 2008), binary asteroids (Polishook et al., 2009) and small main belt asteroids (Polishook and Brosch, 2009). While focusing on a specific target, some random asteroids cross our field of view. These objects are also measured as the prime targets, a lightcurve is drawn, and a search is made to find the spin period. This paper presents photometric results of 14 asteroids with secure periods. The data for these and other asteroids with short coverage of the spin or with low S/N can be received from the author by request.

Observations were performed using the two telescopes of the Wise Observatory: 1-m Ritchey-Chrétien telescope and a 0.46-m Centurion telescope (referred to as C18; see Brosch et al., 2008 for details). Three CCDs were used on both telescopes (see Table I). A filter wheel was used on the 1-m telescope while the C18 was used with no filters (Clear). Exposure times were 10-120s, all with auto-guider. The asteroids were observed while crossing a single field per night, thus the same comparison stars were used while calibrating the images. The observational circumstances are summarized in Table II.

The observational circumstances are summarized in Table I, which lists the asteroid's designation, the telescope and CCD, the filter, the observation date, the time span of the observation during that night, the number of obtained images, the object's heliocentric distance (r), geocentric distance (Δ), phase angle (α), and the Phase Angle Bisector (PAB) ecliptic coordinates (L_{PAB}, B_{PAB} – see Harris et al. (1984) for the definition and ways of calculating these parameters).

The images were reduced in a standard way. We used the IRAF *phot* function for the photometric measurements. After measuring, the photometric values were calibrated to a differential magnitude level using ~600 local comparison stars per field of the *C18* (~40 stars at the field of the 1-m). The brightness of these stars remained constant to ±0.02 mag. Astrometric solutions were obtained using *PinPoint* (www.dc3.com) and the asteroids were identified in the MPC web database. Analysis for the lightcurve period and amplitude was done by the Fourier series analysis (Harris and Lupishko 1989). See Polishook and Brosch (2009) for complete description about reduction, measurements, calibration and analysis.

Lightcurves and spin periods of 14 asteroids with reliability code of 3 and 2 are reported. All objects are main belt asteroids with absolute magnitude in the range of 10.6 – 16.7 mag. None of the asteroids has published photometric measurements, excluding 2294 Andronikov (Carbognani and Calcidese, 2007) and 1406 Komppa, the latter of which has an unpublished lightcurve at Raoul Behrend's website (Behrend, 2009). While the spin value measured by Behrend is 7.0183 ± 0.0007 h, our measurements, with better S/N, show a spin period of 3.49 ± 0.01 h, suggesting that Behrend treated two rotations as part of a single rotation.

Since these asteroids were not the prime targets of our observing campaign, they were observed only for one or few nights. Therefore, the spin results, which are averaged on 4.7 hours, are biased against slow-rotators. The results are listed in Table II, which includes the asteroid name, rotation period, reliability code, photometric amplitude and the absolute magnitude (*H*) as appears in the MPC website (http://www.cfa.harvard.edu/iau/mpc.html). The folded lightcurves are presented afterwards in a relative

Asteroid name	Scope	CCD	Filter	Date	Time span [hrs]	N	R [AU]	Δ [AU]	α [Deg]	L_{PAB} [Deg]	B_{PAB} [Deg]
1406 Komppa	C18	STL	C	Feb 24, 2009	7.56	102	2.72	1.73	1.63	159.5	-1.5
2294 Andronikov	C18	STL	C	Mar 16, 2009	1.76	30	2.83	1.86	5.89	187.7	-7.3
	C18	STL	C	Mar 17, 2009	2.59	49	2.83	1.86	5.56	187.7	-7.4
	C18	STL	C	Mar 21, 2009	5.32	102	2.83	1.85	4.36	187.8	-7.4
2785 Sedov	C18	STL	C	Nov 24, 2008	4.28	66	2.75	1.77	2.03	66.8	1.8
	C18	STL	C	Nov 25, 2008	4.03	66	2.75	1.77	1.63	66.9	1.8
3453 Dostoevsky	C18	STL	C	Mar 03, 2009	6.07	73	2.37	1.39	4.6	170.4	-4.2
6352 Schlaun	C18	STL	C	Feb 24, 2009	7.56	102	2.41	1.42	1.96	159.5	-1.6
	C18	STL	C	Feb 26, 2009	4.58	66	2.41	1.42	1.2	159.6	-1.7
6685 Boitsov	1-m	PI	V	Aug 02, 2008	2.92	26	1.95	1.08	20.6	340.1	2.9
17079 Lavrovsky	C18	STL	C	Jan 20, 2009	5.33	36	2.65	2.11	20	64.8	6.3
	C18	STL	C	Jan 22, 2009	3.88	37	2.66	2.14	20.26	65	6.3
(22600) 1998 HH_{123}	C18	STL	C	Nov 28, 2008	3.16	47	2.41	1.47	8.56	56.9	-12.5
	C18	STL	C	Nov 29, 2008	5.01	77	2.41	1.47	8.81	57	-12.5
22776 Matossian	C18	STL	C	Jan 20, 2009	5.33	47	2.32	1.76	23.08	66.5	6.2
	C18	STL	C	Jan 22, 2009	4.32	41	2.32	1.79	23.35	66.8	6.2
(31017) 1996 EH_2	C18	STL	C	Nov 25, 2008	4.18	61	2.44	1.45	2.16	67.3	1.8
58605 Liutungsheng	C18	STL	C	Nov 25, 2008	4.18	87	1.95	0.96	2.56	66.8	1.5
(92498) 2000 NH_9	1-m	PI	R	Jan 02, 2009	6.49	87	2.59	1.85	17.18	61.9	6.5
(192692) 1999 TH_{41}	C18	STL	C	Nov 30, 2008	4.46	60	2.44	1.47	4.8	69.4	-8.9
	C18	STL	C	Dec 01, 2008	3.63	43	2.44	1.47	4.82	69.5	-9
(194386) 2001 VG_5	C18	STL	C	Nov 25, 2008	4.18	68	1.67	0.68	2.6	65.9	1.5

Table I. Observing details. In the Filter column, "C" is a clear filter.

magnitude scale.

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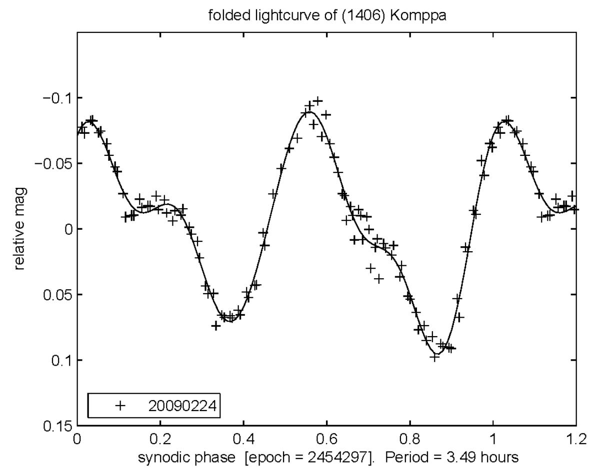
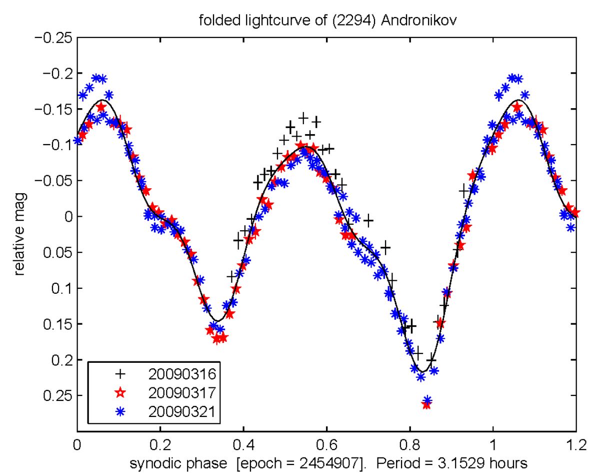
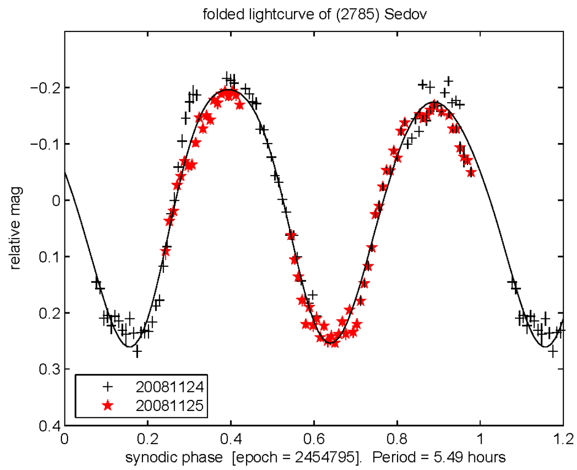
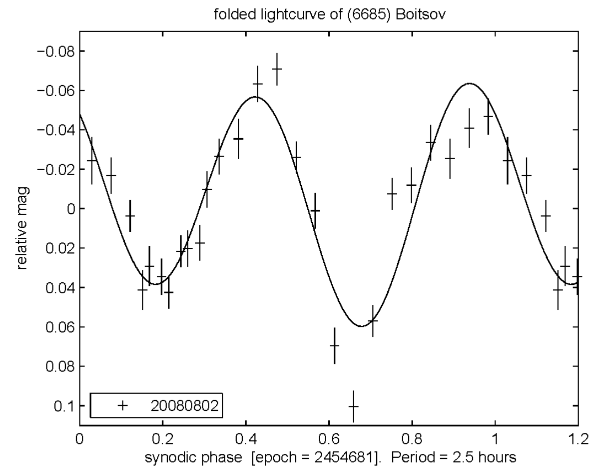
Asteroid name	Period [hours]	U	Amplitude [mag]	H (MPC) [mag]
1406 Komppa	3.49 ± 0.01	3	0.20 ± 0.02	10.6
2294 Andronikov	3.1529 ± 0.0003	3	0.45 ± 0.02	11.6
2785 Sedov	5.49 ± 0.01	3	0.45 ± 0.03	12.2
3453 Dostoevsky	3.20 ± 0.04	3	0.09 ± 0.02	11.8
6352 Schlaun	13.87 ± 0.01	2	0.70 ± 0.05	13.8
6685 Boitsov	2.5 ± 0.1	3	0.12 ± 0.04	14.0
17079 Lavrovsky	4.18 ± 0.01	3	0.5 ± 0.1	14.5
(22600) 1998 HH_{123}	3.23 ± 0.01	3	0.15 ± 0.03	13.6
22776 Matossian	3.407 ± 0.007	3	0.2 ± 0.1	14.9
(31017) 1996 EH_2	3.9 ± 0.2	2	0.45 ± 0.05	14.1
58605 Liutungsheng	4.78 ± 0.04	2	0.8 ± 0.1	15.3
(92498) 2000 NH_9	2.89 ± 0.07	3	0.4 ± 0.2	15.4
(192692) 1999 TH_{41}	5.39 ± 0.05	2	0.4 ± 0.2	15.5
(194386) 2001 VG_5	6.6 ± 0.1	2	0.35 ± 0.05	16.7

Table II. Results. U is the reliability (quality) code per Warner et al. (2009)






folded lightcurve of (2785) Sedov
relative mag
20081124
20081125
synodic phase [epoch = 2454795]. Period = 5.49 hours


folded lightcurve of (6685) Boitsov
relative mag
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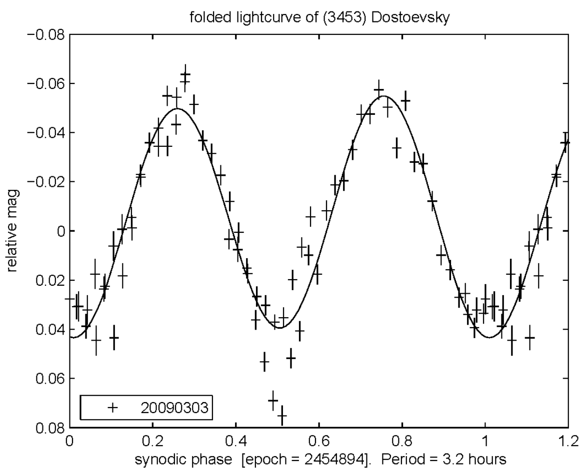
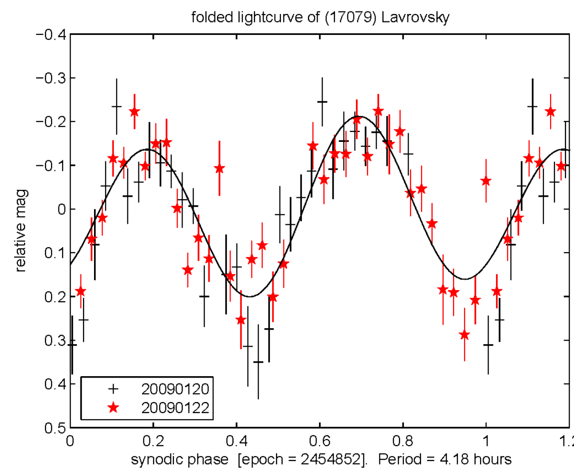
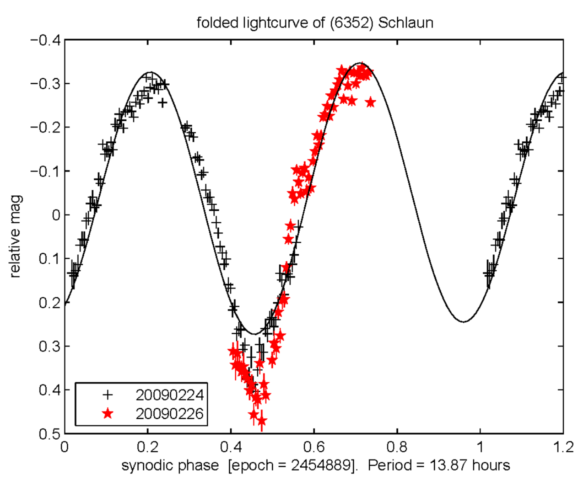
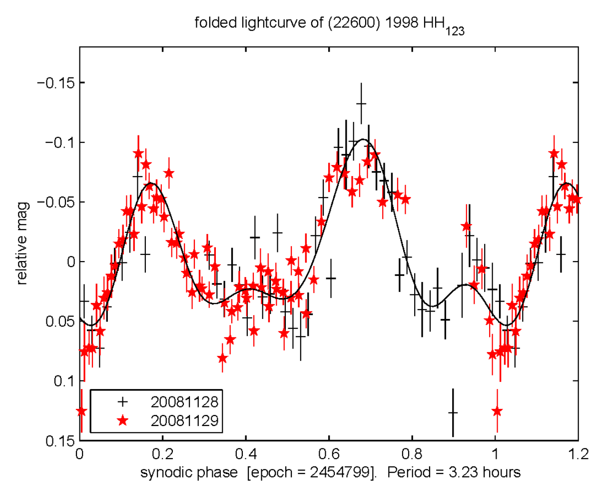
synodic phase [epoch = 2454681]. Period = 2.5 hours


folded lightcurve of (3453) Dostoevsky
relative mag
20090303
synodic phase [epoch = 2454894]. Period = 3.2 hours


folded lightcurve of (17079) Lavrovsky
relative mag
20090120
20090122
synodic phase [epoch = 2454852]. Period = 4.18 hours


folded lightcurve of (6352) Schlaun
relative mag
20090224
20090226
synodic phase [epoch = 2454889]. Period = 13.87 hours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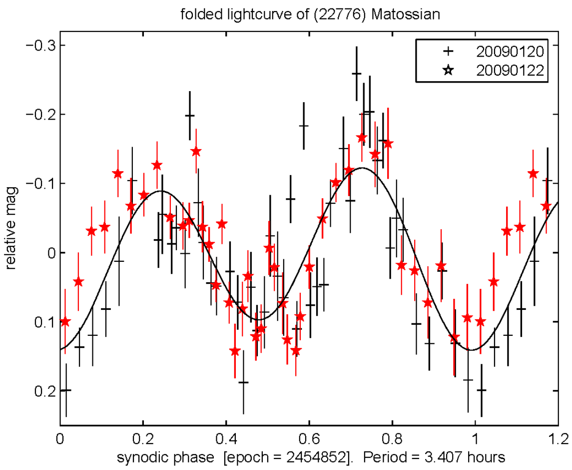
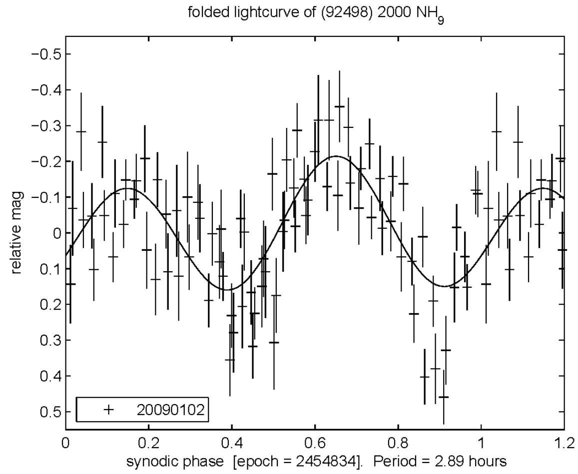
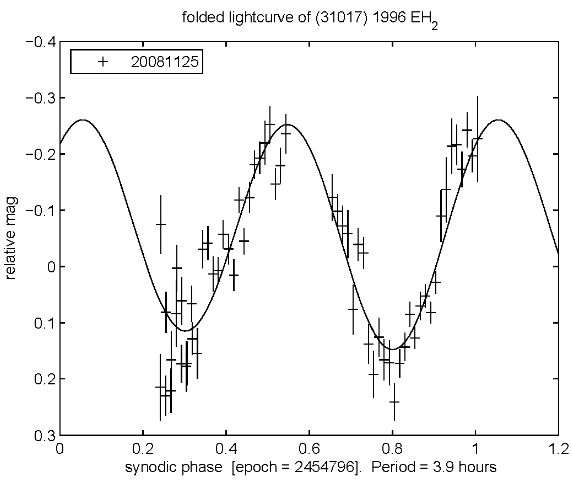
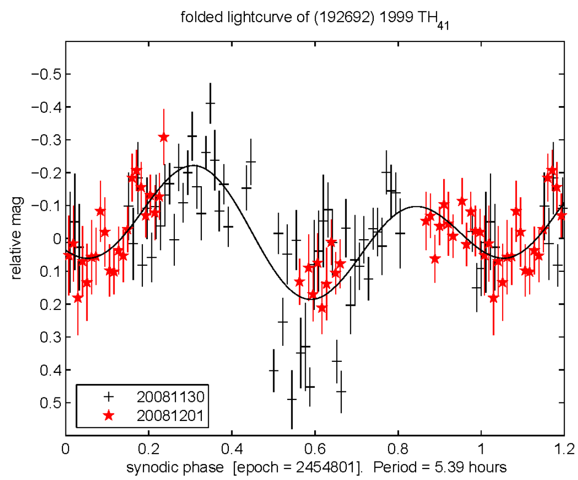
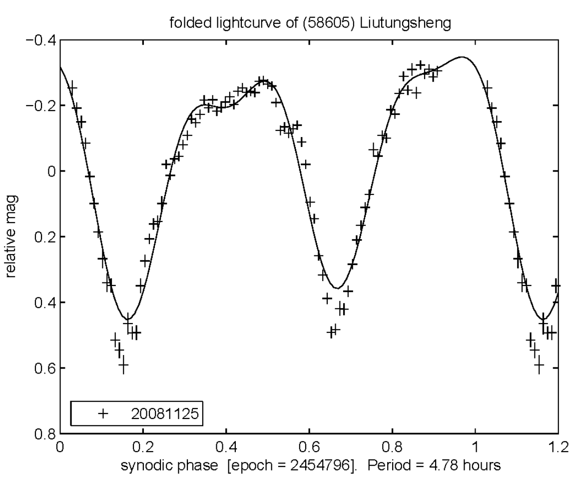
relative mag
20081128
20081129
synodic phase [epoch = 2454799]. Period = 3.23 hours

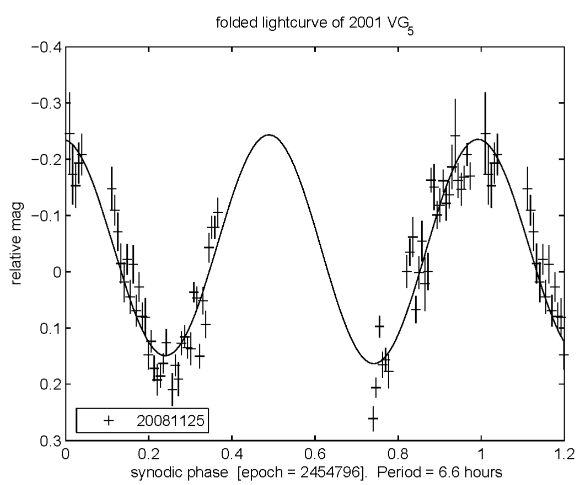

folded lightcurve of (22776) Matossian
20090120
20090122
relative mag
synodic phase [epoch = 2454852]. Period = 3.407 hours


folded lightcurve of (92498) 2000 NH9
20090102
relative mag
synodic phase [epoch = 2454834]. Period = 2.89 hours


folded lightcurve of (31017) 1996 EH2
20081125
relative mag
synodic phase [epoch = 2454796]. Period = 3.9 hours


folded lightcurve of (192692) 1999 TH41
20081130
20081201
relative mag
synodic phase [epoch = 2454801]. Period = 5.39 hours


folded lightcurve of (58605) Liutungsheng
20081125
relative mag
synodic phase [epoch = 2454796]. Period = 4.78 hours


folded lightcurve of 2001 VG5
20081125
relative mag
synodic phase [epoch = 2454796]. Period = 6.6 hours

ANALYSIS OF THE HUNGARIA BINARY ASTEROID 3309 BRORFELDE

Brian D. Warner
Palmer Divide Observatory/Space Science Institute
17995 Bakers Farm Rd., Colorado Springs, CO 80908 USA
brian@MinorPlanetObserver.com

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The Hungaria asteroid, 3309 Brorfelde, is a known binary asteroid. It was observed at the Palmer Divide Observatory in 2009 January. The synodic period of the primary lightcurve was found to be 2.5046 ± 0.0003 h with an amplitude of 0.10 ± 0.01 mag. The orbital period of the satellite was 18.45 ± 0.01 h. The satellite appears to be tidally locked in its orbit, there being no signs of a secondary lightcurve.

3309 Brorfelde was discovered to be a binary asteroid in 2005 (Warner et al., 2005). Follow up observations were conducted in 2009 January at the Palmer Divide Observatory to confirm the original findings and to see if the lightcurve had evolved, specifically, if the mutual events (occultations and eclipses) due to the satellite had changed shape or magnitude.

Images were obtained using a Meade LX200 GPS 0.35-m Schmidt-Cassegrain and SBIG STL-1001E CCD camera. The 240-second exposures were with a clear filter and guided. The images were processed with flats and darks and then measured using differential aperture photometry in *MPO Canopus*. The dual period search in *Canopus*, based on the FALC algorithm (Harris et al., 1989) as modified by Pravec (Pravec et al., 2006), was used to analyze the data. Figures 1 through 3 show, respectively, the entire data set, the rotation of the primary only, and the mutual events as a result of subtracting the primary's lightcurve. Table 1 compares the results from 2005 and 2009. The results for the periods and size ratio are nearly identical. However, the 2005 apparition showed a deeper primary eclipse (~0.15 mag versus ~0.09 mag in 2009), indicating that in 2009 only occultations or eclipses, but not both, were seen (Pravec, private communications). These differences will allow more accurate modeling of the system.

Year	Primary (hrs)	Orbit (hrs)	Ds/Dp
2005	2.5041 ± 0.0002	18.48 ± 0.01	0.26 ± 0.02
2009	2.5046 ± 0.0003	18.45 ± 0.01	0.25 ± 0.02

Table 1. The parameters for 3309 Brorfelde in 2005 and 2009. Ds/Dp is the ratio of the secondary to the primary diameter based on the depths of the mutual events.

Acknowledgements

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Warner, B.D., Pravec, P., Kušnirák, P., Cooney, W., Gross, J., Terrell, D., and Nudds, S. (2005). *CBET* **279**.

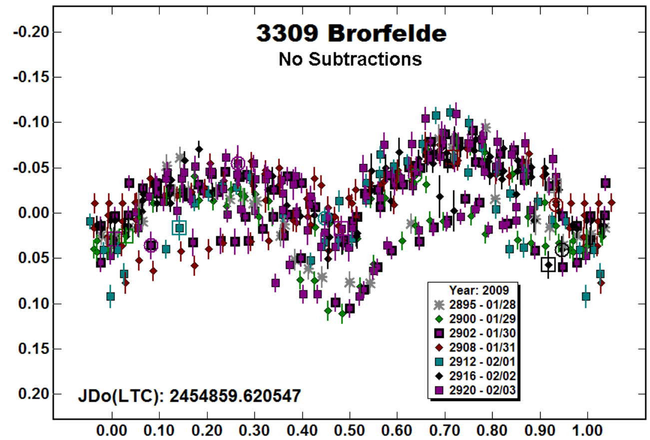

Figure 1. The lightcurve of 3309 Brorfelde with no subtractions.

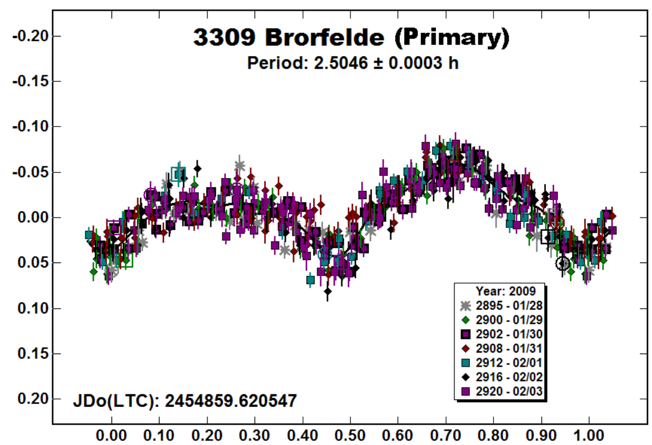

Figure 2. The lightcurve of showing only the primary's rotation.

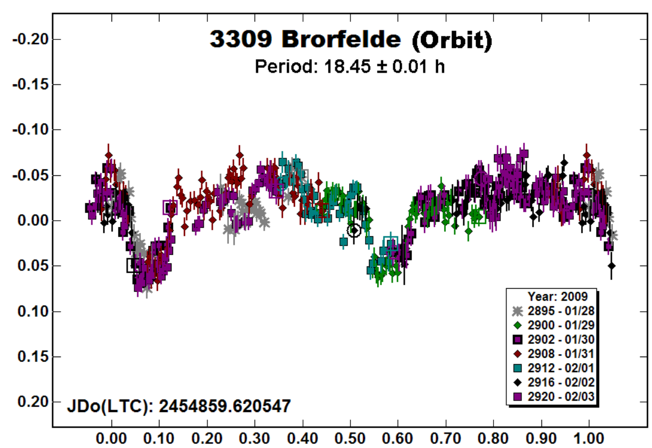

Figure 3. The lightcurve showing the mutual events.

ASTEROID LIGHTCURVE ANALYSIS AT THE PALMER DIVIDE OBSERVATORY: 2008 DECEMBER – 2009 MARCH

Brian D. Warner
Palmer Divide Observatory/Space Science Institute
17995 Bakers Farm Rd., Colorado Springs, CO 80908 USA
brian@MinorPlanetObserver.com

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Lightcurves for 34 asteroids were obtained at the Palmer Divide Observatory from 2008 December through 2009 March: 91 Aegina, 261 Prymno, 359 Georgia, 402 Chloe, 497 Iva, 506 Marion, 660 Crescentia, 691 Lehigh, 731 Sorga, 779 Nina, 802 Epyaxa, 908 Buda, 1015 Christa, 1518 Rovaniemi, 1600 Vyssotsky, 1656 Suomi, 2000 Herschel, 2735 Ellen, 3169 Ostro, 3854 George, 3940 Larion, (5558) 1989 WL_2, (5747) 1991 CO_3, 6517 Buzzi, (11304) 1993 DJ, (22195) 3509 P-L, (26383) 1999 MA_2, (29780) 1999 CJ_{50}, (45878) 2000 WX_{29}, (45898) 2000 XQ_{49}, (76800) 2000 OQ_{35}, (76929) 2001 AX_{34}, (87343) 2000 QH_{25}, and (207398) 2006 AS_2.

Observations of 34 asteroids were made at the Palmer Divide Observatory (PDO) from 2008 December through 2009 March. One of four telescope/camera combinations was used: 0.5m Ritchey-Chretien/SBIG STL-1001E, 0.35m SCT/FLI IMG-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. All exposures were guided and from 30-240 s. Most observations were made with no filter but, for example, when a nearly full moon was present, a Cousins R or SDSS r´ filter was used to decrease the sky background. 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 of variation is greater than it actually is, which can create the impression of a physically implausible lightcurve. There are some cases where the scale has been modified, those being mostly for low amplitude lightcurves, where the above scaling would have resulted in a nearly flat plot. Even so, the vertical scale has been expanded as little as possible to avoid creating misleading interpretations.

Many of the asteroids here were observed to resolve discrepancies among previous results and/or to provide additional data for shape and spin axis modeling. A number of the asteroids were found to have long periods. In these cases, night-to-night calibration of the data became critical. This was done using field stars converted to approximate Cousins R magnitudes based on 2MASS J-K colors (see Warner 2007b and Stephens 2008).

91 Aegina. The period of 6.030 h found here agrees with those found by Harris (1980) and Shevchenko (1997) although the amplitude of 0.27 mag found here is nearly double of any previous results.

261 Prymno. The period of 8.007 h agrees with the 8.002 h found by Harris (1989).

359 Georgia. Previous periods of 7.3 h (Lagerkvist, 1978) and 13.25 (Gil-Hutton, 1995) do not agree with the period of 5.537 h found here and 5.5334 h by Behrend (2009).

402 Chloe. Since at least two, significantly different periods had been previously reported: 9.765 h (Wetter, 1998) and 7.11 h (Denchev, 2000; Behrend, 2009), this asteroid was observed to see if it was possible to find a definitive period. Based on four nights in 2009 February, a period of 10.664 h was found. The PDO data do not fit the previously reported periods.

497 Iva. This asteroid was observed to resolve the discrepancy between the periods found by Harris (1983, 4.62 h) and Behrend (2009, 4.42 h). Data obtained on 2009 Jan 9-11 found a period of 4.621 h, confirming the period found by Harris.

506 Marion. Robinson and Warner (2002) reported a period of 10.58 h, Gil-Hutton and Canada (2003) found 18.505 h, while Behrend (2009) reported one of 13.546 h. The new PDO data confirm Behrend's period, finding 13.538 h based on four sessions in 2009 February.

660 Crescentia. This asteroid was observed to resolve the discrepancy between Harris (1980, 7.92 h) and Behrend (2009, 9.1 h). The Harris result was confirmed, with the new data finding a period of 7.910 h.

691 Lehigh. Previously reported periods were: 5.08 h (Stephens, 2000), 10.482 h (Menke, 2005), and 12.86 h (Behrend, 2009). The PDO found a period of 12.891 h, confirming the Behrend solution. A solution of 14.502 h was also found but the fit of the data was not nearly as good.

731 Sorga. This was follow up to previous work (Warner 2005) which found P = 8.184 h, A = 0.52 mag. The new data found P = 8.192 h, A = 0.19 mag.

779 Nina. The result of P = 11.17 h agrees with P = 11.186 h found by Harris et al. (1992).

908 Buda. Binzel (1987) reported P = 18.20 h and Behrend (2009) P = 14.575 h. The PDO result was P = 14.572 h.

1015 Christa. Behrend (2009) found P = 12.189 h, based on three sessions with gaps of one week to one month between successive sessions. The PDO data, four sessions of which were on consecutive nights, support P = 11.230 and do not fit the longer period.

1518 Rovaniemi. The period of P = 5.249 h agrees with Behrend (2009).

1600 Vyssotsky. The author has worked this asteroid several times in the past (Warner, 1999, 2006a, 2008). It was worked in 2009 with the hope of improving the shape model reported by Warner et al. (2008). Unfortunately, the additional data lead to finding physically improbable solutions (confirmed by Josef Durech, private communications). Plans are to observe the asteroid at its next apparition with renewed hopes for a more definitive spin axis solution.

1656 Suomi. Wisniewski (1997) found *P* = 2.42 h while Stephens (2004) and Brinsfield (2008) both found *P* = 2.59 h, but each with noisy data that precluded a definitive solution. The PDO data had much lower errors, allowing a reliable solution of *P* = 2.583 h.

2000 Herschel. Durkee (2009) found a period of 32 h. The PDO data found 64 h with a bimodal curve of *A* = 0.40 mag. The large amplitude makes the bimodal solution very likely.

2735 Ellen. This is one of the long-period asteroids in this work that relied on night-to-night calibrations. The results were *P* = 159 ± 2 h, *A* = 1.5 ± 0.05 mag.

3854 George. Previous work by Warner et al. (2006b) reported the possibility that this Hungaria asteroid is a binary. No evidence of mutual events was found at this apparition, though it should be noted that the viewing aspects were 135° from one another, and so not at right angles. It's considered unlikely at this time that the asteroid is binary but observations with sufficiently different viewing aspects should be obtained in the future to rule out the possibility entirely.

3940 Larion. The period of *P* = 84 ± 2 h refutes the previous finding of *P* = 4.04 h by the author (Warner, 2007a), which did not properly calibrate night-to-night data and so "latched onto" noise. This emphasizes the need for such calibrations in order to see slow trends in the data that might otherwise be overlooked.

(5558) 1989 WL2. Calibrated data and large amplitude make the solution of *P* = 73.9 ± 0.5 h secure.

6517 Buzzi. The solution, *P* = 8.648 h, agrees with the previous result reported by the author (Warner, 2005).

(22195) 3509 P-L. The plot is for *P* = 14.56 h. A solution of *P* = 9.07 h cannot be formally excluded.

(29780) 1999 CJ50. Calibrated data and large amplitude make the solution of *P* = 63.5 ± 0.05 h secure.

(45878) 2000 WX29. Two solutions, *P* = 8.03 h and its double, *P* = 16.07 h, are possible. Plots for each period are included. The phase angle was < 10° at the time of the observations. This would tend to favor the monomodal lightcurve and, therefore, the shorter period.

(76800) OQ35. Calibrated data, large amplitude, and coverage of most of the curve make the solution of *P* = 392 ± 2 h secure.

(76292) 2001 AX34. The result of *P* = 36.2 ± 0.2 h seems secure. A search around the double period, P ~ 72 h, found a solution but the fit of the data was too contrived to give it much confidence.

#	Name	mm/dd *2008/2009	Data Pts	α	PAB_L	PAB_B	Per (h)	PE	Amp (mag)	AE
91	Aegina	02/07-02/12	284	23.7,24.3	79	2.4	6.030	0.001	0.27	0.01
261	Prymno	03/08-03/16	472	5.1,3.1	174	5.0	8.007	0.002	0.13	0.01
359	Georgia	02/07-02/10	144	19.2,19.6	80	7.5	5.537	0.002	0.23	0.02
402	Chloe	02/07-02/17	383	19.8,22.2	96	-5.5	10.664	0.001	0.30	0.01
497	Iva	01/09-01/11	223	18.9,19.4	68	5.6	4.621	0.001	0.34	0.02
506	Marion	02/22-02/26	946	6.5,8.2	139	-3.6	13.546	0.002	0.21	0.01
660	Crescentia	03/09-03/15	389	15.4,17.1	131	-5.7	7.910	0.002	0.29	0.01
691	Lehigh	01/09-01/16	275	17.4,18.7	62	-4.5	12.891	0.003	0.14	0.01
731	Sorga	02/10-02/17	226	9.7,11.5	114	12.0	8.192	0.003	0.18	0.02
779	Nina	01/09-01/11	491	15.2,15.7	71	7.5	11.17	0.01	0.32	0.02
809	Epyaxa	01/13-01/14	159	23.4,23.2	353	-3.2	4.392	0.002	0.47	0.02
908	Buda	03/09-03/15	418	12.3,14.0	155	17.6	14.572	0.005	0.29	0.02
1015	Christa	01/09-01/16	462	16.5,17.6	59	-8.5	11.230	0.004	0.12	0.01
1518	Rovaniemi	01/13-01/14	222	10.6,11.0	100	9.6	5.249	0.002	0.25	0.01
1600	Vyssotsky (H)	02/17-02/20	142	27.5,26.8	184	27.8	3.201	0.001	0.16	0.01
1656	Suomi (H)	03/21	147	10.0	191	8.4	2.583	0.004	0.11	0.01
2000	Herschel (H)	*12/11-01/13	594	29.2,33.9	52	22.0	64.	1.	0.40	0.03
2735	Ellen (H)	02/18-03/08	529	10.9,0.1,9.1	164	0.2	159.	1.	1.5	0.05
3169	Ostro (H)	03/21-03/22	131	27.9,28.1	151	32.9	6.504	0.002	0.58	0.02
3854	George (H)	02/17-02/20	174	18.6,17.4	160	21.5	3.338	0.001	0.12	0.01
3940	Larion (H)	01/15-01/25	313	24.6,26.6	86	-31.0	84.	2.	0.30	0.05
5558	1989 WL2 (H)	01/18-02/05	394	10.5,5.2	116	-12.2	73.9	0.5	0.70	0.05
5747	1991 CO3	*12/19-01/03	285	22.1,26.3	61	18.5	38.6	0.1	0.30	0.03
6517	Buzzi (H)	02/27-03/01	175	17.2,16.9	172	23.6	8.648	0.005	0.80	0.03
11304	1993 DJ (H)	01/14-01/28	543	12.5,5.7	129	-9.7	95.7	0.2	0.40	0.05
22195	3509 P-L	02/28-03/17	258	18.7,7.9	186	2.3	14.56/9.07	0.01	0.19	0.01
26383	1999 MA2 (H)	01/14-01/29	137	20.6,17.9	355	-0.8	4.889	0.001	0.35	0.03
29780	1999 CJ50	*12/28-01/20	488	12.3,9.5,12.7	107	10.0	63.50	0.05	0.58	0.03
45878	2000 WX29 (H)	01/18-01/29	295	9.3,4.8	131	-5.4	8.03/16.07	0.03	0.05	0.01
45898	2000 XQ49 (H)	01/16-01/17	95	21.2,21.4	93	22.0	5.424	0.004	1.14	0.02
76800	2000 OQ35 (H)	01/29-02/27	1176	16.7,9.4,11.6	146	13.0	392.	2.	1.4	0.05
76929	2001 AX34 (H)	01/30-02/05	340	6.7,3.1	140	3.7	36.2	0.2	0.19	0.02
87343	2000 QH25 (H)	03/04-03/18	381	8.9,6.0	171	5.8	22.6	0.1	0.06	0.01
207398	2006 AS2	02/04-02/07	308	25.9,43.1	118	4.4	4.480	0.002	0.20	0.01

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. PAB_L and PAB_B are the average phase angle bisector longitude and latitude.

<u>(87343) 2000 QH25</u>. This lightcurve warrants only U = 1 (see Warner et al., 2009, for a discussion of the U quality rating in the asteroid Lightcurve Database, LCDB). The data sets were internally calibrated and no long-term trend was found that would indicate a very long period.

<u>(207368) 2006 AS2</u>. Observations were made in support of radar observations. Benner (private communications) reported that the latter indicated a size of ~300 meters and put an upper bound on the rotation period of ~7 h.

Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grants NNG06GI32G and NNX 09AB48G, by National Science Foundation grant AST-0607505, and by a Gene Shoemaker NEO Grant from the Planetary Society.

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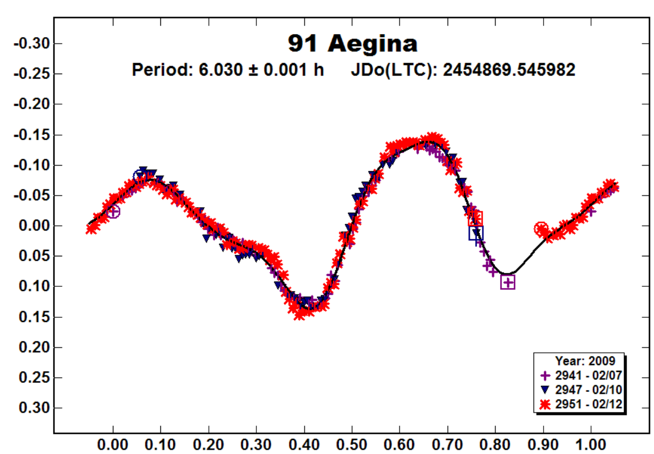

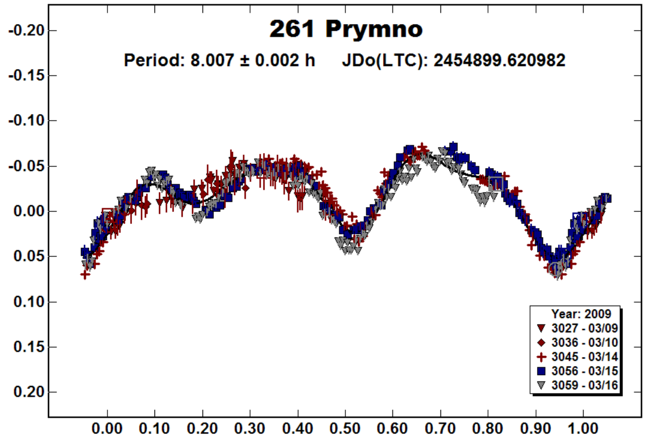
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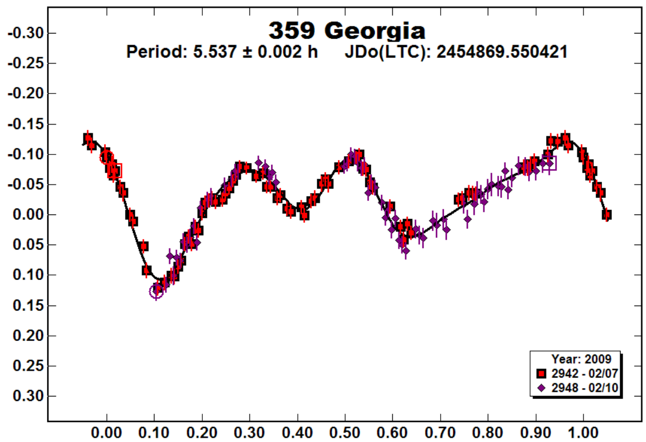
3036 - 03/10
3045 - 03/14
3056 - 03/15
3059 - 03/16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Period: 5.537 ± 0.002 h JDo(LTC): 2454869.550421
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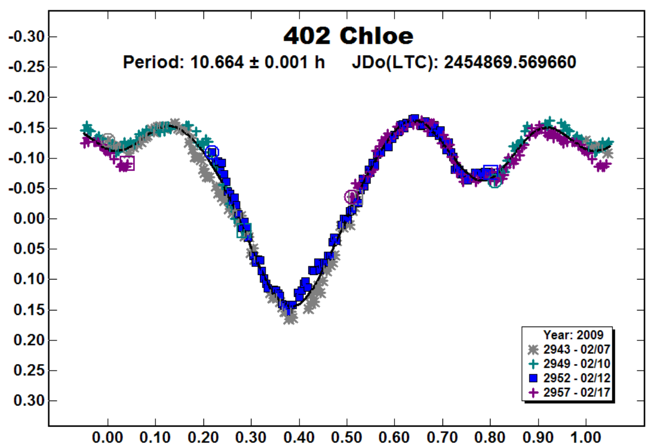
2942 - 02/07
2948 - 02/10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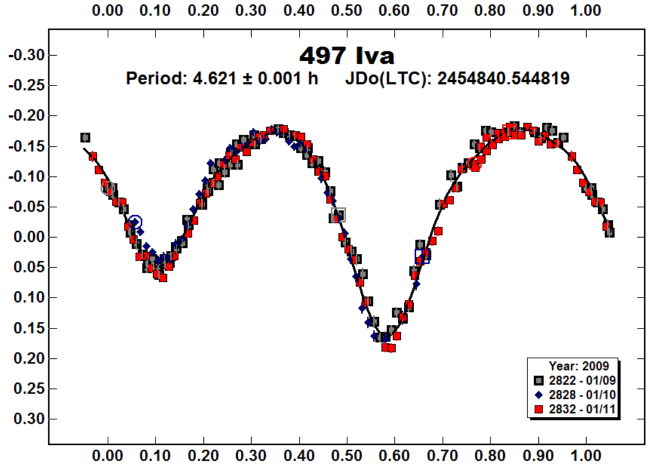
2943 - 02/07
2949 - 02/10
2952 - 02/12
2957 - 02/17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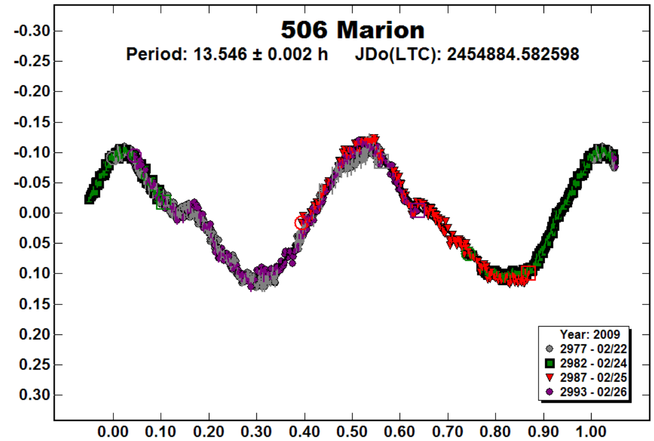
Period: 4.621 ± 0.001 h JDo(LTC): 2454840.544819
Year: 2009
2822 - 01/09
2828 - 01/10
2832 - 01/11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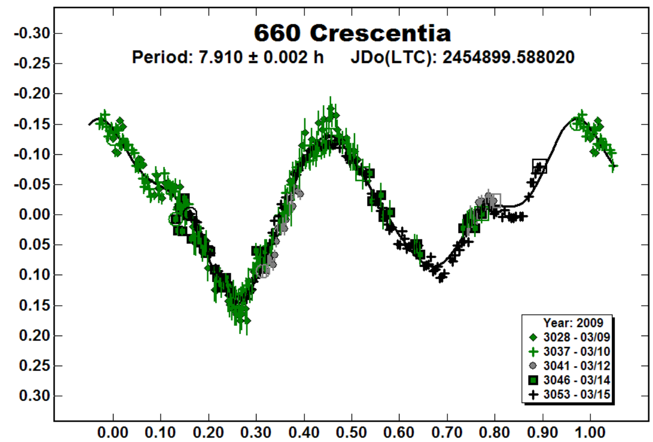
2977 - 02/22
2982 - 02/24
2987 - 02/25
2993 - 02/26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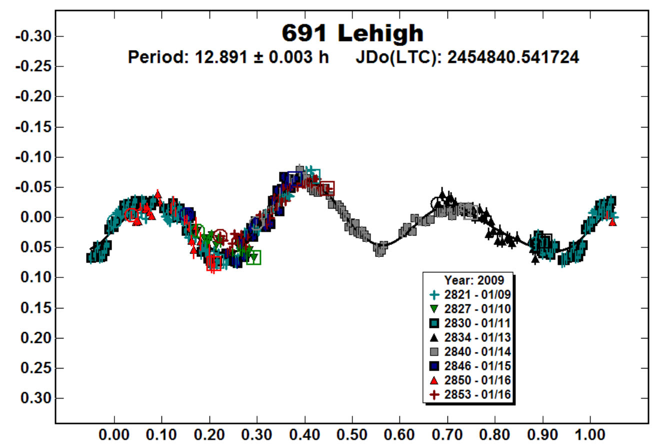
3046 - 03/14
3053 - 03/15


691 Lehigh
Period: 12.891 ± 0.003 h JDo(LTC): 2454840.541724
Year: 2009
2821 - 01/09
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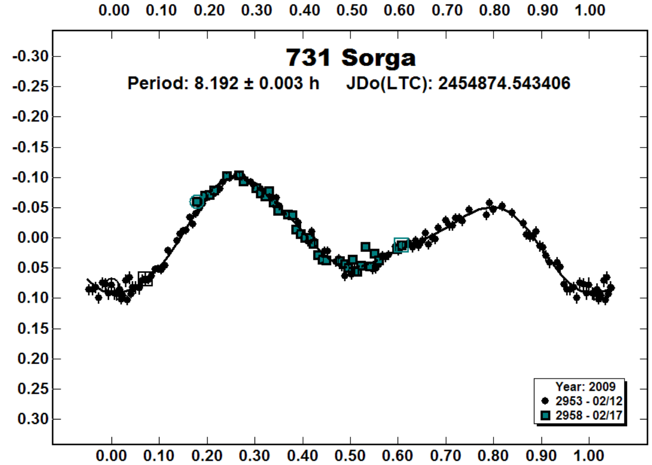
2850 - 01/16
2853 - 01/16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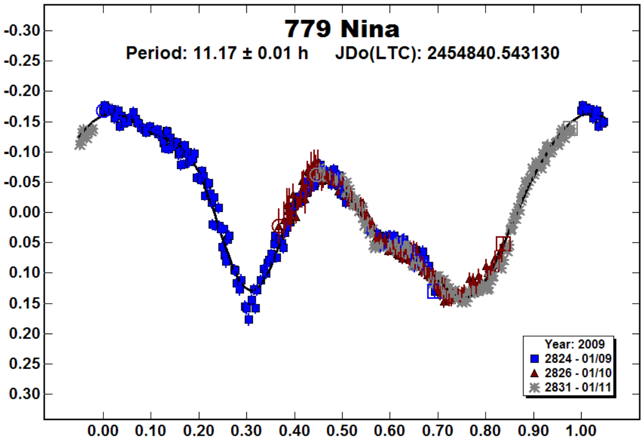
2953 - 02/12
2958 - 02/17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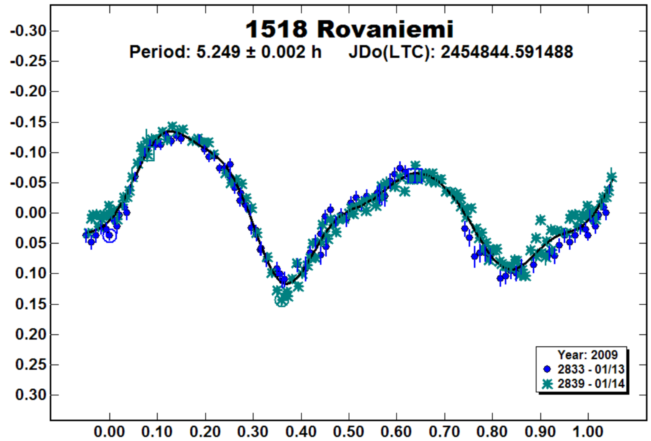
2831 - 01/11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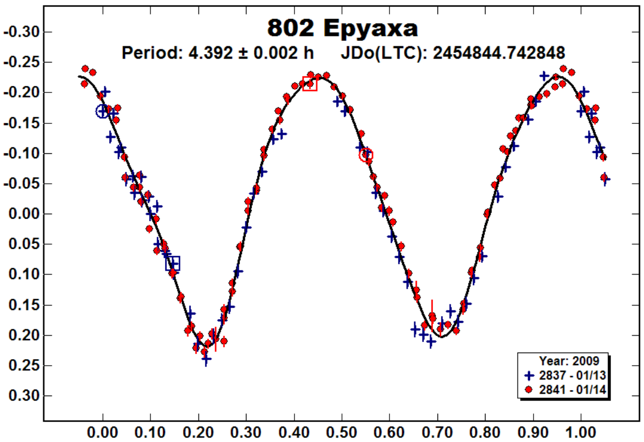
2833 - 01/13
2839 - 01/14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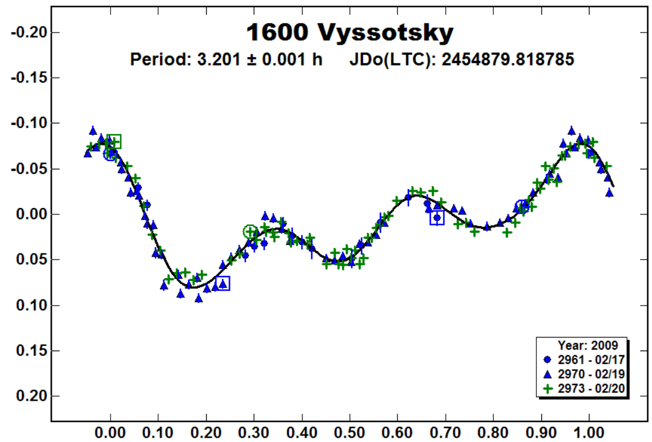
Period: 4.392 ± 0.002 h JDo(LTC): 2454844.742848
Year: 2009
2837 - 01/13
2841 - 01/14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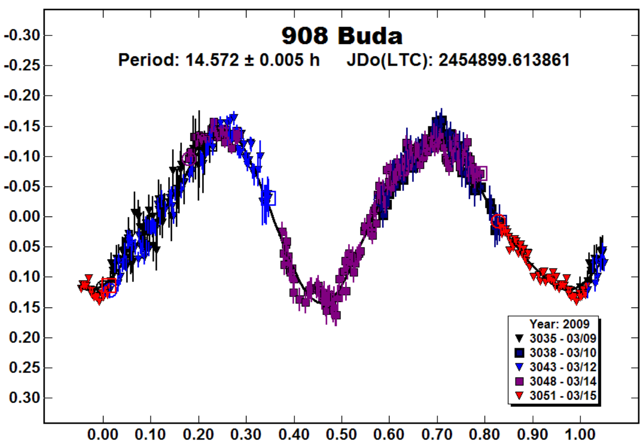
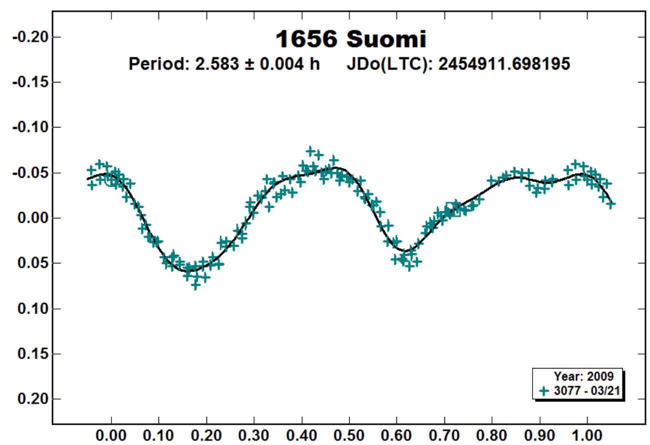
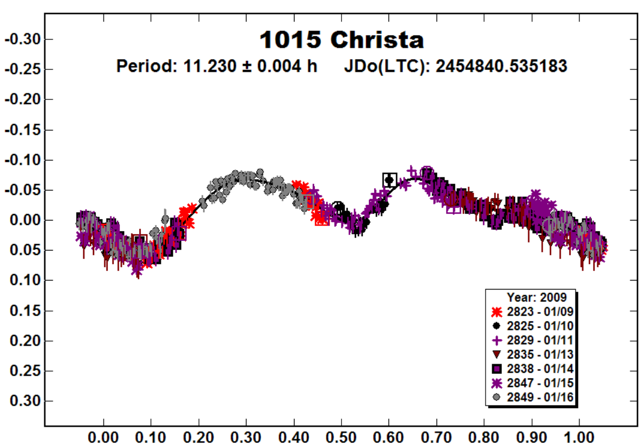
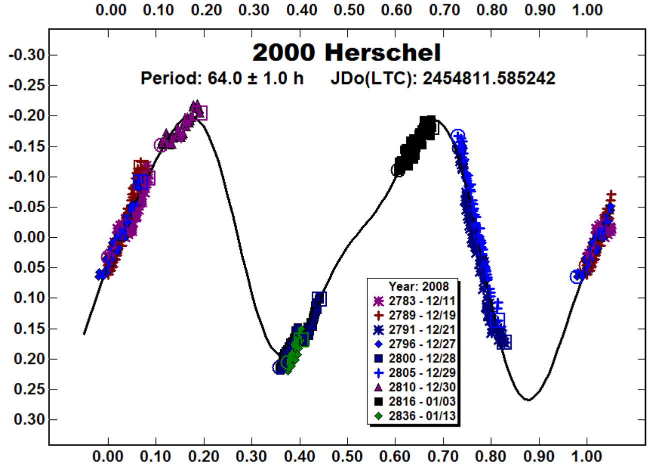
Year: 2009
2961 - 02/17
2970 - 02/19
2973 - 02/20


908 Buda
Period: 14.572 ± 0.005 h JDo(LTC): 2454899.613861
Year: 2009
3035 - 03/09
3038 - 03/10
3043 - 03/12
3048 - 03/14
3051 - 03/15


1656 Suomi
Period: 2.583 ± 0.004 h JDo(LTC): 2454911.698195
Year: 2009
3077 - 03/21


1015 Christa
Period: 11.230 ± 0.004 h JDo(LTC): 2454840.535183
Year: 2009
2823 - 01/09
2825 - 01/10
2829 - 01/11
2835 - 01/13
2838 - 01/14
2847 - 01/15
2849 - 01/16


2000 Herschel
Period: 64.0 ± 1.0 h JDo(LTC): 2454811.585242
Year: 2008
2783 - 12/11
2789 - 12/19
2791 - 12/21
2796 - 12/27
2800 - 12/28
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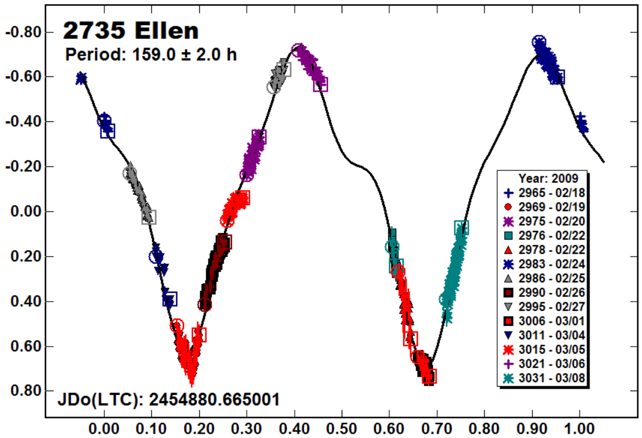
2810 - 12/30
2816 - 01/03
2836 - 01/13


2735 Ellen
Period: 159.0 ± 2.0 h
JDo(LTC): 2454880.665001
Year: 2009
2965 - 02/18
2969 - 02/19
2975 - 02/20
2976 - 02/22
2978 - 02/22
2983 - 02/24
2986 - 02/25
2990 - 02/26
2995 - 02/27
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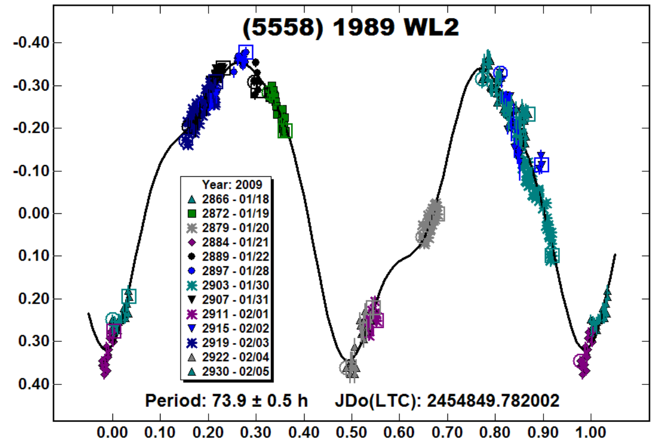
3021 - 03/06
3031 - 03/08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Period: 73.9 ± 0.5 h
JDo(LTC): 2454849.782002
Year: 2009
2866 - 01/18
2872 - 01/19
2879 - 01/20
2884 - 01/21
2889 - 01/22
2897 - 01/28
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2907 - 01/31
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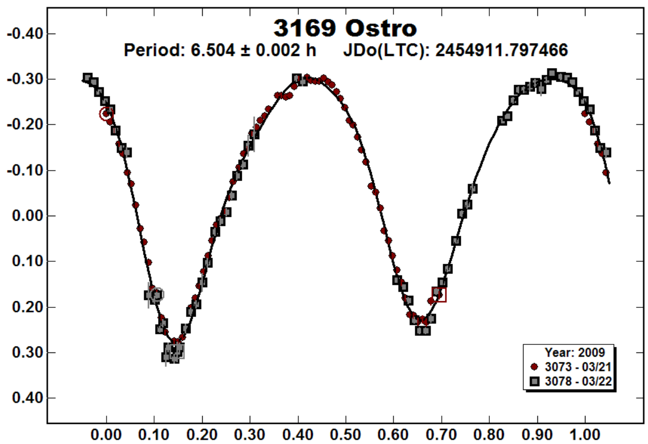
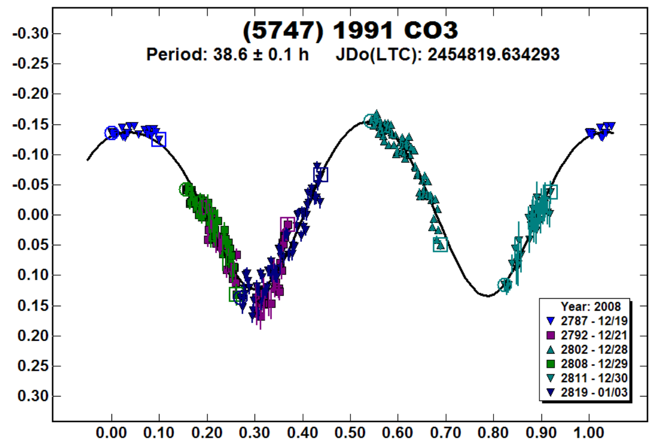
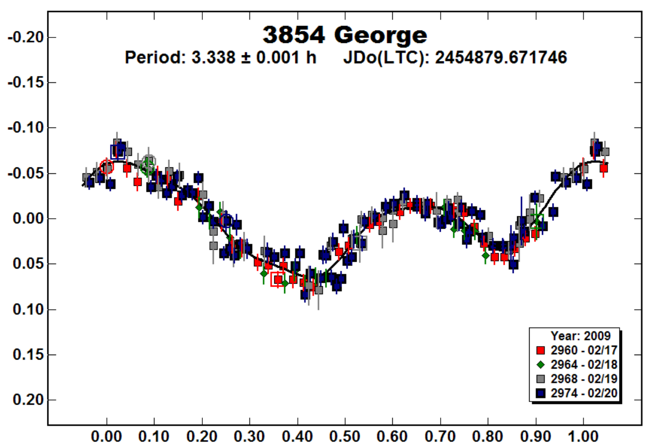
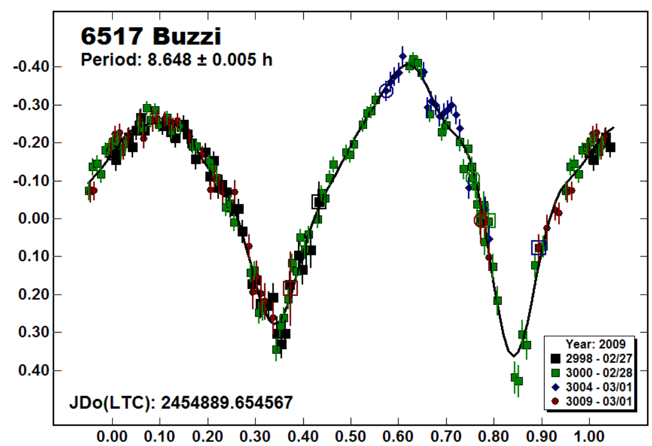
2922 - 02/04
2930 - 02/05


3169 Ostro
Period: 6.504 ± 0.002 h
JDo(LTC): 2454911.797466
Year: 2009
3073 - 03/21
3078 - 03/22


(5747) 1991 CO3
Period: 38.6 ± 0.1 h
JDo(LTC): 2454819.634293
Year: 2008
2787 - 12/19
2792 - 12/21
2802 - 12/28
2808 - 12/29
2811 - 12/30
2819 - 01/03


3854 George
Period: 3.338 ± 0.001 h
JDo(LTC): 2454879.671746
Year: 2009
2960 - 02/17
2964 - 02/18
2968 - 02/19
2974 - 02/20


6517 Buzzi
Period: 8.648 ± 0.005 h
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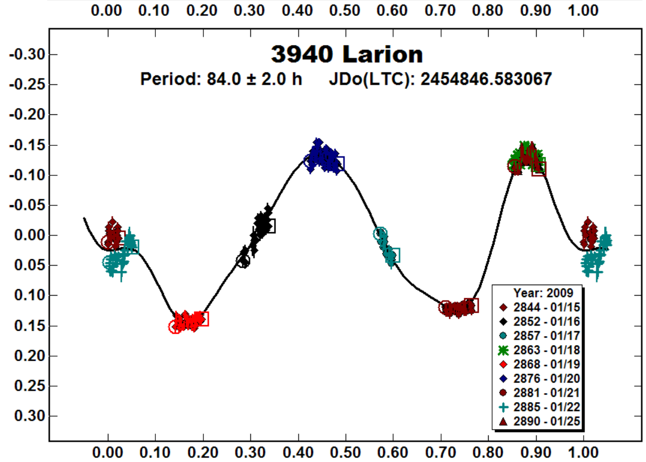
Year: 2009
2998 - 02/27
3000 - 02/28
3004 - 03/01
3009 - 03/01


3940 Larion
Period: 84.0 ± 2.0 h
JDo(LTC): 2454846.583067
Year: 2009
2844 - 01/15
2852 - 01/16
2857 - 01/17
2863 - 01/18
2868 - 01/19
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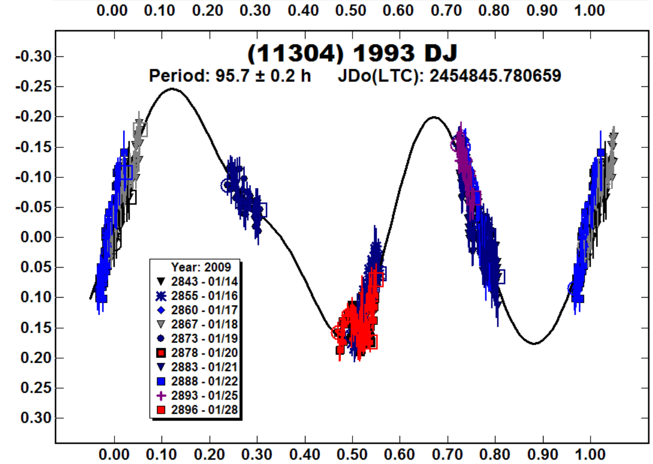
2890 - 01/25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Period: 95.7 ± 0.2 h
JDo(LTC): 2454845.780659
Year: 2009
2843 - 01/14
2855 - 01/16
2860 - 01/17
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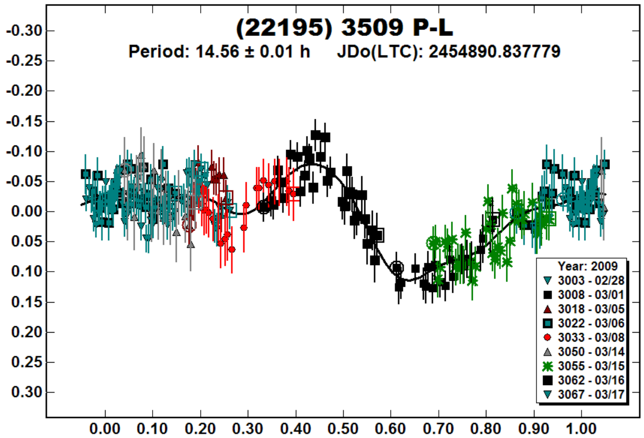
2896 - 01/28


(22195) 3509 P-L
Period: 14.56 ± 0.01 h JDo(LTC): 2454890.837779
Year: 2009
3003 - 02/28
3008 - 03/01
3018 - 03/05
3022 - 03/06
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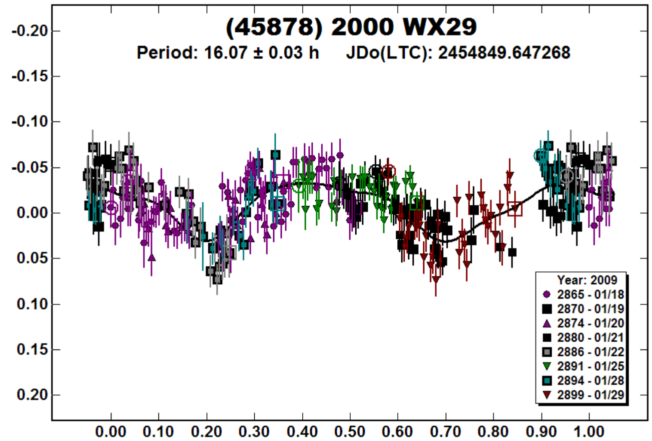
3062 - 03/16
3067 - 03/17


(45878) 2000 WX29
Period: 16.07 ± 0.03 h JDo(LTC): 2454849.647268
Year: 2009
2865 - 01/18
2870 - 01/19
2874 - 01/20
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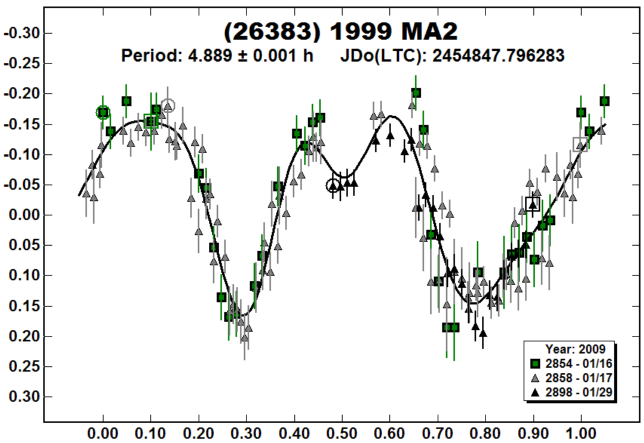
2891 - 01/25
2894 - 01/28
2899 - 01/29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Year: 2009
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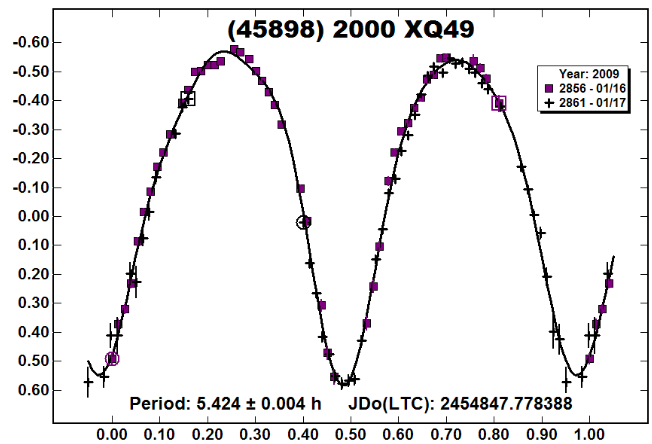
2858 - 01/17
2898 - 01/29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Year: 2009
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2861 - 01/17
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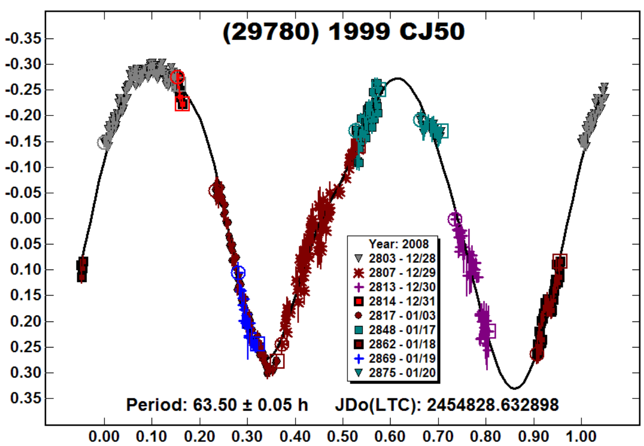
(29780) 1999 CJ50
Year: 2008
2803 - 12/28
2807 - 12/29
2813 - 12/30
2814 - 12/31
2817 - 01/03
2848 - 01/17
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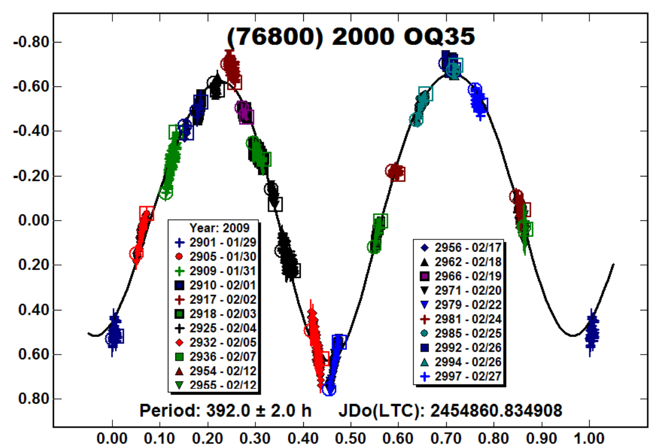
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Year: 2009
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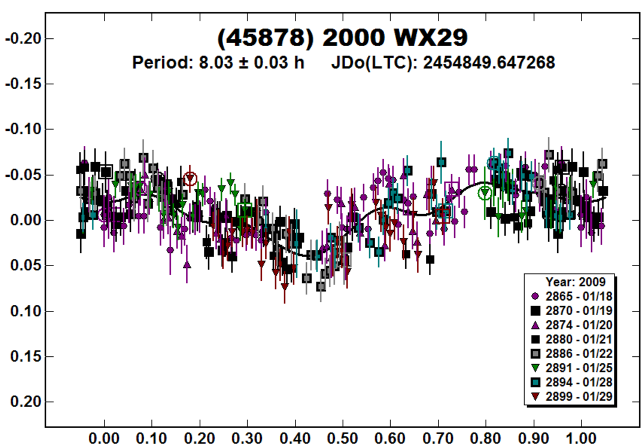
2905 - 01/30
2909 - 01/31
2910 - 02/01
2917 - 02/02
2918 - 02/03
2925 - 02/04
2932 - 02/05
2936 - 02/07
2954 - 02/12
2955 - 02/12
2956 - 02/17
2962 - 02/18
2966 - 02/19
2971 - 02/20
2979 - 02/22
2981 - 02/24
2985 - 02/25
2992 - 02/26
2994 - 02/26
2997 - 02/27
Period: 392.0 ± 2.0 h JDo(LTC): 2454860.834908


(45878) 2000 WX29
Period: 8.03 ± 0.03 h JDo(LTC): 2454849.647268
Year: 2009
2865 - 01/18
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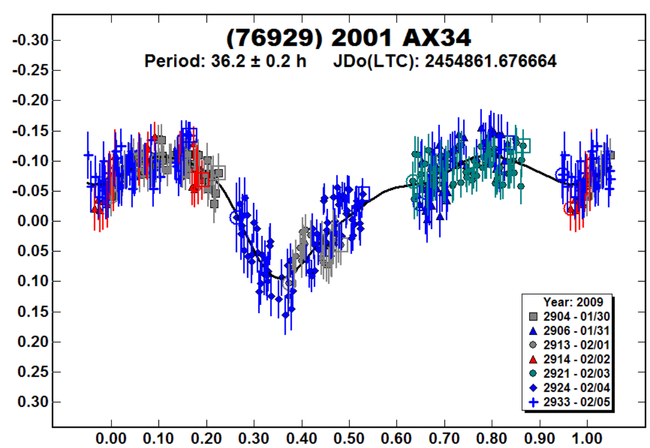
2899 - 01/29


(76929) 2001 AX34
Period: 36.2 ± 0.2 h JDo(LTC): 2454861.676664
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2904 - 01/30
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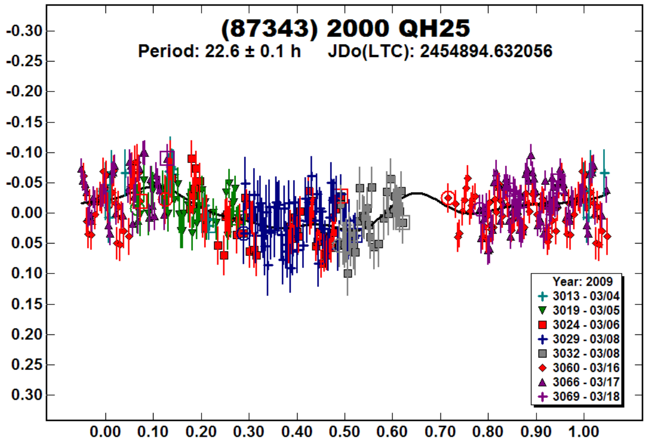
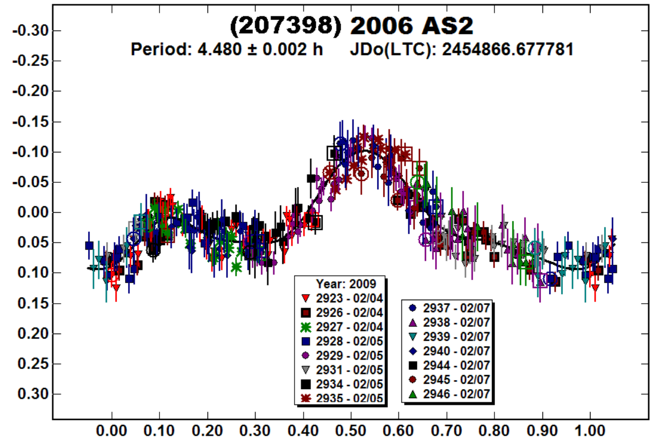
2933 - 02/05





RELATIVE PHOTOMETRY OF NINE ASTEROIDS FROM MODRA

Adrián Galád
Modra Observatory,
Department of Astronomy, Physics of the Earth, and Meteorology
FMFI UK, 842 48 Bratislava, SLOVAKIA
and
Astronomical Institute AS CR, 251 65 Ondřejov,
CZECH REPUBLIC
galad@fmph.uniba.sk

Jozef Világi, Leonard Kornoš, Štefan Gajdoš
Modra Observatory,
Department of Astronomy, Physics of the Earth, and Meteorology
FMFI UK, 842 48 Bratislava,
SLOVAKIA

(Received: 2009 Apr 6)

We present photometric observations of asteroids 100 Hekate, 718 Erida, 2857 NOT, 3928 Randa, 4758 Hermitage, 4935 Maslachkova, 9000 Hal, (68181) 2001 BK49, and 2008 EV5.

Routine photometric observations of main belt asteroids with unknown or poorly known rotation periods were conducted at Modra observatory with its 0.6-m f/5.5 reflector and AP8p CCD camera. The field of view of 25’ x 25’ is appropriate to link relative data from consecutive nights for main belt asteroids if needed.

100 Hekate. Rotation periods of bright asteroids (V<13) are usually well known. Additional photometric observations in different apparitions help construct their shapes and pole positions. Moreover, since some stellar occultation data are usually available for bright asteroids, the shape (and size) may be better derived. One positive occultation by this object was observed also in Modra in 2005. We decided to add photometric data as well (though from a different apparition). Tedesco (1979) and Hainaut-Rouelle et al. (1995) estimated P > 10 h. Based on observations during five consecutive nights in 1988, Gil-Hutton (1990) reported the rotation period P = 13.333 ± 0.005 h and amplitude A = 0.11 ± 0.01 mag for this asteroid, which seemed to be a secure result. However, observations during two nights 16 days apart in 2005 by Roy (Behrend, 2009) did not support it. Instead, somewhat longer period was suggested, namely 16.944 h. Our first data in February 2008 confirmed the longer period, but were in contrast with previous solutions. Therefore, more sessions were added that revealed a peculiar shape of the lightcurve and the secure result for the period.

718 Erida. It is strange that only one photometric observation was known for this bright target prior to our sessions. In 2007 Leroy (Behrend, 2009) recorded the descending branch of the lightcurve, so the rotation period was estimated to be > 12 h. We obtained a secure result.

2857 NOT. This asteroid was observed from Modra as a byproduct target in the previous apparition (Galád and Kornoš, 2008). Two solutions were possible to fit data at that time so we used the data from the recent favourable apparition to find the true period. We confirmed the previously determined period, making the secure result.

3928 Randa. Randa was observed during 14 nights as a target of Photometric Survey for Asynchronous Binary Asteroids (PSABA, Pravec, 2005). Despite the fact that some data were mutually linked to the same magnitude level, we did not obtain a secure

Number	Name	Dates yyyy mm/dd	Phases deg	LPAB deg	BPAB deg	Period [h]	Amp [mag]
100	Hekate	2008 02/20-04/05	01.7-09.1	168	5	27.066 ± 0.002	0.23
718	Erida	2009 01/09-25	14.4-15.8	51	3	17.447 ± 0.002	0.37
2857	NOT	2009 01/10-26	12.7-19.2	148	-1	5.6353 ± 0.0003	0.25
3928	Randa	2008 08/06-23	02.7-11.1	329	3	29.9 ± 0.1	0.12
4758	Hermitage	2007 10/20-12/09	00.7-12.6	42	-1	10.1505 ± 0.0004	0.23
4935	Maslachkova	2008 11/06-18	06.2-09.7	44	-9	2.90192 ± 0.00007	0.23
9000	Hal	2008 07/29-08/25	08.1-14.1	323	10	908 ± 12	0.9
(68181)	2001 BK49	2007 09/29-10/07	09.6-13.0	352	9	5.0366 ± 0.0003	0.82
	2008 EV5	2008 12/24-2009 01/04	31.5-42.8	104-115	-1-21	3.725 ± 0.001	0.06

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.

result for the rotation period, the main reason being the low amplitude of the lightcurve. Except for the solution that is presented here as visually the best one, we cannot rule out longer periods. For example, P ~ 79.9 h also fits data comparatively well.

4758 Hermitage. The rotation period was derived unambiguously based on ten unevenly distributed sessions.

4935 Maslachkova was observed during its favourable apparition as a target of PSABA.

9000 Hal was also a target of PSABA. Its extremely slow rotation period was revealed from three groups of observations linked to a given instrumental magnitude. The solution was assessed based on an assumption that monomodal shape of the lightcurve represents half the actual rotation period.

(68181) 2001 BK49. This asteroid was close to a PSABA target for two nights. It was fainter than 17 mag, but because the amplitude of the lightcurve was large, two more sessions were added and a secure result for the rotation period was obtained.

2008 EV5 is a subkilometer near-Earth asteroid, currently with an Aten type orbit. It was a fast moving bright object during our observations. The shape of the lightcurve changed from the end of December 2008 to the beginning of January 2009 and so we processed two groups of data independently. The nominal values for the synodic rotation periods and amplitudes were $P = 3.7255 \pm 0.0006$ h, $A = 0.06$ mag for the first group and $P = 3.725 \pm 0.002$ h, $A = 0.05$ mag for the second group. The shape of the lightcurve may have changed within the first group alone, but the changes were small.

Acknowledgements

While new software for data analysis that was developed by one of authors (J.V.) was successfully tested on some of the presented targets, we are grateful to Petr Pravec, Ondřejov Observatory, Czech Republic, for his ALC software used here as well. We also thank to Juraj Tóth, Comenius University, Bratislava, for assistance in part of observations. The work was supported by the Slovak Grant Agency for Science VEGA, Grants 2/0016/09 and 1/0636/09, and the Grant Agency of the Czech Republic, Grant 205/09/1107.

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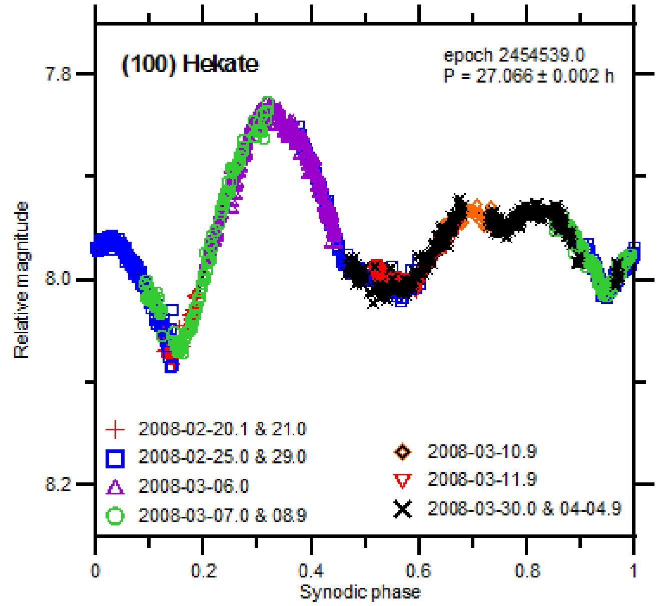

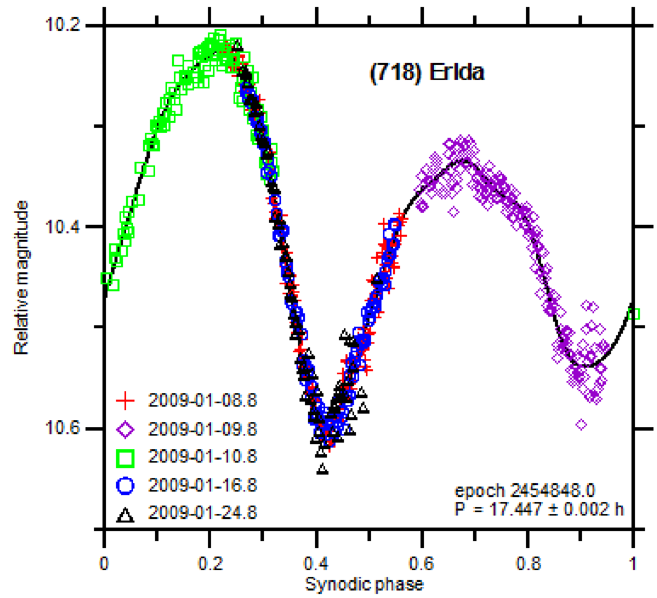

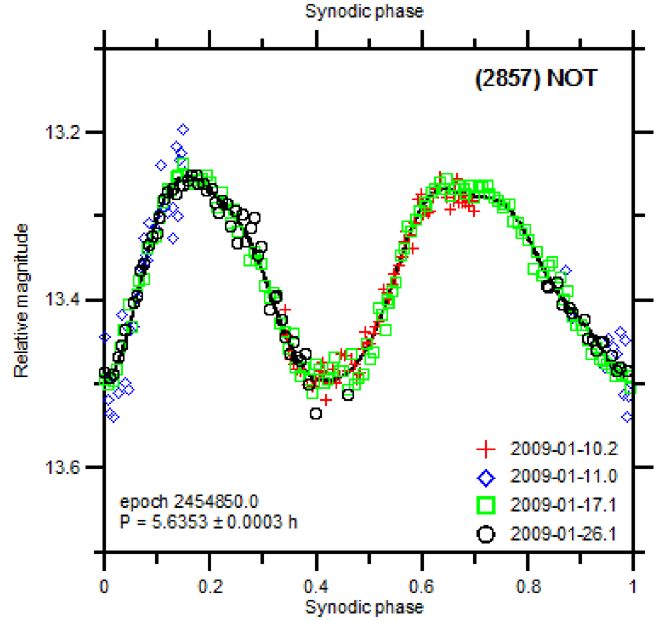

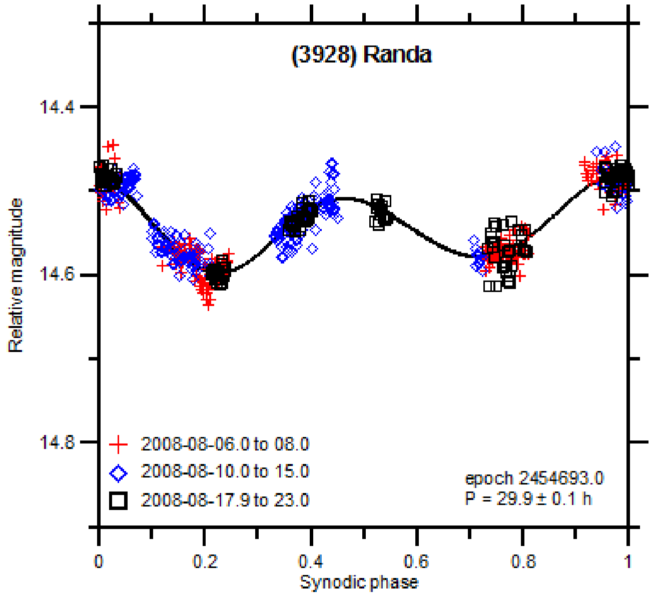
(3928) Randa
Relative magnitude
Synodic phase
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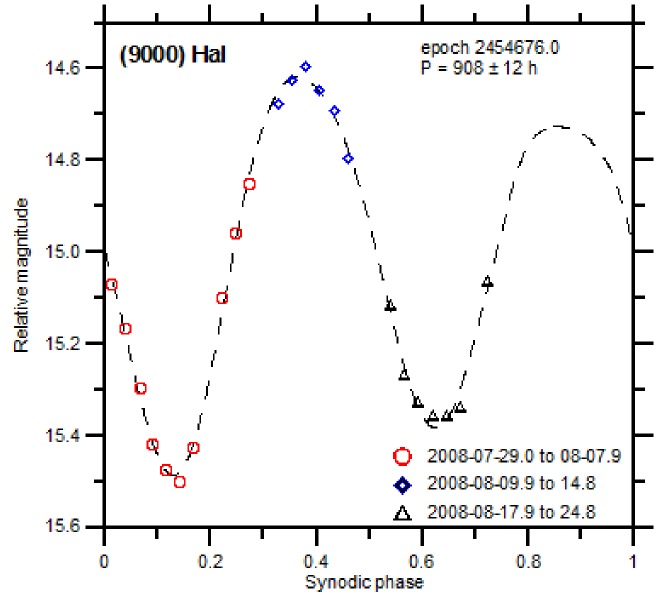
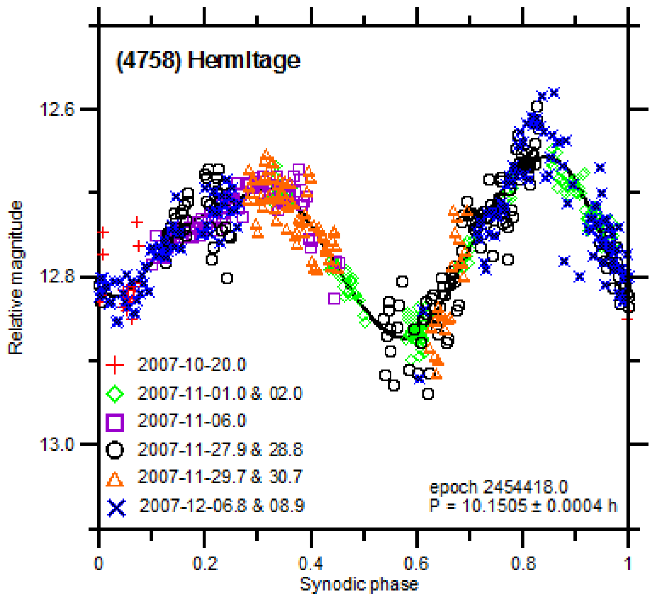
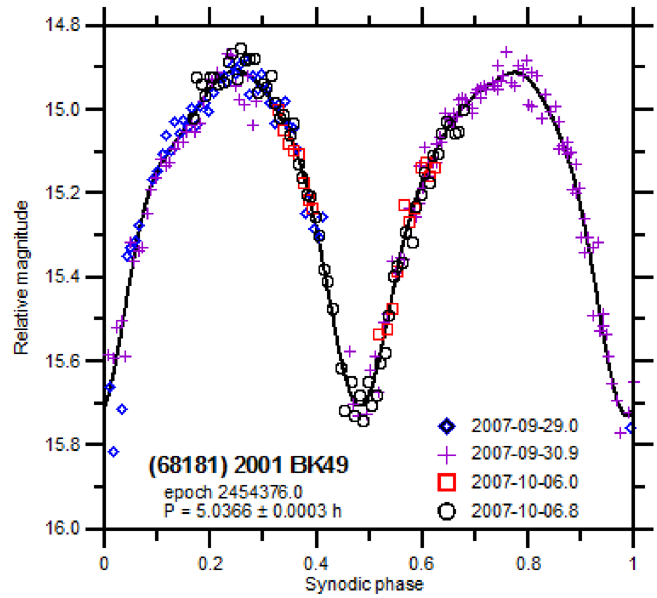
2008-08-10.0 to 15.0
2008-08-17.9 to 23.0
epoch 2454693.0
P = 29.9 ± 0.1 h


(9000) Hal
epoch 2454676.0
P = 908 ± 12 h
Relative magnitude
Synodic phase
2008-07-29.0 to 08-07.9
2008-08-09.9 to 14.8
2008-08-17.9 to 24.8


(4758) Hermitage
Relative magnitude
Synodic phase
2007-10-20.0
2007-11-01.0 & 02.0
2007-11-06.0
2007-11-27.9 & 28.8
2007-11-29.7 & 30.7
2007-12-06.8 & 08.9
epoch 2454418.0
P = 10.1505 ± 0.0004 h


Relative magnitude
Synodic phase
(68181) 2001 BK49
epoch 2454376.0
P = 5.0366 ± 0.0003 h
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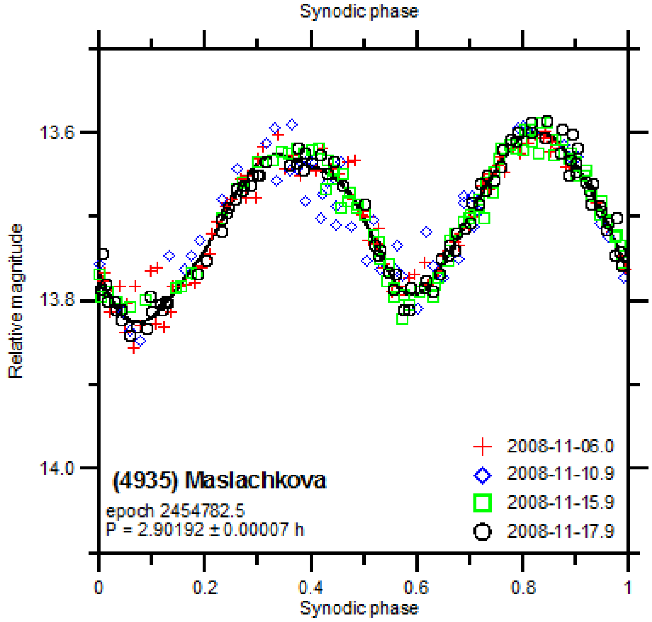
2007-09-30.9
2007-10-06.0
2007-10-06.8


Relative magnitude
Synodic phase
(4935) Maslachkova
epoch 2454782.5
P = 2.90192 ± 0.00007 h
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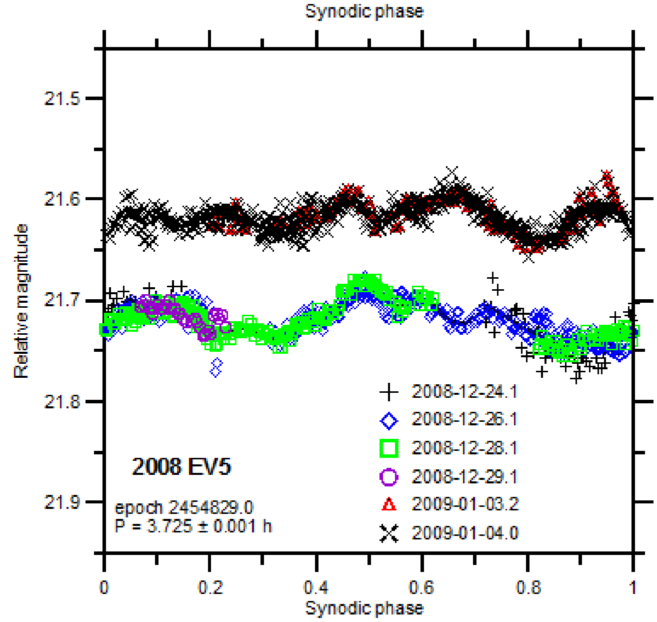
2008-11-15.9
2008-11-17.9


Relative magnitude
Synodic phase
2008 EV5
epoch 2454829.0
P = 3.725 ± 0.001 h
2008-12-24.1
2008-12-26.1
2008-12-28.1
2008-12-29.1
2009-01-03.2
2009-01-04.0

LIGHTCURVES FOR SHAPE MODELING OBTAINED AT THE WISE OBSERVATORY

David Polishook
The Wise Observatory and
the Department of Geophysics and Planetary Sciences
Tel-Aviv University, Tel-Aviv 69978, Israel
david@wise.tau.ac.il

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The asteroids 29 Amphitrite, 107 Camilla, 1620 Geographos, and (5587) 1990 SB were photometrically observed at the Wise Observatory and their lightcurves were used by Josef Durech for the database of asteroid models from inversion techniques. We report here the lightcurves and period analysis of those asteroids.

The shapes of asteroids can be deduced using inversion techniques when the asteroids are observed from different aspects angles and at different apparitions (Kaasalainen et al. 2001). Josef Durech from the Astronomical Institute of the Charles University in Prague is using archival data and new observations to model the shapes of asteroids and calculate their spin axis orientations (http://astro.troja.mff.cuni.cz/projects/asteroids3D/web.php). We observed some relevant asteroids at the Wise Observatory that were used by Durech for the shape modeling. This paper presents the lightcurves themselves and the spin results.

Observations were performed using the two telescopes of the Wise Observatory (code: 097, E 34:45:47, N 30:35:46): A 1-m Ritchey-Chrétien telescope; and our new 0.46-m Centurion telescope (referred to as *C18;* see Brosch et al. (2008) for a description of the telescope and its performance). Two cryogenically-cooled CCDs were used at the f/7 focus of the 1-m telescope: a SITe CCD and a Princeton Instruments (PI) CCD. The *C18* telescope was operated at the f/2.8 prime focus. Table I presents technical details. A V filter was used on the 1-m telescope while the *C18* was used with no filters (Clear). Exposure times were 10-120s, all with auto-guider. The asteroids were observed while crossing a single field per night, thus the same comparison stars were used while calibrating the images. The observational circumstances are summarized in Table II.

The images were reduced in a standard way. We used the IRAF *phot* function for the photometric measurements. After measuring, the photometric values were calibrated to a differential magnitude level using ~200 local comparison stars per field of the *C18* (~20 stars at the 1-m field). The brightness of these stars remained constant to ±0.02 mag. The measurements of 1620 Geographos and (5587) 1990 SB were also calibrated to standard magnitude scale by using the Landolt equatorial standards (Landolt 1992). Astrometric solutions were obtained using *PinPoint* (www.dc3.com) and the asteroids were identified with the MPC web database. Analysis for the lightcurve period and amplitude was done by the Fourier series analysis (Harris and Lupishko, 1989). See Polishook and Brosch (2009) for a complete description of the reduction, measurements, calibration and analysis.

Lightcurves and spin periods of asteroids 29 Amphitrite, (107) Camilla, 1620 Geographos, and (5587) 1990 SB are reported. 29 Amphitrite was observed for only 30 minutes, thus a short lightcurve is presented. The lightcurves of 107 Camilla and 1620 Geographos do not cover a full rotation, but the periodicity was found combining observations on consecutive nights. The resultant periods are equal within the error range to those found in the literature (Kaasalainen et al., 2001, Pravec et al., 1998). The shape models including the contributions of this paper can be found at the web page of the database of asteroid models using inversion techniques. The results are listed in Table III. Below each folded lightcurve is a plot of the spin model over the observed data points.

Acknowledgement

The author is grateful for an *Ilan Ramon* doctoral scholarship from the Israel Space Agency (ISA) and the Ministry of Science, Culture and Sports. The guidance and help of Dr. Noah Brosch and Prof. Dina Prialnik is always essential. The collaboration with Dr. Durech was very fruitful. We thank the Wise Observatory staff for their continuous support.

CCD	SITe	PI	ST-10XME
Scope	1-m	1-m	C18
Pixels	4096x2048	1340x1300	3072x2048
FOV	34′x17′	13′x13′	40′x27′
Arcsec/pixel	1″ (binned)	1.66″	1.28″

Table I. Instrument details.

Asteroid	Scope	CCD	Filter	Date	Time span [hr]	N	R [AU]	Δ [AU]	α [Deg]	L_{PAB} [Deg]	B_{PAB} [Deg]
29 Amphitrite	1-m	PI	V	Feb 03, 2008	0.62	20	2.38	2.03	24.27	65.2	6.6
107 Camilla	1-m	PI	R	May 31, 2008	1.48	44	3.45	2.74	13.49	206.1	7.1
	C18	ST10	C	Jun 27, 2008	1.69	63	3.47	3.10	16.58	208.3	7.4
	C18	ST10	C	Jun 28, 2008	2.05	82	3.47	3.11	16.63	208.4	7.4
1620 Geographos	C18	ST10	C	Oct 27, 2008	1.95	44	1.51	0.57	20.42	36.4	17
	C18	ST10	C	Oct 28, 2008	5.53	59	1.51	0.57	20.31	36.5	17
(5587) 1990 SB	1-m	SITe	V	Nov 04, 2005	6.22	48	2.52	1.55	6.37	43.2	-12.4
	1-m	SITe	V	Nov 05, 2005	5.51	38	2.53	1.56	6.37	43.2	-12.5

Table II. Observing circumstances.

Asteroid	Period [hours]	U	Amp [mag]	H MPC [mag]
29 Amphitrite	-	-	-	5.85
107 Camilla	4.844 ± 0.003	2	0.45 ± 0.03	7.08
1620 Geographos	5.224 ± 0.007	2	1.10 ± 0.02	15.6
(5587) 1990 SB	5.052 ± 0.006	3	0.7 ± 0.1	13.6

Table III. Results. The U code is the reliability of the solution with 3 being secure.

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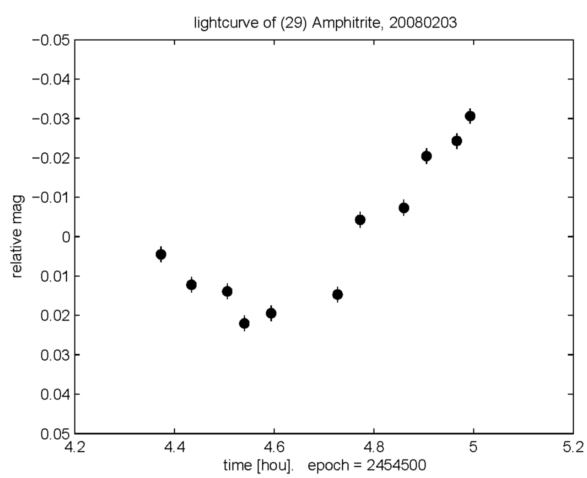

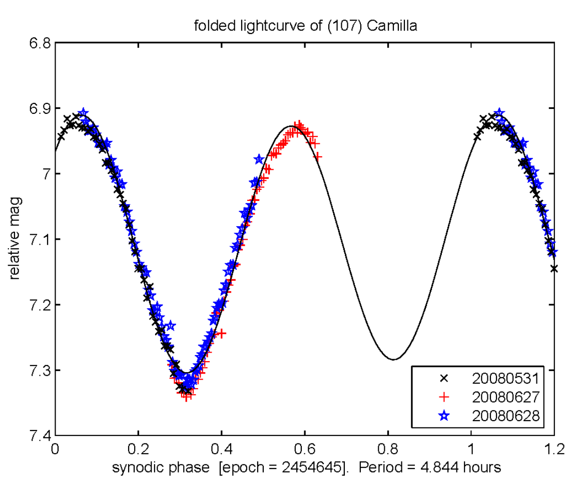

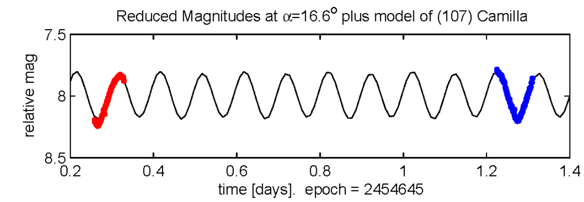

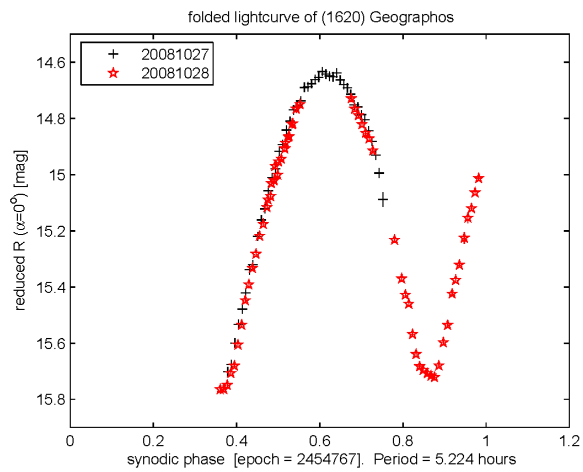

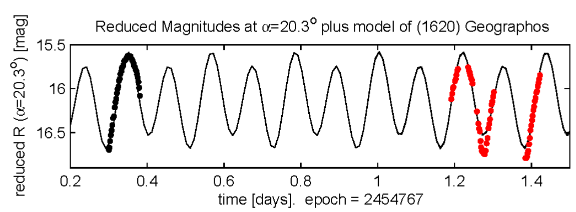

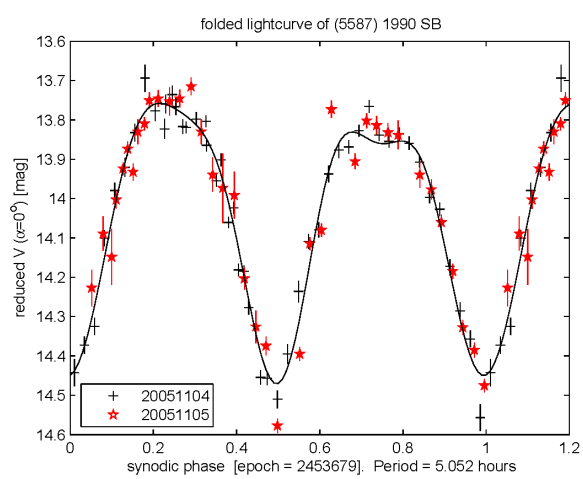

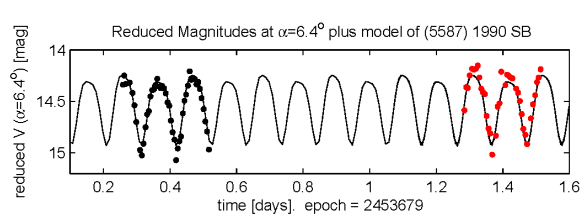

PHOTOMETRIC OBSERVATIONS AND LIGHTCURVE ANALYSIS OF ASTEROIDS 129 ANTIGONE, 174 PHAEDRA, 232 RUSSIA, 291 ALICE, AND 343 OSTARA

John C. Ruthroff
Shadowbox Observatory
12745 Crescent Drive
Carmel, IN 46032
john@theastroimager.com

(Received: 2009 Apr 7)

From 2008 November through 2009 March photometric data were obtained and analyzed for five asteroids. Synodic periods were found for four of the asteroids while only a lower limit could be established for the fifth: 129 Antigone, $P = 4.96 \pm 0.01$ h; 174 Phaedra, $P = 5.75 \pm 0.01$ h; 232 Russia, $P = 21.91 \pm 0.01$ h; 291 Alice, $P = 4.32 \pm 0.01$ h; and 343 Ostara, P > 6 h.

Main belt asteroids 129 Antigone, 174 Phaedra, 232 Russia, and 343 Ostara along with Flora family asteroid 291 Alice were observed during late 2008 and early 2009. All observations were made with a 0.3-m Schmidt-Cassegrain (SCT) operating at f/6 on a German equatorial mount. The imager was an SBIG ST9, working at 1x1 binning, which results in an image scale of 2.22 arc seconds/pixel. When a suitable guide star was available, an SBIG AO-8 adaptive optics unit was employed. All images were unfiltered, with the exception of 291 Alice, for which a Johnson V-band filter was used. The camera temperature was set to between -25C and -40C depending on ambient air temperature. Image acquisition and reduction was done with *CCDSoft*. All images were reduced with master dark and flat frames. *MPO Canopus* v.9.5.0.3 was used for period analysis, which incorporates the Fourier algorithm developed by Harris (1989).

Asteroids 129 Antigone and 174 Phaedra were chosen as "standard candle" targets to allow the author to test observation and reduction procedures against well-studied objects. 129 Antigone has been worked numerous times with published results back to Scaltriti and Zappala (1977), while 174 Phaedra's lightcurve history reaches back to Magnusson and Lagerkvist (1991). Both 129 Antigone and 174 Phaedra have published quality of period solution codes of "3" (Harris et al., 2008). Photometric observations of 232 Russia were conducted with the intention of improving on the two partial-coverage lightcurves published by Behrend (2008) and by Torno et al. (2008). The goal was to increase the quality code from a "2" to a "3". 291 Alice was targeted based on its inclusion in a list of 'Shape/Spin Modeling Opportunities' (Warner et al., 2008). Published lightcurves have been found dating back to Lagerkvist (1976) and as recent as Oey (2006).

<u>129 Antigone</u>. Data were obtained during six sessions from 2009 January 3-17. The period was found to be 4.96 ± 0.01 h, in good agreement with those previously reported (e.g., Scaltriti and Zappala, 1977; Drummond et al., 1988; Behrend, 2008).

<u>174 Phaedra</u>. Data were collected during five nights from 2008 November 4- 28. The period was found to be 5.75 ± 0.01 h., which is consistent with all previously published results (e.g., Magnusson and Lagerkvist, 1991; Ivarsen et al., 2004).

<u>232 Russia</u>. Data were collected during eleven observing sessions from 2009 January 17 to March 5. The derived period of 21.91 ± 0.01 h is within the margin of error of 21.8 ± 0.2 h found by Torno (2008), and is slightly longer than the 21.7 h found by Behrend (2008). The previously published uncertainty code was 2- (Harris and Warner, 2008). Warner (private correspondence) believes the quality code of the author's curve to be a "3-", representing an improvement over previously published data.

<u>291 Alice</u>. A four session observing run was conducted during the period 2009 March 13-22. The last two sessions were 'split' over one night to negate the "meridian flip" problem addressed by Miles and Warner (2009). The period found was 4.32 ± 0.02 h, consistent with all previously published results (e.g., Binzel and Mulholland, 1983).

<u>343 Ostara</u>. A lengthy spell of bad weather prevented acquiring more than two sessions (2.7 and 3.1 hours). Only descending branches of the lightcurve were observed. If the lightcurve is bimodal, it seems likely that the period would be considerably longer than the 6.42 h published by Binzel (1987). Dr. George Stecher (University of Wisconsin, private communication), who was also observing this object at about the same time, independently reached this same conclusion. The plot forces the data to a period of 15.8 h, one of many possible solutions.

Acknowledgement

The author thanks Brian Warner for his advice, assistance, and encouragement.

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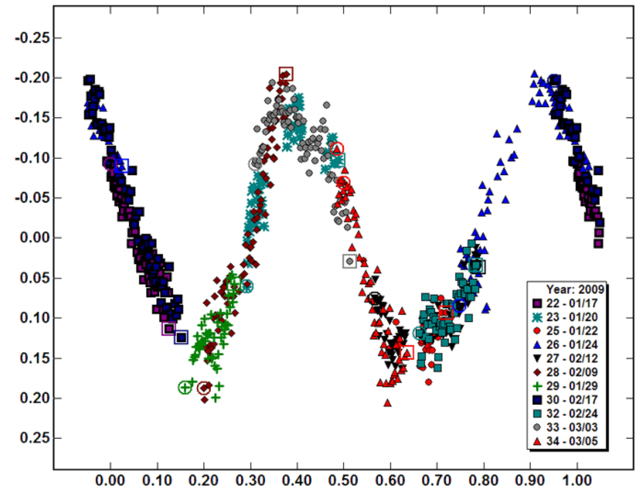
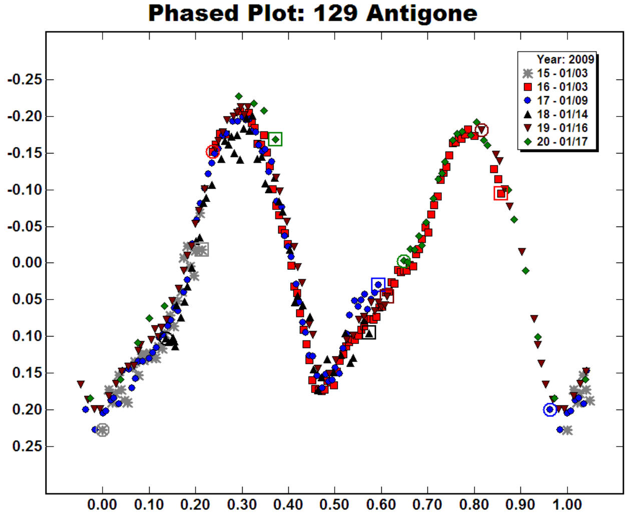
Phased Plot: 232 Russia



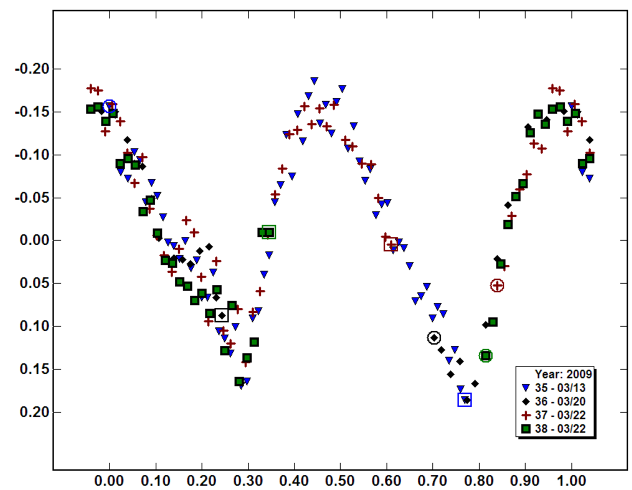
Period: 21.91 ± 0.01 h JDo(LTC): 2454848.506158

Phased Plot: 129 Antigone



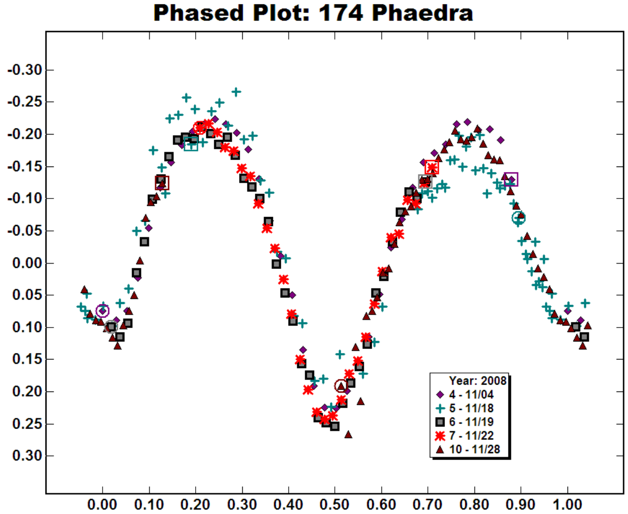
Period: 4.96 ± 0.01 h JDo(LTC): 2454834.652322

Phased Plot: 291 Alice



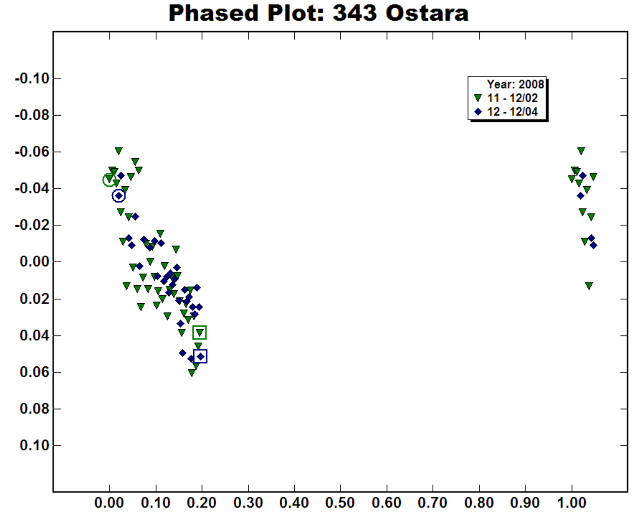
Period: 4.32 ± 0.01 h JDo(LTC): 2454903.612711

Phased Plot: 174 Phaedra



Period: 5.75 ± 0.01 h JDo(LTC): 2454774.643967

Phased Plot: 343 Ostara



Period: 15.8 ± 0.1 h JDo(LTC): 2454803.475744

ASTEROID LIGHTCURVE ANALYSIS AT RICKY OBSERVATORY

Craig Bennefeld
Physics Dept., Imagine Renaissance Academy
414 Wallace
Kansas City, Missouri. 64125
craig.bennefeld@imagineschools.com

Science Department Students
Vanessa Aguilar, Terrance Cooper, William Hupp,
Jeanne Pecha, Elysabeth Soar

(Received: 2009 Apr 15)

Lightcurves for six asteroids were obtained at Ricky Observatory from 2007 October through 2008 January: 802 Epyaxa, 1666 Van Gent, 2320 Blarney, 2358 Bahner, 2509 Chukota, 3416 Dorrit.

Observations of the 6 asteroids were carried out at Bennefeld's Observatory (MPC H46), which is equipped with a 0.35m Meade LX200 GPS telescope operating at f/6.3 coupled to a SBIG ST7-XME CCD camera, resulting in a resolution of ~1.7 arcsec/pixel (binned 2×2). Unfiltered exposure times varied between 30-60 s.

The asteroids under observation were selected from the list of asteroid lightcurve photometry opportunities which is posted on the Collaborative Asteroid Lightcurve Link (CALL) website (Warner, 2007a). The students measured the photometric properties of the images using Brian Warner's *MPO Canopus*, which employs differential aperture photometry to produce the raw data (Warner, 2007b). Period analysis of the raw data was done using *Canopus*, which incorporates the Fourier analysis algorithm developed by Harris (Harris et al., 1989). As well as reporting the synodic rotational period, amplitude, and phase angle of the asteroids, every attempt was made to expand on the knowledge base of the asteroids by, where appropriate, reporting the minimum axial ratio a/b of an elliptical asteroid and the Phase Angle Bisector longitude and latitude, PAB_L and PAB_B, respectively.

802 Epyaxa. This main-belt asteroid was sampled 434 times over 3 nights to achieve a synodic rotation period of 4.389 ± 0.001 h. The absolute value of the peak-to-peak magnitude differential (Δm) of 0.58 mag implies an axial ratio (a/b) of 1.70, assuming an equatorial viewing aspect. The period agrees with Warner (2009).

1666 van Gent. The main-belt asteroid was sampled 156 times over 2 nights to yield a synodic rotation period of 4.166 ± 0.003 h. The absolute value of the peak-to-peak magnitude differential (Δm) of 0.50 mag implies an axial ratio (a/b) of 1.58. No other lightcurves for this asteroid are known to exist.

2320 Blarney. The main-belt asteroid was sampled 154 times over a single night to yield a synodic rotation period of 5.097 ± 0.001 h. The absolute value of the peak-to-peak magnitude differential is 0.44 mag, implying an axial ratio (a/b) of 1.50. No other lightcurves for this asteroid are known to exist.

2358 Bahner. This main-belt asteroid was sampled 226 times over a 4 night period to yield a synodic rotation period of 14.194 ± 0.002 h. Due to an incomplete data set, the axial ratio was not computed. Behrend (2009) reports a provisional period of 10.848 ± 0.003 h and Owings (2009) a period of 10.855 h. We did test our data against the shorter period but found a lower RMS fit for the longer period. Given the lack of consecutive nights and the incomplete coverage of the curve in our data set, we admit that our solution may not correct and so present it here more for the purpose of putting our data on record.

2509 Chukotka. This main-belt asteroid was sampled 431 times over a 4 night period to yield a synodic rotation period of 3.19 ± 0.01 h. Due to the poor SNR and the inconclusive nature of the lightcurve, no attempt was made to calculate the axial ratio. No other lightcurves for this asteroid are known to exist.

3416 Dorrit. This Mars-crossing asteroid was sampled 247 times over a 2 night period to yield a synodic rotation period of 2.714 ± 0.003 h. The absolute value of the peak-to-peak magnitude differential is 0.38 mag, implying an axial ratio (a/b) of 1.42. No other lightcurves for this asteroid are known to exist.

Acknowledgements

The students would like to thank the entire staff at Imagine Renaissance Academy (Wallace Campus) including Mrs. Debbie Jones-Fowler, Head of Schools, Mr. Geoffrey Alderman, Assistant Director, and Mr. Greg McGhee, Activities Director, for striving to provide us with a project-based learning environment second to none. Thanks also go out to Mr. Brian D. Warner for his input in the preparation of this paper and finally to Mr. Bennefeld our Physics and Astronomy teacher.

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# Name	Date Range (mm/dd)	Data Pts	Phase	PAB_L	PAB_B	Per (h)	PE	Amp	AE
802 Epyaxa	11/15-18/2008	434	6.05	104.4	7.6	4.389	0.002	0.58	0.02
1666 van Gent	12/31/2008-01/01/2009	156	18.57	66.3	0.5	4.166	0.003	0.50	0.03
2320 Blarney	01/01/2009	154	1.66	103.2	-3.9	5.097	0.001	0.44	0.02
2358 Bahner	10/26-11/25/2008	226	13.50	12.9	6.8	14.194	0.001	0.44	0.01
2509 Chukotka	09/29-10/29/2008	431	14.3	358.2	1.4	3.19	0.01	0.16	0.03
3416 Dorrit	11/19-11/20/2008	247	19.03	31.9	12.1	2.714	0.003	0.38	0.03

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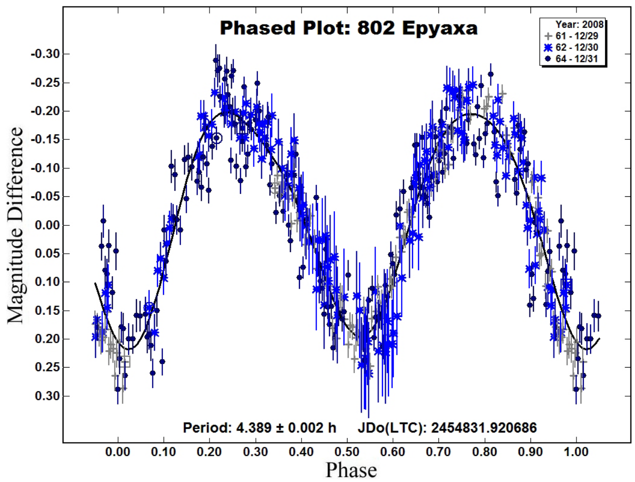

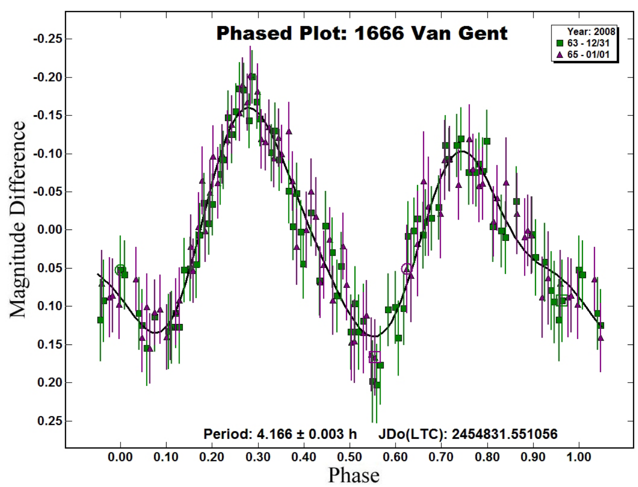

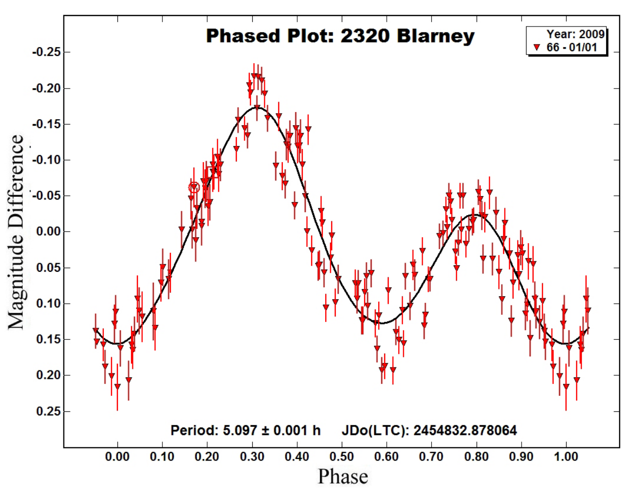

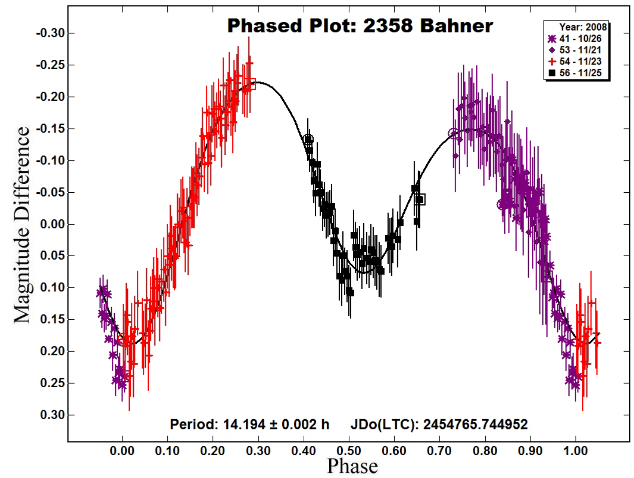

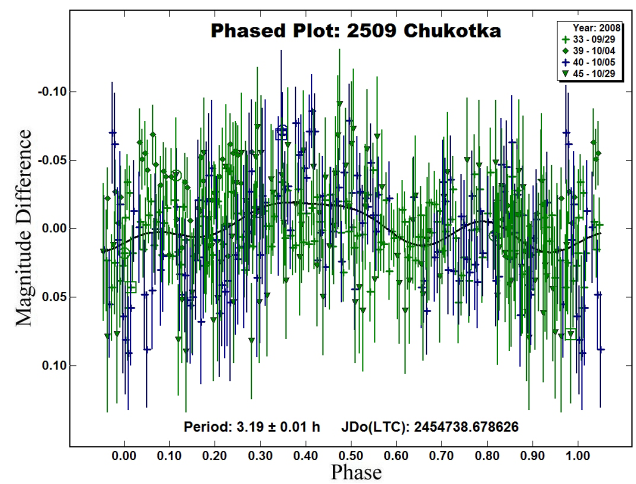

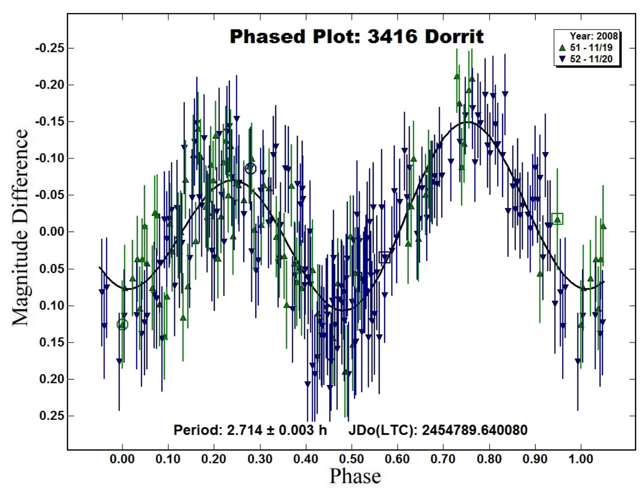

ASTEROIDS OBSERVED FROM GMARS AND SANTANA OBSERVATORIES: 2009 JANUARY - FEBRUARY

Robert D. Stephens
Goat Mountain Astronomical Research Station (GMARS)
11355 Mount Johnson Court, Rancho Cucamonga, CA 91737
RStephens@foxandstephens.com

(Received: 2009 Apr 12)

Lightcurves for 654 Zelinda, 946 Poesia, and 1655 Comas Sola were obtained from Santana and GMARS Observatories in 2009 January and February.

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). The asteroids were selected from the list of asteroid photometry opportunities published on the Collaborative Asteroid Lightcurve Link (CALL) website (Warner et al., 2008).

654 Zelinda. 654 Zelinda had a favorable opposition in 2009. Images were obtained on February 11, 19, 20 and 21 with the 0.30-m SCT at Santana Observatory. All others were obtained with the 0.35-m SCT at GMARS. Warner and Higgins (2008) obtained a lightcurve in 2008 September, reporting a period of 32.0 ± 0.1 h. Schrober (1975) reported a period of 31.9 ± 0.05 h with a $U = 2$ rating.

946 Poesia. Images on January 19 and 28, and February 3 and 4 were obtained with the 0.30-m SCT at Santana Observatory. All others were obtained with the 0.35-m SCT at GMARS. The data were linked to an internal standard using a method developed by Warner (2007) and described by Stephens (2008) included in the latest release of *Canopus*. No previously reported result has been published.

1655 Comas Sola. Images on January 1 were obtained with the 0.35-m SCT at GMARS. All others were obtained with the 0.30-m SCT at Santana Observatory. Addleman (2005) obtained a partial lightcurve at Rose-Hulman Institute of Technology and reported a period of 20.4 ± 0.1 h, in good agreement with this result. Behrend (2009) reported a period of greater than 12 h.

Acknowledgements

Thanks are given to Dr. Alan Harris of the Space Science Institute, Boulder, CO, and Dr. Petr Pravec of the Astronomical Institute, Czech Republic, for their ongoing support of amateur asteroid research. Also, thanks to Brian Warner for his continuing work and enhancements to the software program *MPO Canopus* which makes it possible for amateur astronomers to analyze and collaborate on asteroid rotational period projects and for maintaining the CALL Web site which helps coordinate collaborative projects between amateur astronomers.

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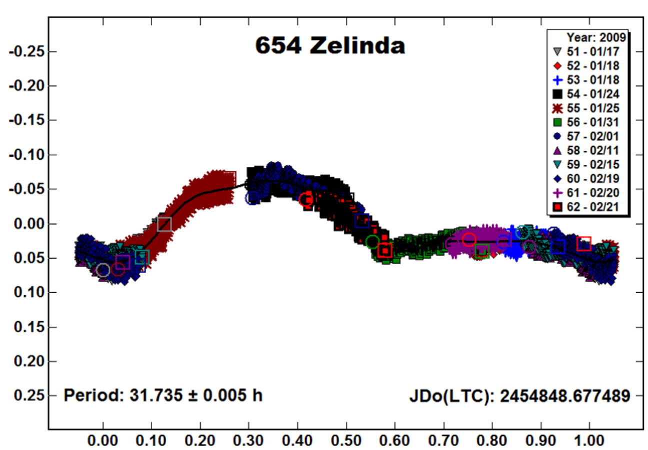
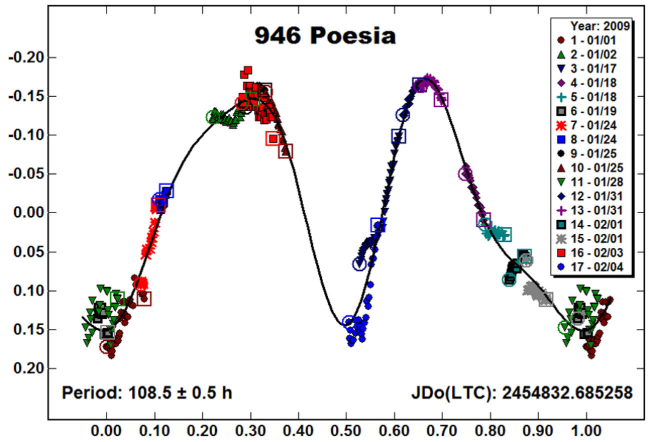
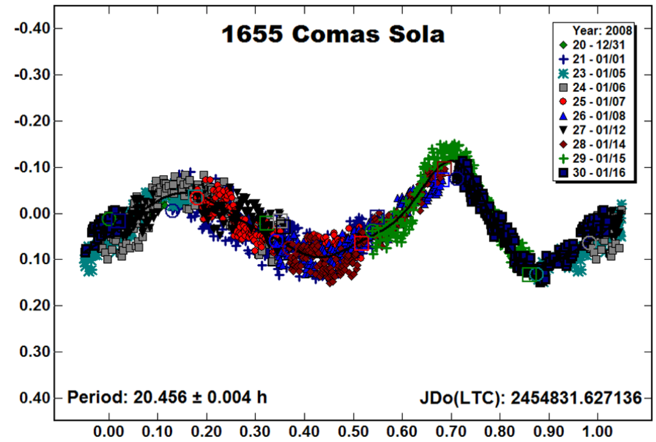
	654 Zelinda	946 Poesia	1655 Comas Sola
Dates	01/17-02/21	01/01-02/04	12/31-01/16
Data Pts	5,126	1,938	1,962
α	8.7, 22.2	6.5, 8.7	7.6, 15.4
Avg L_{PAB}	123	116	88
Avg B_{PAB}	-14	1	-4
Per. (h)	31.735	108.5	20.456
PE (h)	0.01	0.5	0.004
Amp (mag)	0.12	0.32	0.22
AE (mag)	0.02	0.05	0.03

Table 1. Observing circumstances. Dates are in 2009, except for the first observation of 1655, which was 2008.







CCD LIGHTCURVE ANALYSIS OF (53430) 1999 TY16

Quanzhi Ye
Department of Atmospheric Science, Sun Yat-sen University,
Guangzhou, China (mainland)
tom6740@gmail.com

Liaoshan Shi
School of Physics and Engineering, Sun Yat-sen University,
Guangzhou, China (mainland)

Hung-Chin Lin
Graduate Institute of Astronomy, National Central University,
Chung-li, Taiwan

(Received: 2009 Apr 4 Revised: 2009 Apr 15)

Photometric observations of high-inclination near-Earth asteroid (53430) 1999 TY16 were obtained in the course of Lulin Sky Survey (LUSS) in late 2008. These data allowed determination of the rotation period to be 9.582 ± 0.001 h.

High inclination near-Earth asteroid (53430) 1999 TY16 was discovered by LINEAR program on 1999 October 13 (Williams, 1999) and no photometric result had been published before this work. From 2008 November 14 to December 3, six nights of data were obtained using Lulin Observatory's 0.41-m Ritchey-Chretien telescope equipped with a 4-mega pixel back-illuminated CCD. The data were measured with Raab's *Astrometrica* and Warner's *MPO Canopus* and were internally calibrated with Warner's UCAC-2MASS system (Warner, 2007). The observations yielded a period of 9.582 ± 0.001 h with an amplitude of 0.80 ± 0.03 mag. BVRI observations were also obtained on November 21 and 30, but reduction to a standard system was not possible due to an insufficient number of standard stars in the image and poor photometric conditions.

Acknowledgements

We would like to thank Brian D. Warner for his review of the manuscript. We would like to thank Hsiang-Yao Hsiao and Chi Sheng Lin for their assistance on obtaining the observations. This work is supported by a 2007 Gene Shoemaker NEO Grant from the Planetary Society. The 0.41-m Ritchey-Chretien telescope is operated with support from the Graduate Institute of Astronomy, National Central University.

Reference

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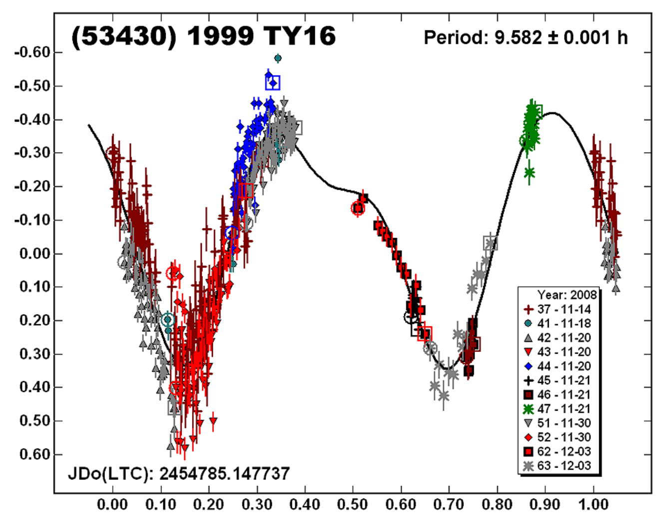


ASTEROID LIGHTCURVE ANALYSIS AT THE VIA CAPOTE OBSERVATORY: 2009 1ST QUARTER

James W. Brinsfield
Via Capote Observatory
5180 Via Capote, Thousand Oaks CA 91320
jbrinsfi@gmail.com

(Received: 2009 Apr 10)

Lightcurves for 4 asteroids were measured at the Via Capote Observatory from 2009 January through March: 1254 Erfordia (*P* = 12.287 h), 2678 Aavasaksa (*P* >24 h), 2679 Kittisvaara (*P* = 10.123), 4606 Saheki (*P* = 5.032).

Observations of 4 asteroids were made using a Meade LX200 0.35-m Schmidt-Cassegrain working at f/10. The CCD imager was an 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" per pixel. All images were dark and flat field corrected. Images were measured using *MPO Canopus* (Bdw Publishing) and differential photometry. The data were light-time corrected. Period analysis was also done with *Canopus*, incorporating the Fourier analysis algorithm developed by Harris (1989). 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. The results are summarized in the table below and include average phase angle information across the observational period. Where 3 numbers are indicated for phase angle, 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. Individual lightcurve plots along with additional comments, as required, are also presented.

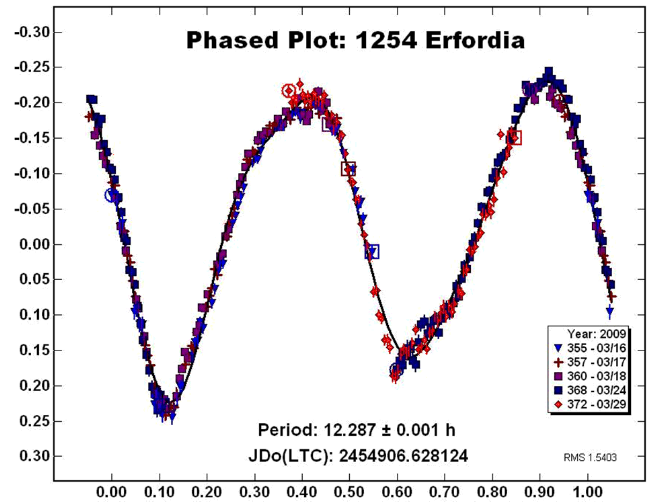
None of the four targets studied during the reporting period have published lightcurves. 1254 Erfordia exhibits and interesting departure on its ascending node around phase 0.65, perhaps the effects of an impact crater on one end of the object. Observations of 2678 Aavasaksa were interrupted during the second session of the campaign due to equipment malfunction. With only limited partial coverage of the target, the continuous rising amplitude of the first session over approximately 6 hours would suggest a rotation period of greater than 24 hours and amplitude greater than 0.35 mag. The longer of the two observing sessions are plotted in this report.

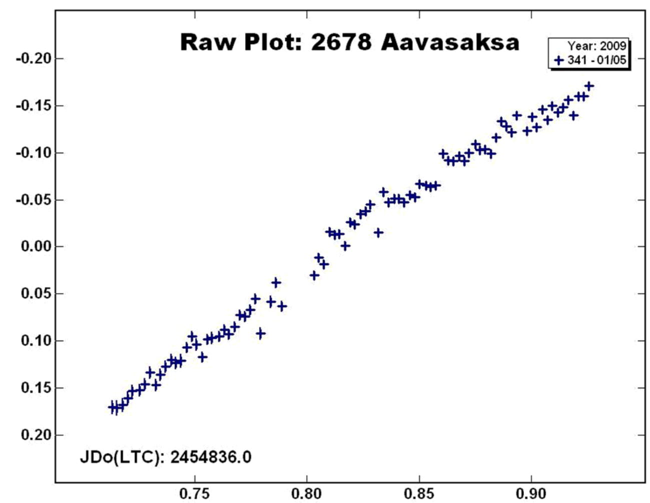
Acknowledgments

The author whishes to thank Brian Warner for his assistance with interpreting the lightcurve shape of 1254 Erfordia.

References

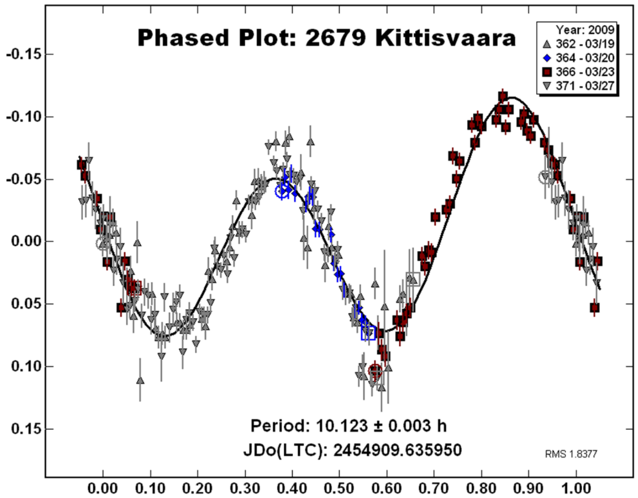
Harris, A.W., Young, J.W., Bowell, E., Martin, L.J., Millis, R.L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H.J., Debehogne, H., and Zeigler, K.W., (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.

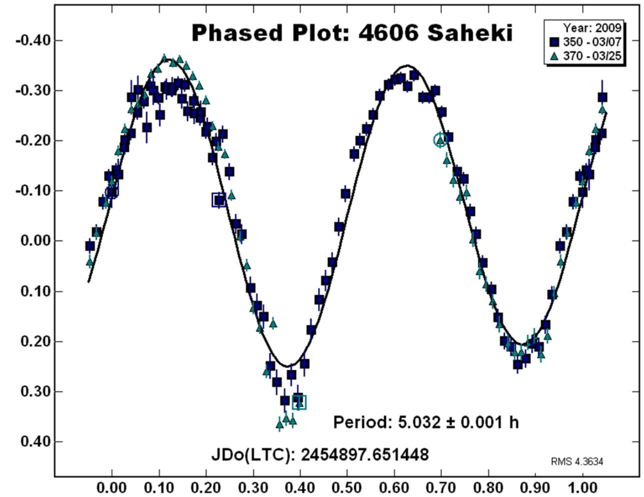




#	Name	Dates (mm/dd/2009)	Data Points	Phase	L_{PAB}	B_{PAB}	Per(h)	PE	Amp(m)	AE
1254	Erfordia	03/16-03/29	369	9.6	157	-7	12.287	0.001	0.47	0.02
2678	Aavasaksa	01/05-01/06	95	3.0	108	+4	>24 hr		>0.35	
2679	Kittisvaara	03/19-03/27	219	9.0	167	-8	10.123	0.003	0.22	0.03
4606	Saheki	03/07-03/25	135	15	151	-4	5.032	0.001	0.68	0.01

Table 1. Observing circumstances.





LIGHTCURVE PHOTOMETRY OPPORTUNITIES: 2009 JULY-SEPTEMBER

Brian D. Warner
Palmer Divide Observatory/Space Science Institute
17995 Bakers Farm Rd.
Colorado Springs, CO 80908 USA
brian@MinorPlanetObserver.com

Alan W. Harris
Space Science Institute
La Canada, CA 91011-3364 USA

Petr Pravec
Astronomical Institute
CZ-25165 Ondřejov, CZECH REPUBLIC

Josef Durech
Astronomical Institute
Charles University in Prague
18000 Prague, CZECH REPUBLIC
durech@sirrah.troja.mff.cuni.cz

Lance A.M. Benner
Jet Propulsion Laboratory
Pasadena, CA 91109-8099 USA
lance@reason.jpl.nasa.gov

We present here four lists of “targets of opportunity” for the period 2009 July-September. The first list is those asteroids reaching a favorable apparition during this period, are <15m at brightest, and have either no or poorly constrained lightcurve parameters. By “favorable” we mean that the asteroid is brighter than 14m regardless of circumstances and/or that it is unusually bright. In some cases, a favorable apparition may not occur again for many years, if ever. The goal for these asteroids is to find a well-determined rotation rate. Don’t hesitate to solicit help from other observers at widely spread longitudes should the initial findings show that a single station may not be able to finish the job.

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”, which is when objects near opposition brighten more than simple geometry would predict.

The third list is of those asteroids needing only a small number of lightcurves to allow shape and spin axis modeling. Some asteroids have been on the list for some time, so work on them is strongly encouraged so that models can be completed. For modeling work, absolute photometry is recommended, meaning that data not differential magnitudes but absolute values put onto a standard system such as Johnson V. If this is not possible or practical, good relative photometry, where all differential values are based on a calibrated internal or standard zero point, is just as acceptable. When working any asteroid, keep in mind that the best results for shape and spin axis modeling come when lightcurves are obtained over a large range of phase angles within an apparition. If at all possible, try to get lightcurves not only close to opposition, but before and after, e.g., when the phase angle is 15° or more. This can be difficult at times but the extra effort can and will pay off.

The fourth list gives a brief ephemeris for planned radar targets. Supporting optical observations made to determine the lightcurve’s period, amplitude, and shape are needed to supplement the radar data. Reducing to standard magnitudes is not required but high precision work, 0.01-0.03mag, usually is. *The geocentric ephemerides are for planning purposes only.* The date range may not always coincide with the dates of planned radar observations. Use the on-line services such as those from the Minor Planet Center or JPL’s Horizons to generate high-accuracy *topocentric* ephemerides (MPC: *http://cfa-www.harvard.edu/iau/mpc.html* JPL: *http://ssd.jpl.nasa.gov/?horizons*). Those obtaining lightcurves in support of radar observations should contact Dr. Benner directly at the email given above.

There are several web sites of particular interest for coordinating radar and optical observations. Future targets (up to 2021) can be found at *http://echo.jpl.nasa.gov/~lance/future.radar.nea.periods.html*. Past radar targets can be found at *http://echo.jpl.nasa.gov/~lance/radar.nea.periods.html* This page can be used to plan optical observations for those past targets with no or poorly-known rotation periods. Obtaining a rotation period will significantly improve the value of the radar data and help with 3D shape estimation. Slightly different information for Arecibo is given at *http://www.naic.edu/~pradar/sched.shtml*. For Goldstone, additional information is available at *http://echo.jpl.nasa.gov/*

asteroids/goldstone_asteroid_schedule.html.

Once you have data and have analyzed them, it's important that you publish your results, if not part of a pro-am collaboration, then in the *Minor Planet Bulletin.* It's also important to make the data available at least on a personal website or upon request. Note that the lightcurve amplitude in the tables could be more, or less, than what's given. Use the listing as a guide and double-check your work. Those doing modeling should refer to the Database of Asteroid Models from Inversion Techniques (DAMIT) project at the Astronomical Institute of the Charles University, Czech Republic (*http://astro.troja.mff.cuni.cz/projects/asteroids3D*). Results and the original data for a large number of asteroid models can be browsed and downloaded at this location.

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. For an explanation of the U code, see the documentation for the Lightcurve Database at *http://www.minorplanetobserver.com/astlc/LightcurveParameters.htm*. Objects with no U rating or 1 should be given higher priority when possible. Also note that a U = 2 rating could be the result of an ambiguous period solution. The one given here is the preferred but not necessarily the only period reported for a given asteroid. Regardless, you should not let the existing period influence your analysis since even high quality ratings have been proven wrong at times.

Funding for Warner and Harris in support of this article is provided by NASA grants NNG06GI32G, NNX 09AB48G and by National Science Foundation grant AST-0607505.

<u>Lightcurve Opportunities</u>

		Brightest				LCDB Data	
#	Name	Date	Mag	Dec	U	Period	Amp
	2001 FE90	6 30.5	12.3	-22			
2784	Domeyko	7 01.0	14.5	-21	2	5.98	0.15
2379	Heiskanen	7 01.9	13.7	-22			
2739	Taguacipa	7 02.7	14.7	-23			
386	Siegena	7 03.2	11.9	+ 5	2	9.76	0.11-0.18
838	Seraphina	7 03.8	13.8	-12	2	15.67	0.07-0.30
795	Fini	7 03.9	13.7	-52	2	8.64	0.05
15621	Erikhovland	7 05.1	15.0	-19			
2591	Dworetsky	7 06.5	15.0	-25	2	12.77	0.45
33903	2000 KH68	7 06.7	14.8	- 3			
407	Arachne	7 08.2	12.1	-24	2	22.62	0.31-0.45
1243	Pamela	7 08.7	13.9	- 9	2	26.01	0.42-0.71
3237	Victorplatt	7 09.8	14.3	-21	2	10.36	0.24
16123	Jessiecheng	7 09.9	15.2	-21			
6560	Pravdo	7 10.0	13.9	-20			
18897	2000 HG30	7 10.5	14.3	-26			
5916	van der Woude	7 10.9	14.7	-12			
21126	1993 BJ2	7 11.0	14.7	-19			
13028	Klaustschira	7 12.0	14.8	-18			
2882	Tedesco	7 12.6	15.0	-22			
2238	Steshenko	7 13.2	15.0	-24			
27128	1998 WB25	7 13.9	14.8	-15			
2933	Amber	7 14.7	14.7	-20			
924	Toni	7 14.8	13.1	-13	1	8.98	0.1
23297	2001 AX3	7 15.2	14.8	-12			
6381	1988 DO1	7 16.3	14.8	-20			
1904	Massevitch	7 16.7	14.6	-24			
14668	1999 CB67	7 18.0	14.8	- 8			
7021	1992 JN1	7 19.8	14.9	-32			
2604	Marshak	7 20.0	14.2	-18			
1075	Helina	7 20.8	13.8	-26			
1458	Mineura	7 22.1	14.1	+ 0	1	36.	0.04
6027	1993 SS2	7 24.6	14.1	-23			
1634	Ndola	7 24.6	14.5	-28	2	64.23	0.4
2714	Matti	7 24.9	14.3	-17	2	9.	0.25
275	Sapientia	7 26.6	12.8	-18	2	14.76	0.06
29742	1999 BQ12	7 26.8	14.9	-31			
13123	Tyson	7 26.8	14.3	-58			
10922	1998 BG2	7 26.9	14.6	-21			
1358	Gaika	7 28.6	14.1	-23			
1853	McElroy	7 28.7	14.5	-16	2	8.01	0.20
1611	Beyer	7 28.8	14.8	-13			
395	Delia	7 29.2	13.6	-15	2	19.71	0.25
577	Rhea	7 30.3	12.8	-22	2	12.26	0.31
140	Siwa	7 30.7	10.4	-20	2	18.49	0.05-0.15
6003	1988 VO1	8 01.2	15.0	- 7	1	5.	0.07
912	Maritima	8 01.7	13.9	-42	2	48.43	>0.11
514	Armida	8 02.6	13.0	-14	2+	21.87	0.16-0.42
705	Erminia	8 03.6	13.0	-47	2	53.96	0.12
582	Olympia	8 04.5	13.7	+ 2	2	36.0	>0.6
10828	Tomjones	8 04.9	15.0	-13			
890	Waltraut	8 05.3	14.8	- 9			
3730	Hurban	8 05.8	14.3	-15			
2536	Kozyrev	8 08.3	14.5	-10			
1984	Fedynskij	8 09.0	14.7	-10			
328	Gudrun	8 10.1	13.4	-29	2-	18.	0.15
1366	Piccolo	8 11.5	13.7	-29	2	16.57	0.33
2532	Sutton	8 13.1	14.4	-18			
331	Etheridgea	8 13.7	13.3	-23	2	6.82	0.05
605	Juvisia	8 14.1	13.5	-27	2	15.85	0.26
2672	Pisek	8 15.0	14.3	-20			
4381	Uenohara	8 15.0	15.0	-23			
326	Tamara	8 15.5	12.1	-51	2	14.18	0.11
14339	1983 GU	8 15.8	14.3	-25			
1256	Normannia	8 16.5	14.7	- 8	1	6.8	0.06
3034	Climenhaga	8 16.6	13.5	-21			
43259	2000 CK104	8 17.1	15.0	-17			
5709	Tamyeunleung	8 17.7	15.0	-17			
2705	Wu	8 18.3	14.9	-20			
764	Gedania	8 19.4	14.0	+ 0	2+	24.97	0.35
7305	Ossakajusto	8 22.5	14.0	- 4			
6049	Toda	8 24.0	15.0	- 9			
32209	2000 OW9	8 24.3	15.0	+ 8			
1409	Isko	8 24.9	13.8	- 6	2	11.64	0.20
877	Walkure	8 25.2	13.1	-15	2	17.44	0.33-0.40
1621	Druzhba	8 25.6	13.8	- 8	1	>12.	>0.16
2385	Mustel	8 26.8	14.3	-10			
2949	Kaverznev	8 27.0	14.7	- 9			
2863	Ben Mayer	8 27.1	15.0	-12			
1023	Thomana	8 28.4	13.8	- 1	2	17.56	0.28
5110	Belgirate	8 28.8	15.0	- 7	1	11.04	0.08
1735	ITA	8 29.3	13.4	-22	2	12.59	0.26
2690	Ristiina	8 29.5	14.9	-15			
2614	Torrence	8 29.8	15.0	-19			
1263	Varsavia	8 29.8	14.0	- 7	2	7.23	0.15
1994	Shane	8 30.2	14.1	+ 9	1	U25.	>0.1
5026	Martes	8 30.5	14.0	- 4			
6180	Bystritskaya	8 30.9	14.8	-11			
4212	Sansyu-Asuke	8 31.1	14.6	-27			
2089	Cetacea	9 01.6	13.9	-30	2	39.12	0.25-0.35
4552	Nabelek	9 04.2	14.7	- 8			
982	Franklina	9 04.7	13.3	+ 9	1	3.6	0.03
569	Misa	9 05.0	13.4	- 6	2	13.52	0.25
6566	1992 UB2	9 05.3	15.0	- 8			
2434	Bateson	9 06.0	14.7	-23			
6014	Chribrenmark	9 07.7	15.0	+ 1			
65	Cybele	9 07.7	11.1	- 7	2	4.03	0.04-0.12
1298	Nocturna	9 08.6	14.1	+ 0	2	34.80	0.11
4843	Megantic	9 09.1	14.5	- 6			
8067	Helfenstein	9 10.2	15.0	- 4			
4995	Griffin	9 10.7	14.6	+13	2	26.37	0.82
5847	Wakiya	9 11.4	14.1	+ 7	1	23.95	0.10
5404	Uemura	9 12.4	14.6	-12			
23	Thalia	9 13.3	11.2	-18	2	12.31	0.14
12721	1991 PB	9 13.9	14.6	- 5			
375	Ursula	9 16.6	11.3	+ 5	2	16.83	0.17
	2000 CO101	9 16.6	14.6	-31			
422	Berolina	9 17.5	11.6	- 5	2	12.79	0.11
1997	Leverrier	9 17.9	14.0	- 2			
2816	Pien	9 18.3	14.3	-14			
530	Turandot	9 18.5	12.6	-11	2+	19.94	0.10-0.16
6792	Akiyamatakashi	9 19.2	14.1	- 9			
1700	Zvezdara	9 21.9	13.4	+ 0			
1398	Donnera	9 22.0	14.1	+15	2	7.3	0.23
4336	Jasniewicz	9 22.2	14.8	+ 3			
3552	Don Quixote	9 22.3	14.8	-48	2	7.7	0.57
9144	Hollisjohnson	9 23.2	14.5	- 9			
681	Gorgo	9 23.4	14.8	- 1			
503	Evelyn	9 24.7	12.9	- 6	2	38.7	0.30-0.5
1442	Corvina	9 25.8	14.8	+ 2			
481	Emita	9 25.9	11.8	-13	2	14.35	0.30
4969	Lawrence	9 27.3	14.7	+ 5			
4820	Fay	9 27.4	14.0	+12			
936	Kunigunde	9 27.5	13.4	- 1	2	8.80	0.25
449	Hamburga	9 27.8	13.1	- 3	?		
152664	1998 FW4	9 28.0	13.9	- 6			
26380	1999 JY65	9 28.8	15.0	+11			
517	Edith	9 29.2	12.9	+ 7	2	9.27	0.12-0.18
8982	Oreshek	9 30.6	14.9	+ 3			
711	Marmulla	9 30.7	13.6	+ 5	?		
6463	Isoda	9 30.9	14.5	+23			

Low Phase Angle Opportunities

#	Name	Date		V	Dec	Period	Amp	U
2379	Heiskanen	7 01.8	0.27	13.7	-22			
407	Arachne	7 08.2	0.74	12.1	-24	22.62	0.45	2
554	Peraga	7 13.5	0.22	12.1	-22	13.7128	0.22	3
5	Astraea	7 23.6	0.97	10.9	-17	16.800	0.30	3
275	Sapientia	7 26.7	0.45	12.9	-18	14.766	0.06	2
140	Siwa	7 30.7	1.00	10.4	-20	18.495	0.06	2
243	Ida	8 01.6	0.20	13.7	-18	4.634	0.86	3
123	Brunhild	8 02.0	0.11	12.5	-17	10.04	0.16	3
16	Psyche	8 06.1	0.54	9.3	-15	4.196	0.42	3
28610	2000 EM158	8 08.8	0.28	13.9	-16	3.288	0.24	3
586	Thekla	8 15.4	0.75	13.6	-12	13.670	0.30	3
909	Ulla	8 23.2	0.57	13.5	-13	8.73	0.24	3
78	Diana	8 24.7	0.18	12.2	-11	7.2991	0.26	3
286	Iclea	8 26.2	0.61	13.2	-12	15.365	0.13	3
1263	Varsavia	8 29.6	0.81	14.0	-07	7.231	0.15	2
212	Medea	8 31.9	0.91	12.3	-06	10.283	0.08	3
443	Photographica	9 02.8	0.87	12.8	-06	18.190	0.34	2
569	Misa	9 04.9	0.51	13.5	-06	13.52	0.25	2
65	Cybele	9 07.7	0.26	11.2	-07	4.041	0.12	3
41	Daphne	9 15.1	0.82	11.3	-01	5.988	0.38	3
147	Protogeneia	9 20.7	0.90	12.4	+02	7.853	0.25	3
1700	Zvezdara	9 21.9	0.19	13.5	+00			
723	Hammonia	9 23.0	0.77	13.5	-02	5.436	0.18	3
720	Bohlinia	9 24.3	0.70	13.6	-01	8.919	0.46	3
20	Massalia	9 24.4	0.26	9.3	+01	8.098	0.27	3

Shape/Spin Modeling Opportunities

#	Name	Brightest Date	V	Dec	Per (h)	Amp Min	Max	U
337	Devosa	7 12.2	12.4	-33	4.65	0.08	0.75	3
37	Fides	7 20.3	11.1	-25	7.3335	0.10	0.25	3
747	Winchester	7 23.0	11.6	-15	9.4146	0.08	0.13	3
5	Astraea	7 23.6	10.9	-17	16.800	0.10	0.30	3
389	Industria	7 26.3	11.3	-15	8.53	0.18	0.34	3
480	Hansa	7 28.6	12.5	+11	16.19		0.58	3
243	Ida	8 01.6	13.7	-18	4.634	0.45	0.86	3
347	Pariana	8 07.5	13.1	-29	4.0529	0.09	0.42	3
165	Loreley	8 21.0	11.6	-05	7.226	0.04	0.15	3
1727	Mette	8 23.3	14.5	-25	2.982		0.27	3
212	Medea	9 01.0	12.3	-06	10.283		0.08	3
42	Isis	9 06.9	9.4	-21	13.597	0.29	0.32	3
65	Cybele	9 07.7	11.1	-07	4.036	0.04	0.12	2
375	Ursula	9 16.6	11.3	+05	16.83	0.05	0.17	2
28	Bellona	9 23.9	11.2	-08	15.707	0.03	0.28	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 resources given above 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.

Of the following, 2001 FE90, 1998 FW4, 2001 CV26, and 1999 AP10 are particularly favorable radar imaging targets.

2001 FE90 (2009 June-July)

2001 FE90 is estimated to be only 0.35 km in size. Northern Hemisphere observers will have only a few days in late June to work this asteroid. After that it moves quickly into the southern sky. There are no known lightcurve parameters. Note the ephemeris interval of 3 days. This was included in *MPB* 36-2 and is repeated here since the asteroid is available mostly in July.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
06/23	12 31.62	+39 37.1	0.038	1.010	16.23	98.1
06/26	13 57.14	+28 02.2	0.024	1.020	14.54	80.1
06/29	16 16.09	-04 35.7	0.019	1.031	12.72	37.0
07/02	18 21.94	-31 35.9	0.027	1.044	12.70	9.6
07/05	19 32.30	-40 05.5	0.042	1.057	13.98	18.1
07/08	20 09.68	-42 54.2	0.059	1.070	14.87	22.7
07/11	20 31.26	-44 01.6	0.076	1.085	15.52	24.5
07/14	20 44.64	-44 30.5	0.094	1.101	16.02	24.9
07/17	20 53.34	-44 41.1	0.112	1.117	16.43	24.7

(163697) 2003 EF54 (2009 August-September)

There are no known lightcurve parameters for this 0.3 km NEA. Larger telescopes, 0.5-m or more, will be needed to get high-precision observations in late August.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	V	α
08/15	14 56.64	+30 25.5	0.057	0.999	17.55	102.8
08/18	16 42.89	+31 45.1	0.053	1.017	16.57	82.9
08/21	18 24.54	+27 45.1	0.058	1.037	16.13	62.9
08/24	19 34.78	+21 47.9	0.070	1.057	16.14	47.7
08/27	20 18.76	+16 43.1	0.086	1.077	16.36	37.7
08/30	20 47.16	+12 55.4	0.105	1.098	16.64	31.3
09/02	21 06.62	+10 06.8	0.125	1.119	16.95	27.1
09/05	21 20.75	+07 59.1	0.147	1.140	17.25	24.4

2005 CW25 (2009 August)

2005 CW25 is about 0.6 km in diameter. It will be moving rapidly across the sky in late August, which may require larger telescopes to get high precision observations. There are no known lightcurve parameters.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	V	α
08/15	16 11.92	+37 50.4	0.108	1.015	16.81	86.0
08/17	16 46.54	+28 58.4	0.096	1.027	16.30	78.4
08/19	17 21.69	+17 28.9	0.088	1.041	15.83	68.8
08/21	17 55.92	+04 22.6	0.087	1.054	15.52	58.8
08/23	18 27.97	-08 20.5	0.092	1.067	15.42	50.2
08/25	18 57.04	-19 00.5	0.102	1.081	15.52	44.4
08/27	19 22.82	-27 09.0	0.117	1.095	15.74	41.2
08/29	19 45.34	-33 06.2	0.134	1.109	16.03	39.7
08/31	20 04.89	-37 24.6	0.153	1.123	16.34	39.2

2000 CO101 (2009 September)

There are no known lightcurve parameters for this 0.43-km NEA. Southern Hemisphere observers are favored during most of the September apparition.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	V	α
09/01	23 55.80	-70 42.8	0.090	1.053	16.21	59.1
09/04	23 02.74	-68 53.1	0.079	1.048	15.87	57.9
09/07	22 07.71	-64 59.3	0.068	1.044	15.50	56.4
09/10	21 17.70	-58 10.0	0.059	1.040	15.13	55.0
09/13	20 36.66	-47 41.6	0.051	1.035	14.80	54.2
09/16	20 04.89	-33 31.9	0.047	1.031	14.63	55.6
09/19	19 40.85	-17 15.8	0.046	1.027	14.72	59.8
09/22	19 22.68	-01 45.5	0.049	1.023	15.04	65.8
09/25	19 08.76	+10 57.5	0.056	1.019	15.49	71.7
09/28	18 57.89	+20 36.5	0.065	1.015	15.96	76.4

(152664) 1998 FW4 (2009 September)

This NEA is about 0.4-km in diameter. There are no known lightcurve parameters. Given the wide range of phase angles, it may be possible to get sufficient data to try lightcurve inversion from this one apparition. If nothing else, it should be possible to get an accurate set of values for H and G (absolute magnitude and phase angle parameter, respectively).

DATE	RA(2000)	DC(2000)	E.D.	S.D.	V	α
09/15	23 22.85	-07 02.3	0.158	1.163	16.28	3.8
09/17	23 17.60	-07 06.5	0.136	1.141	16.04	6.2
09/19	23 10.46	-07 11.0	0.115	1.118	15.77	9.3
09/21	23 00.26	-07 15.5	0.094	1.096	15.45	13.3
09/23	22 44.59	-07 19.4	0.074	1.073	15.06	18.8
09/25	22 17.70	-07 19.7	0.054	1.051	14.60	27.0
09/27	21 23.17	-06 59.8	0.036	1.029	14.11	42.1
09/29	19 12.98	-04 39.6	0.024	1.007	14.14	76.1

(68216) 2001 CV26 (2009 September-October)

This 1.6-km NEA is within relatively easy reach for Southern observers for all of September and into October. There are no known lightcurve parameters.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	V	α
09/01	2 13.63	-50 42.7	0.262	1.160	15.66	49.4
09/06	2 23.08	-51 59.0	0.228	1.134	15.36	51.5
09/11	2 33.36	-53 22.7	0.194	1.108	15.03	54.0
09/16	2 45.59	-54 59.4	0.160	1.083	14.66	57.2
09/21	3 02.43	-56 59.6	0.126	1.058	14.22	61.3
09/26	3 31.66	-59 44.5	0.093	1.035	13.68	67.4
10/01	4 44.10	-63 36.9	0.060	1.012	13.04	78.2
10/06	8 39.38	-57 53.0	0.031	0.990	12.87	107.2

(159402) 1999 AP10 (2009 August-November)

This is another potential opportunity to do shape modeling from a single apparition. It will require a number of lightcurves at different phase angles. Since the synodic period may change significantly, data for individual lightcurves should be grouped over short intervals, i.e., a few days. See Koff et al., *Minor Planet Bulletin* **29**, 51-53, for an excellent case study along these lines involving (5587) 1990 SB.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	V	a
08/15	23 00.04	-20 42.4	0.425	1.418	16.12	14.5
08/25	22 57.66	-20 15.0	0.340	1.343	15.36	10.4
09/04	22 51.19	-18 56.8	0.266	1.271	14.66	9.3
09/14	22 40.68	-15 56.4	0.204	1.203	14.16	14.1
09/24	22 26.54	-09 40.2	0.152	1.142	13.68	22.8
10/04	22 09.38	+02 54.6	0.110	1.090	13.20	34.0
10/14	21 46.55	+26 50.9	0.082	1.049	12.92	49.4
10/24	21 00.84	+60 25.4	0.078	1.022	13.29	67.5
11/03	16 32.28	+82 18.2	0.099	1.011	14.05	76.2
11/13	11 34.26	+73 53.6	0.130	1.016	14.61	74.5

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.

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Nonmembers are invited to join ALPO by communicating with: Matthew L. Will, A.L.P.O. Membership Secretary, P.O. Box 13456, Springfield, IL 62791-3456 (will008@attglobal.net). The Minor Plan-ets Section is directed by its Coordinator, Prof. Frederick Pilcher, 4438 Organ Mesa Loop, Las Cruces, NM 88011 USA (pilcher@ic.edu), assisted by Lawrence Garrett, 206 River Road, Fairfax, VT 05454 USA (LSGasteroid@msn.com). Dr. Alan W. Harris (Space Science Institute; awharris@spacescience.org), Dr. Petr Pravec (Ondrejov Observatory; ppravec@asu.cas.cz), and Steve Larson (Lunar and Planetary Laboratory; slarson@lpl.arizona.edu) serve as Scientific Advisors. The Asteroid Photometry Coordinator is Brian D. Warner, Palmer Divide Observatory, 17995 Bakers Farm Rd., Colorado Springs, CO 80908 USA (brian@MinorPlanetObserver.com).

Brian D. Warner (address above) is the *MPB* Acting Editor while Dr. Richard P. Binzel is on sabbatical (*MPB* **35**, p. 141). The *MPB* is produced by Dr. Robert A. Werner, JPL MS 301-150, 4800 Oak Grove Drive, Pasadena, CA 91109 USA (robert.a.werner@jpl.nasa.gov) and dis-tributed by Derald D. Nye.

The contact for all subscriptions, contributions, address changes, etc. is:

Mr. Derald D. Nye
Minor Planet Bulletin
10385 East Observatory Drive
Corona de Tucson, AZ 85641-2309 USA
(nye@kw-obsv.org)
(Telephone: 520-762-5504)

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* * * * *

The deadline for the next issue (36-4) is July 15, 2009. The deadline for issue 37-1 is October 15, 2009.