NINETEEN ASTEROIDS LIGHTCURVES AT ASTEROIDS OBSERVERS (OBAS) - MPPD: 2015 APRIL - SEPTEMBER

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Photometric observations of 19 asteroids were made from 2015 April to September. We report the results of our lightcurve analysis for 392 Wilhelmina, 631 Philippina, 738 Alagasta, 758 Mancunia, 863 Benkoela, 873 Mechthild, 891 Gunhild, 900 Rosalinde, 1166 Sakuntala, 1232 Cortusa, 1243 Pamela, 1284 Latvia, 1331 Solvejg, 1353 Maartje, 1795 Woltjer, 2166 Handahl, 2379 Heiskanen, 2692 Chkalov, and 4875 Ingalls.

This paper contains lightcurve analysis for 19 asteroids obtained from the Spanish photometric asteroid analysis group (OBAS). The observatories coordinated their efforts as a network of telescopes working around weather and equipment issues. All lightcurves will be uploaded to Minor Planet Photometric Database (*http://www.minorplanet.es*) in order to get a visual database of asteroid lightcurves. The data have been sent to Collaborate Asteroid Lightcurve, as were previous works.

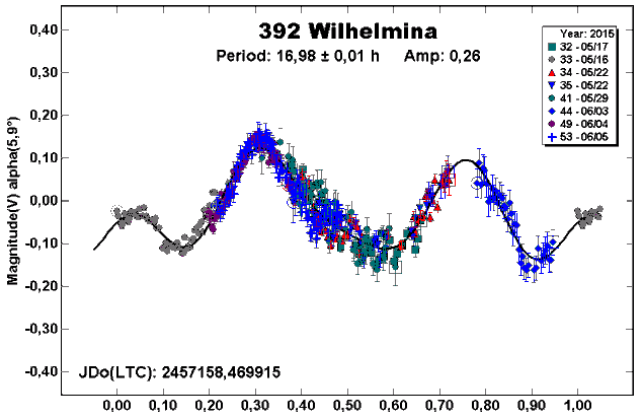
The data for our analysis were obtained from 2015 April to September. These asteroids were selected from the Collaborative Asteroid Lightcurve Link (CALL): 392 Wilhelmina, 631 Philippina, 738 Alagasta, 758 Mancunia, 863 Benkoela, 873 Mechthild, 891 Gunhild, 900 Rosalinde, 1166 Sakuntala, 1232 Cortusa, 1243 Pamela, 1284 Latvia, 1331 Solvejg, 1353 Maartje, 1795 Woltjer, 2166 Handahl, 2379 Heiskanen, 2692 Chkalov and 4875 Ingalls.

Nine observers: Alfonso Carreño, Amadeo Aznar, Enrique Arce, Pedro brines, Juan Lozano, Alvaro Fornas, Gonzalo Fornas, Onofre Rodrigo, and Vicente Mas contributed lightcurves. All exposures were made with clear filters (see Table I for equipment details) and all images were dark and flat-field corrected.

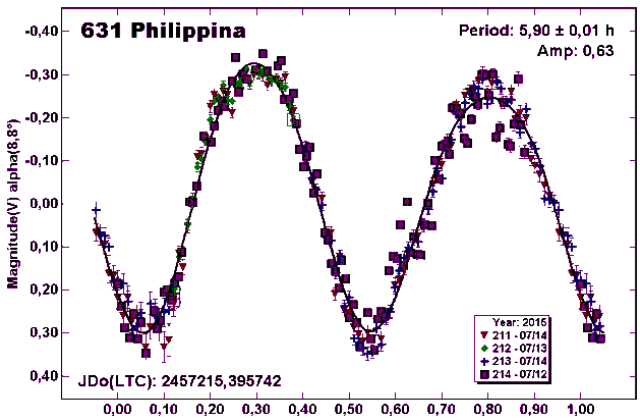
Telescope	Observatory	CCD
Refractor 10cm	Zonalunar	Atik 383L+
Cassegrain 35cm	Isaac Aznar	SBIG STL1001E
Cassegrain 25cm	Vallbona	SBIG ST7-XME
R-Chretien 20cm	TRZ	QHY8
D-Kirkham 25cm	Elche	SBIG ST8-XME
Cassegrain 20cm	Oropesa	Atik 16I
Cassegrain 23cm	Bétera	Atik 314L+
D-Kirkham 43cm	CAAT	SBIG STX-11K

Table I. List of instruments used for the observations.

392 Wilhelmina is a main-belt asteroid (D = 62.9 km) discovered by Max Wolf in 1894. A total of 431 data points were obtained over 8 nights from 2015 May 16 to Jun 5. The solar phase angle was –6.0° and +5° at the start and end of the period. Its magnitude was V ~ 14.3. The lightcurve shows a period of 16.98 ± 0.01 h and amplitude of 0.26 mag. The LCDB (Warner *et al.*, 2009) shows a period of 17.96 h and amplitude between 0.04-0.70.



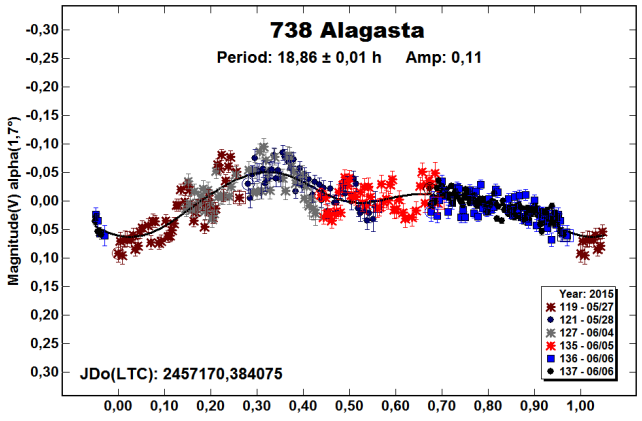
631 Philippina is a main-belt asteroid (D = 57.65 km) discovered by August Kopff in 1907. 300 points were obtained over 4 nights from 2015 July 12-14. The solar phase angle was 9º during span of observations. The asteroid's magnitude was V ~ 13.2. The lightcurve shows a period of 5.90 ± 0.01 h and amplitude of 0.63 mag. The LCDB shows several periods, *e.g.,* Behrend (2011, 5.899 h) and Hanus *et al.* (2011, 5.902 h).



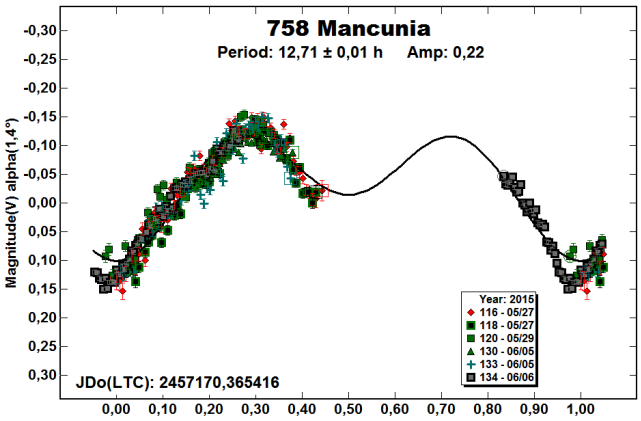
#	Name	Date Range	Nights	Period (h)	Error (h)	Amp (mag)	Points	LCD B
392	Wilhelmina	May 16 - Jun 05 2015	8	16.98	0.01	0.26	431	2
631	Philippina	Jul 12 - Jun 14 2015	4	5.90	0.01	0.63	300	3
738	Alagasta	May 27 - Jun 06 2015	6	18.86	0.01	0.11	338	2
758	Mancunia	May 27 - Jun 06 2015	6	12.71	0.01	0.22	349	3
863	Benkoela	Apr 04 - Apr 08 2015	3	8.20	0.01	0.27	176	2+
873	Mechthild	May 12 - May 16 2015	6	10.99	0.01	0.18	519	3
891	Gunhild	Jun 14 - Jul 17 2015	14	11.892	0.001	0.36	679	2
900	Rosalinde	Jun 19 - Jul 19 2015	5	16.70	0.01	0.28	297	2
1166	Sakuntala	Jun 28 - Jul 08 2015	4	6.29	0.01	0.38	210	2
1232	Cortusa	Jun 18 - Jun 27 2015	4	22.05	0.01	0.17	292	2
1243	Pamela	Aug 27 - Sep 22 2015	6	26.00	0.01	0.51	350	2
1284	Latvia	Sep 22 - Sep 30 2015	4	9.55	0.01	0.23	347	2
1331	Solvejg	Aug 23 - Sep 21 2015	6	19.30	0.01	0.44	309	2
1353	Maartje	Jun 30 - Jul 20 2015	18	22.930	0.001	0.46	724	2
1795	Woltjer	Jun 07 - Jun 16 2015	5	12.102	0.001	0.36	298	
2166	Handahl	Jul 23 - Jul 28 2015	4	7.21	0.01	0.11	269	3
2379	Heiskanen	Sep 21 - Sep 24 2015	3	3.76	0.01	0.17	271	
2692	Chkalov	Apr 30 - May 08 2015	3	6.11	0.01	0.13	184	
4875	Ingalls	May 28 - Jun 04 2015	3	3.78	0.01	0.13	360	

Table 2: Dates of observation, number of nights, and derived periods/amplitudes. The LCDB column gives the U rating (quality) listed in the in the asteroid lightcurve database (Warner *et al.,* 2009). A rating in the 2's indicates some uncertainty, *e.g.*, by up to 30% or being the double or half period of the "true" period. A rating of U=3 indicates a secure result.

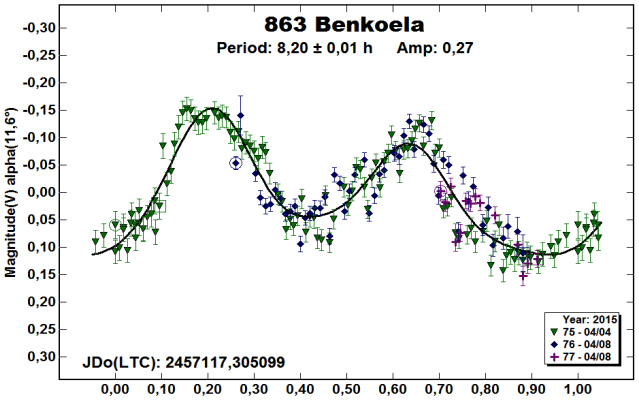
738 Alagasta is a main-belt asteroid (*D* = 62.79 km) discovered by Franz Heinrich in 1913. 338 points were obtained over 6 nights, from 2015 May 27 to Jun 6. The solar phase angle was +2° and +4° at the start and end of the period. The asteroid was V ~ 14.2. The lightcurve shows a period of 18.86 ± 0.01 h and amplitude of 0.11 mag. Sada *et al.* (2005) found a period of 17.83 h.



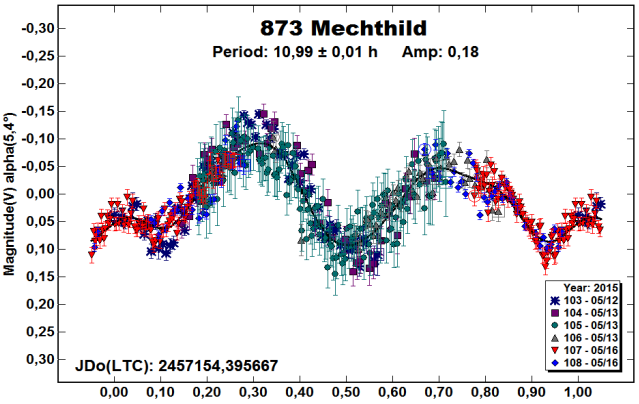
758 Mancunia is a main-belt asteroid (*D* = 85.48 km) discovered by Harry Edwin in 1912. 349 points were obtained over 6 nights in the period 2015 May 27 to Jun 6. The solar phase angle was +1° and +3° at the start and end of the period. The asteroid was V ~ 13.4. The lightcurve shows a period of 12.71 ± 0.01 h and amplitude of 0.22 mag. Due to weather problems, we could not get a complete lightcurve. Nevertheless, the Fourier analysis provides a consistent result. The LCDB shows a period of 12.73 h (Warner, 2008), 12.72 h (Behrend, 2007), and 12.8 h (Chang, 2014).



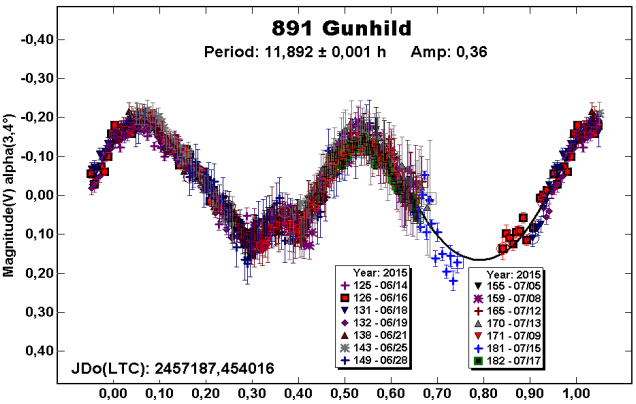
863 Benkoela is a main-belt asteroid (D = 27.06 km) discovered by Max Wolf in 1917. 176 points were obtained over 3 nights from 2015 April 4-8. The solar phase angle was +12°. The asteroid was V ~ 14 at the time. The lightcurve shows a period of 8.20 ± 0.01 h and amplitude of 0.27 mag. The LCDB shows a period of 7.03 h (Behrend, 2003) and Warner (2004), the latter having the better LCDB U rating of 2+.



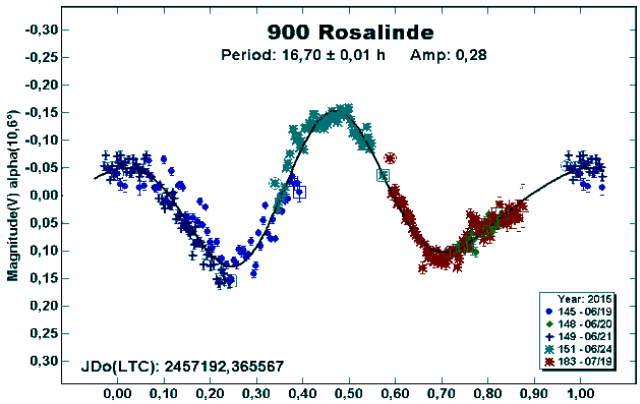
873 Mechthild is a main-belt asteroid (D = 29.04 km) discovered by Max Wolf in 1917. 519 points were obtained over 6 nights from 2015 May 12-16. The solar phase angle was +5°. The asteroid was V ~ 14.2 at the time. The lightcurve shows a period of 10.99 ± 0.01 h and amplitude of 0.18 mag. The LCDB shows periods of 10.6 h (Lagerkvist, 1978), 11.007 h (Warner, 2009), and 11.006 h (Wakszczak, 2015).



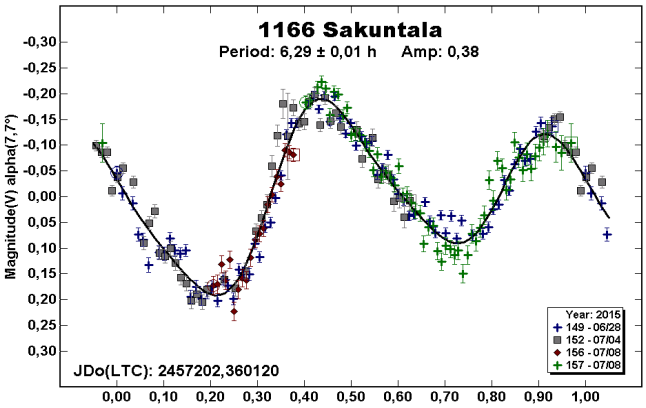
891 Gunhild is a main-belt asteroid (D = 51.95 km) discovered by Max Wolf in 1918. 679 points were obtained over 14 nights from 2015 June 14 to July 17. The solar phase angle was +4° and +14° at the start and end of the period. The asteroid was V ~ 14.0-14.6 over the period. The lightcurve shows a period of 11.892 ± 0.001 h and amplitude of 0.36 mag. The deformation near first minimum is likely due to a shape feature of the asteroid. Stephens (2000) reported a period of 7.93 h while Behrend (2005) reported P = 11.853.



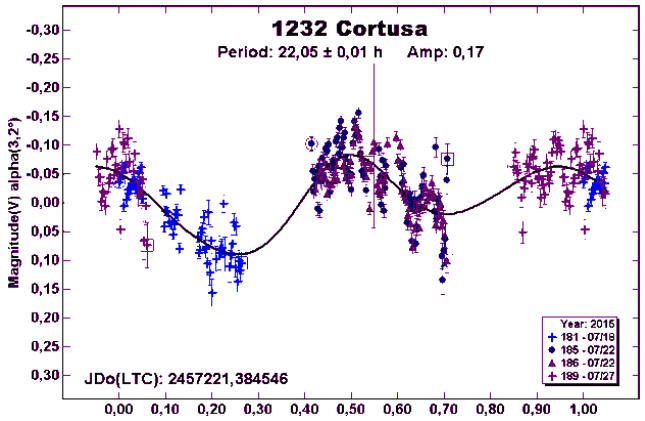
900 Rosalinde is a main-belt asteroid (D = 18.78 km) discovered by Max Wolf in 1918. 297 points were obtained over 5 nights from 2015 June 19 to July 19. The solar phase angle was +10° and +17° at the start and end of the period. The asteroid was V ~ 14.3 at the time. The lightcurve shows a period of 16.70 ± 0.01 h and amplitude of 0.28 mag. The LCDB shows a period of 16.5 h (Binzel, 1987) rated U = 2. There is another provisional lightcurve obtained by Behrend (2007), which has a period of 23.0 hours. Although it clearly shows a slope form, it covers less than 25% of a full rotation and so the lightcurve amplitude, and even period, can't be reliably determined.



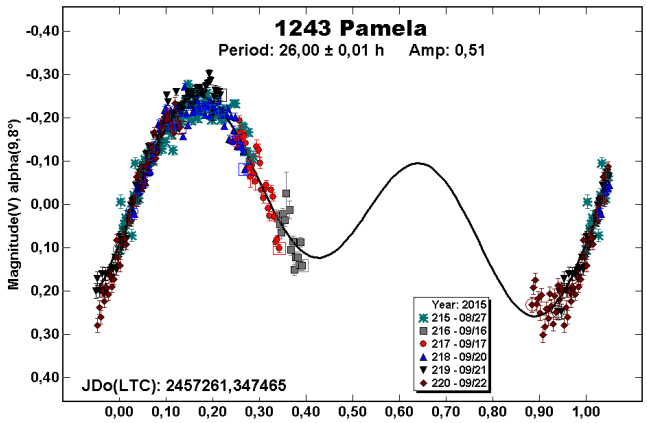
1166 Sakuntala is a main-belt asteroid (D = 28.74 km) discovered by Serguéi Beliavski in 1930. 210 points were obtained over 4 nights from 2015 Jun 28 to July 08. The solar phase angle was +8° and +12° at the start and end of the period. The asteroid was V ~ 12.6 at the time. The lightcurve shows a period of 6.29 ± 0.01 h and amplitude of 0.38 mag. Malcolm (2001) found a period of 6.30 h (U = 2). The LCDB contains other periods reported only as P > 20 h; those are rated U = 1.



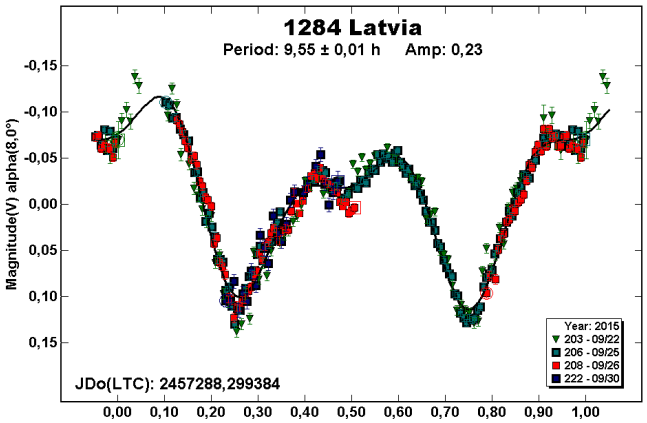
1232 Cortusa is a main-belt asteroid (D = 33.13 km) discovered by Karl Reinmuth in 1931. 292 points were obtained over 4 nights from 2015 Jul 18-27. The solar phase angle was +3° and +6° at the start and end of the period. The asteroid was V ~ 14.2 at the time. The lightcurve shows a period of 22.05 ± 0.01 h and amplitude of 0.17 mag. The LCDB shows a period of 25.16 h attributed to Behrend (2004; U = 2).



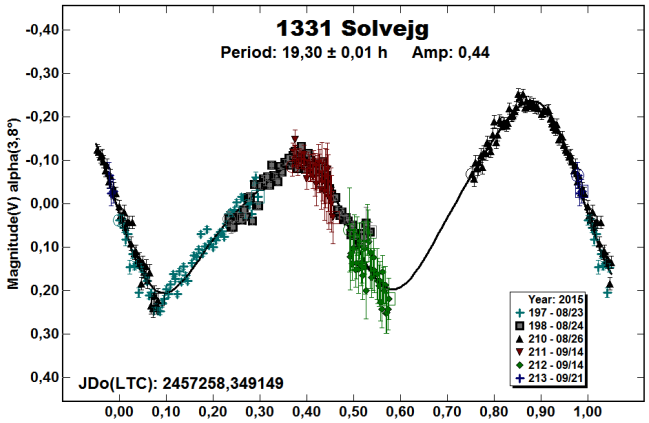
1243 Pamela is a main-belt asteroid of 70.07 km discovered by Cyril Jackson in 1932. 350 points were obtained over 6 nights from 2015 Aug 27 to Sep 22. The solar phase angle was +7° and +10° at the start and end of the period. The asteroid was V ~ 14.2 at the time. The lightcurve shows a period of 26.00 ± 0.01 h and amplitude of 0.51 mag. Warner (2000) reported a period of 26.017 h based on less than full coverage, the same us our curve.



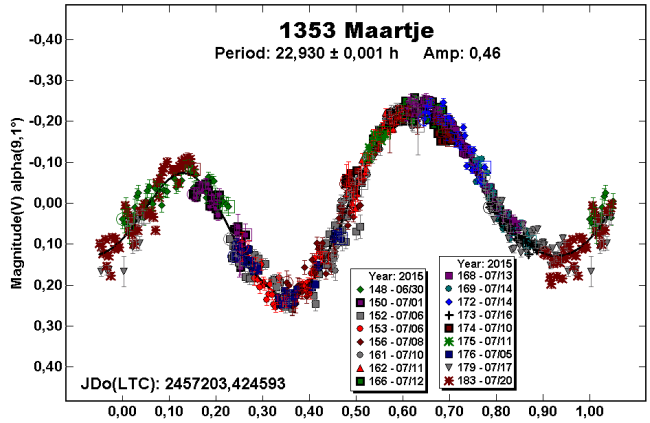
1284 Latvia is a main-belt asteroid (D = 36.81 km) discovered by Karl Reinmuth in 1933. 347 points were obtained over 4 nights from 2015 Sep 22-30. The solar phase angle was +7° at the start and end of the period. The asteroid was V ~ 13.2 at the time. The lightcurve shows a period of 9.55 ± 0.01 h and amplitude of 0.23 mag. Previously reported periods include Behrend (2004; 9.644 h) and Brinsfield (2008; 9.552 h). Both are rated U = 2.



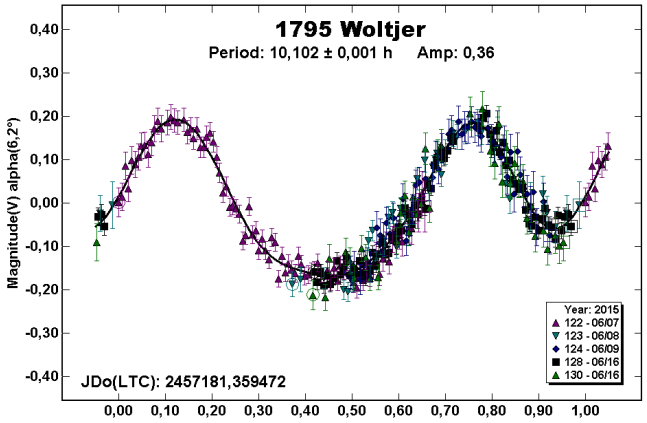
1331 Solvejg is a main-belt asteroid (D = 32.08 km) discovered by Grigori Neúimin in 1933. 309 points were obtained over 6 nights from 2015 Aug 23 to Sep 21. The solar phase angle was +4° and –15° at the start and end of the period. The asteroid was V ~ 13.5-14.2 at the time. The lightcurve shows a period of 19.3 ± 0.01 h and amplitude of 0.44 mag. Waszczak *et al.* (2015) found a period of 19.2885 h. This was a wide-field survey from which the results were imported into the LCDB *en masse* and given only a pass/fail rating, *i.e.,* U = 2 or U = 1, respectively. Many of the Waszczak *et al.* lightcurves are worthy of higher ratings, even U = 3.



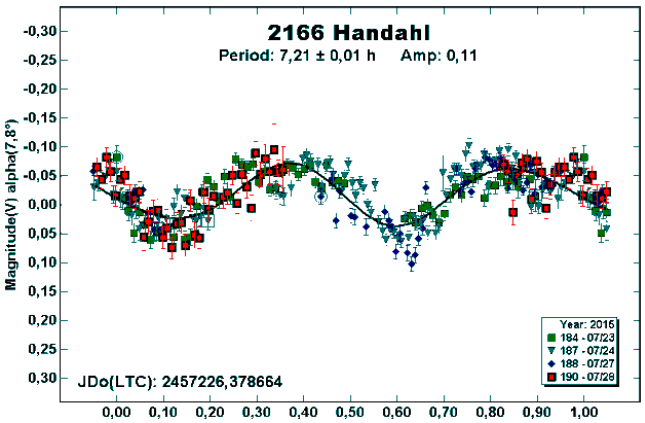
1353 Maartje is a main-belt asteroid (D = 33.75 km) discovered by Hendrik van Gent in 1935. 724 points were obtained over 18 nights from 2015 Jun 30 to Jul 20. The solar phase angle was –9° and +5° at the start and end of the period. The asteroid was V ~ 13.5 at the time. The lightcurve shows a period of 22.93 ± 0.001 h and amplitude of 0.46 mag. Behrend (2005) found a period of 22.98 h. Using the Behrend data along with those from other observers, Hanus *et al.* (2013) derived two possible spin axis orientations and shape. They reported a *sidereal* rotation period of 22.9926 h.



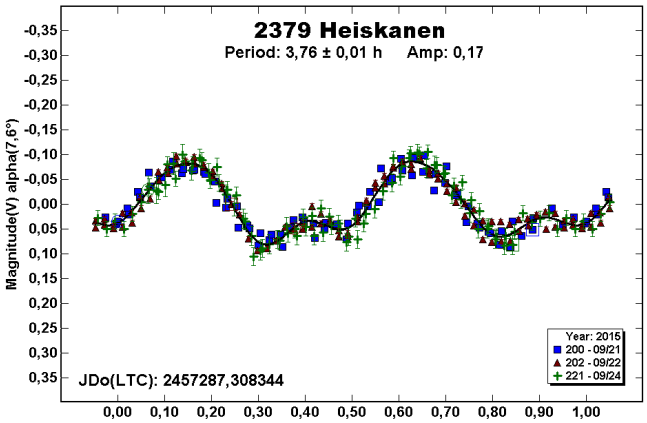
1795 Woltjer is a main-belt asteroid (D = 27.09 km) discovered by The P-L Survey at Palomar in 1960. 298 points were obtained over 5 nights from 2015 Jun 7-16. The solar phase angle was +6° and +10° at the start and end of the period. The asteroid was V ~ 14.7 at the time. The lightcurve shows a period of 12.102 ± 0.001 h and amplitude of 0.36 mag. The LCDB doesn't show a period for this asteroid.



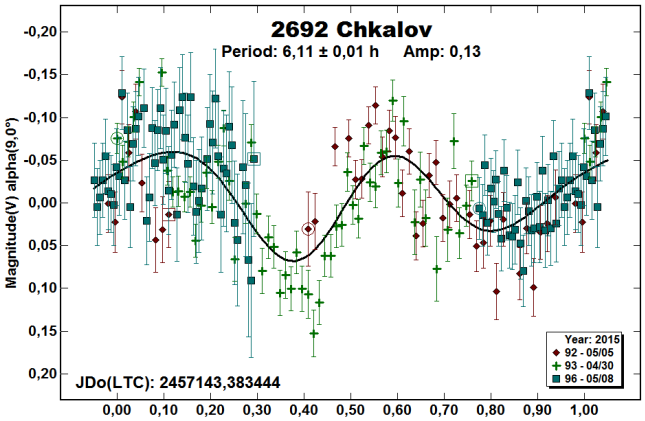
2166 Handahl is a main-belt asteroid (D ~ 5.5 km) discovered by Nikoláievich Neúimin in 1936. 269 points were obtained over 4 nights from 2015 Jul 23-28. The solar phase angle was –7° and +4° at the start and end of the period. The asteroid was V ~ 14.2 at the time. The lightcurve shows a period of 7.21 ± 0.01 h and amplitude of 0.11 mag. Chang *et al.* (2015) found a period of 7.330 h. Pravec *et al.* (2015) found a secure period of 7.2263 h based on observations in mid-2015.



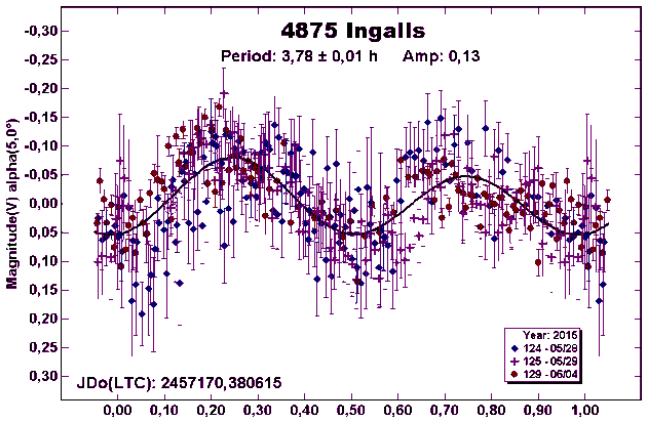
2379 Heiskanen is a main-belt asteroid (D = 31.6 km) discovered by Y. Vaisala in 1941. 271 points were obtained over 3 nights from 2015 Sep 21-24. The solar phase angle was +8°. The asteroid was V ~ 13.9 at the time. The lightcurve shows a period of 3.76 ± 0.01 h and amplitude of 0.17 mag. The LCDB doesn't show a period for this asteroid.



2692 Chkalov is a main-belt asteroid (D ~ 12 km) discovered by L. Chernykh in 1976. 184 points were obtained over 3 nights from 2015 April 30 to May 8. The solar phase angle was +7° and +14° at the start and end of the period. The asteroid was V ~ 14.5 at the time. The lightcurve shows a period of 6.11 ± 0.01 h and amplitude of 0.13 mag. The LCDB doesn't show a period for this asteroid.



4875 Ingalls is a main-belt asteroid. The WISE survey (Mainzer *et al.*, 2011) gives an estimated diameter of 5.5 km based on an albedo of p_V = 0.3679 and H = 13.0. The asteroid was discovered by Y. Kushida and R. Kushida at Yatsugatake in 1991. 360 points were obtained over 3 nights from 2015 May 28 to Jun 4. The solar phase angle was +5° and +7° at the start and end of the period. The asteroid was V ~ 14.6 at the time. The lightcurve shows a period of 3.78 ± 0.01 h and amplitude of 0.13 mag. The LCDB doesn't show a period for this asteroid.



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LIGHTCURVE AND ROTATION PERIOD DETERMINATION FOR MINOR PLANET 5236 YOKO

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CCD photometric observations of minor planet 5236 Yoko (1990 TG3) were undertaken in 2015 October. Analysis of the data from four nights found a synodic rotation period of $P = 2.6175 \pm 0.0004$ h and lightcurve amplitude $A = 0.39 \pm 0.05$ mag.

Cherryvalley Observatory (MPC Code I83) is an amateur observatory located in Ireland. Observations were conducted with a 0.2-m Schmidt-Cassegrain Telescope (SCT) operating at *f*/7.6. The camera was an SBIG STL-1301E CCD with a 1280x1024 array of 16-micron pixels fitted with an R-band Bessel filter. The resulting image scale was 2.17 arcseconds per pixel at 1x1 binning. Image acquisition was undertaken with Software Bisque's *TheSky6 Professional* and *CCDSoft v5* (Software Bisque, 2011). All science images were aligned, dark, and flat-field corrected using *CCDSoft* v5 with mid-exposure times light corrected using *MPO Canopus v10.7.0.1* (Warner, 2015).

Data were reduced in *MPO Canopus* using differential photometry to facilitate easy exportation. The Comp Star Selector (CSS) utility in *MPO Canopus* allows selecting up to five near solar colour stars within the field of view for differential photometry. This also helped with night-to-night zero point calibrations. The Cousins R Magnitudes for the comparisons were derived using the 2MASS to BVRI formulae developed by Warner (2007). Period analysis was completed using *MPO Canopus*, which incorporates the Fourier analysis algorithm (FALC) developed by Harris (Harris *et al*., 1989).

5236 Yoko is a main-belt asteroid constrained by a defined orbit (JPL, 2015) of $2.0 < a < 3.2$ AU; $q > 1.666$ AU, where a is the orbital semi-major axis and q is the perihelion distance. The asteroid has an orbital period of approximately 3.56 years and an absolute magnitude $H = 13.2$. Based upon IRAS (Tedesco, 2004) observations, its effective diameter and geometric albedo are estimated at 8.98 km and 0.1383, respectively. Discovery was on 1990 October 10 by Mizuno and Furuta at Kani Observatory Japan.

5236 Yoko was reported as a lightcurve opportunity in the *Minor Planet Bulletin* (Warner *et al.*, 2015). A total of 317 useful data points were used in the calculations, which were obtained over five nights during the period 2015 Oct 8-14. The solar phase angle varied from +14.9° through to +12.0° during observation period. The Earth distance was approximately 1.149 AU during the observation span.

The phased plot of the data demonstrates a classical bimodal shape with two maximums and minimums. The period solution of 2.6175