SIXTEEN ASTEROIDS LIGHTCURVES AT ASTEROIDS OBSERVERS (OBAS) - MPPD: 2016 JUNE-NOVEMBER

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We report on the photometric analysis result of sixteen main-belt asteroids (MBA) done by Asteroids Observers (OBAS). This work is part of the Minor Planet Photometric Database tasks, initiated by a group of Spanish amateur astronomers. We have managed to obtain a number of accurate and complete lightcurves as well as some additional incomplete lightcurves to help analysis at future oppositions.

In this paper we publish the result of sixteen asteroids analyzed under the Minor Planet Photometric Database project (*http://www.minorplanet.es*). As it is indicated in previous papers, this database is focused on collecting lightcurves of main-belt asteroids using photometric techniques. This database shows graphic results of the data, mainly lightcurves, with the plot phased to a given period.

Observatory	Telescope (m)	CCD
C.A.A.T.	0.45 DK	SBIG STL-11002
Zonalunar	0.20 NW	Atik 314L+
Vallbona	0.25 SCT	SBIG ST7-XME
TRZ	0.20 R-C	QHY8
Elche	0.25 DK	SBIG ST8-XME
Oropesa	0.20 SCT	Atik 16I
Bétera	0.23 SCT	Atik 314L+
Serra Observatory	0.25 NW	Atik 414L+

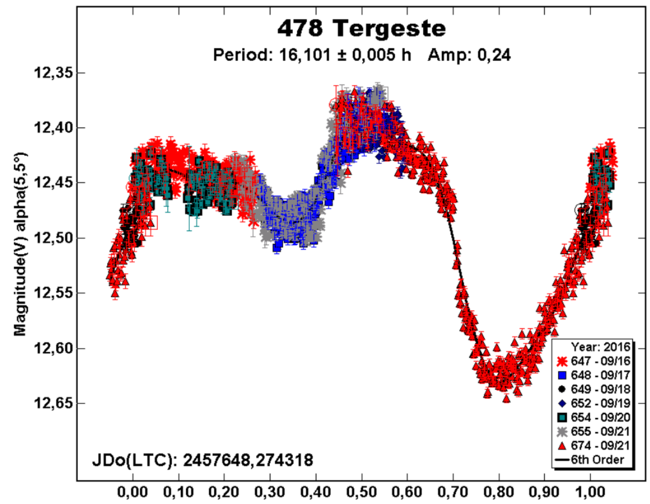
Table I. List of instruments used for the observations. SCT: Schmidt-Cassegrain: R-C: Ritchey-Chrétien; DK: Dall-Kirkham. NW: Newtonian.

Table I shows the equipment at observatories that participated in this work. We concentrated on asteroids with no reported period and those where the reported period was poorly established and needed confirmation. All the targets were selected from the Collaborative Asteroid Lightcurve (CALL) website at *http://www.minorplanet.info/call.html*, paying special attention to keeping the asteroid's magnitude within reach of the telescopes being used. We tried to observe asteroids at a phase angle of less than 14°, but this was not always possible.

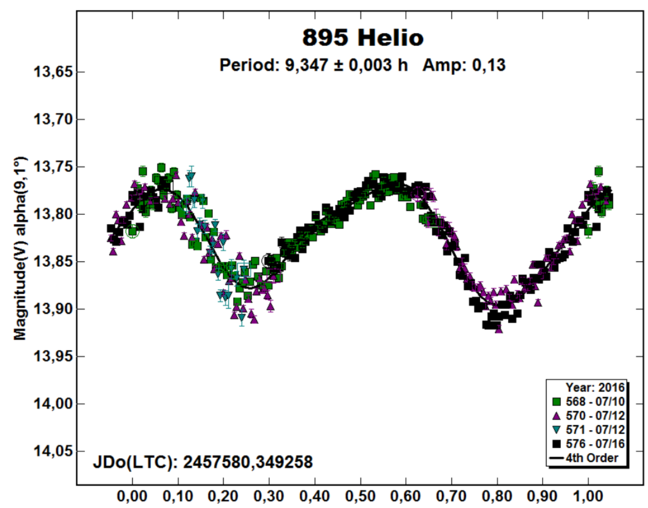
Images were measured using *MPO Canopus* (Bdw Publishing) with a differential photometry technique. For more information about technic topics see Aznar et al. (2016).

Table II lists the individual results along with the range of dates for the observations and the number of nights that observations were made.

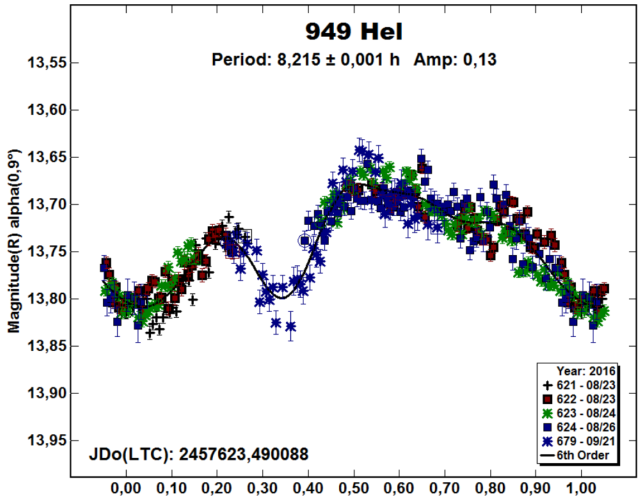
478 Tergeste. Our period of 16.101 ± 0.005 h is consistent with Behrend (2005), who found 16.104 h



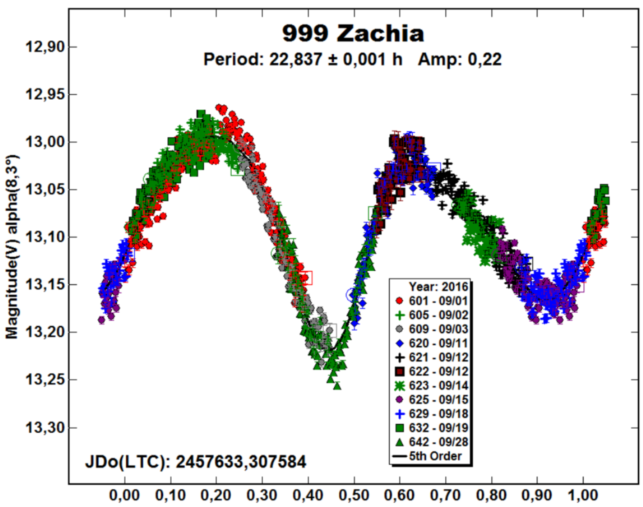
895 Helio. Previous results include Behrend (2005; 9.396 h) and Polakis (2016; 9.391 h). Our analysis found 9.347 ± 0.003 h.



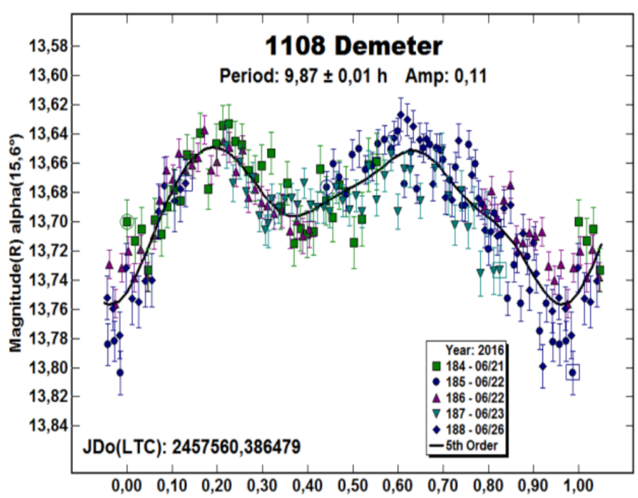
949 Hel. Our period of 8.215 ± 0.01 h differs from the 10.85 h period found by Behrend (2004).



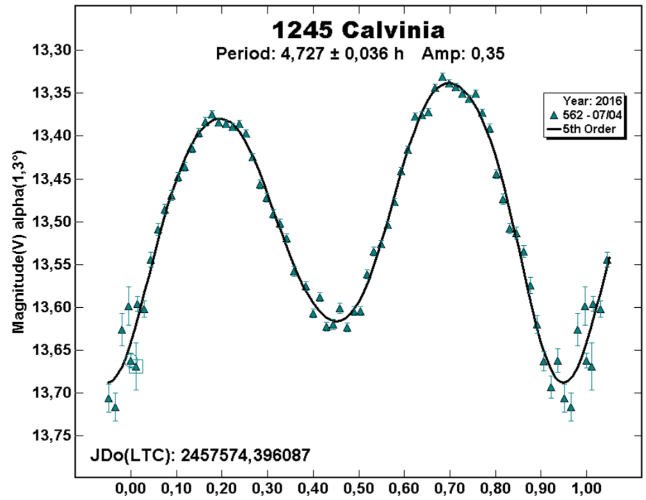
999 Zachia. Warner (2000) found a period of 22.77 h, which is similar to our result of 22.837 ± 0.001 h.



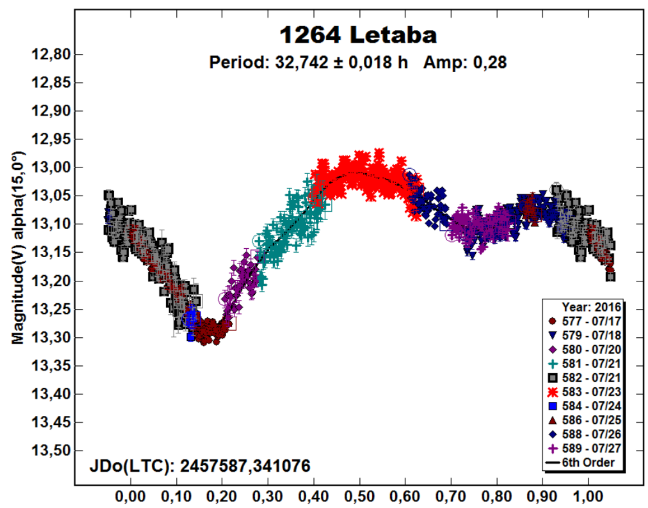
1108 Demeter. Our period of 9.87 ± 0.01 h is consistent with Polakis (2016), who found 9.846 h



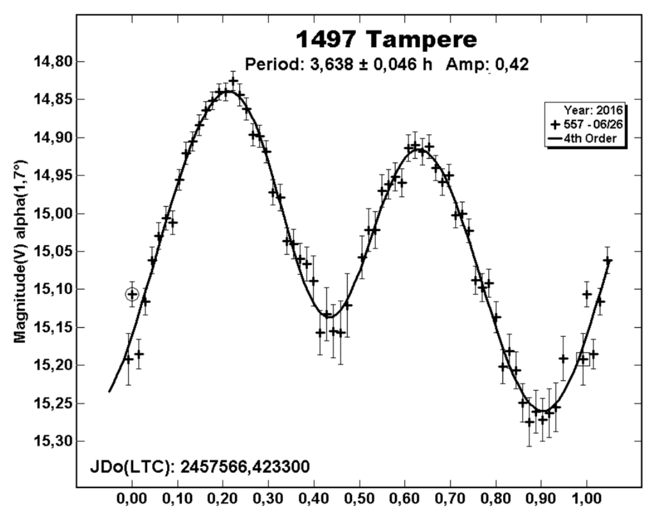
1245 Calvinia. Our period of 4.727 ± 0.036 h is consistent with Durech (2016), who reported a *sidereal* period of 4.85148 h.



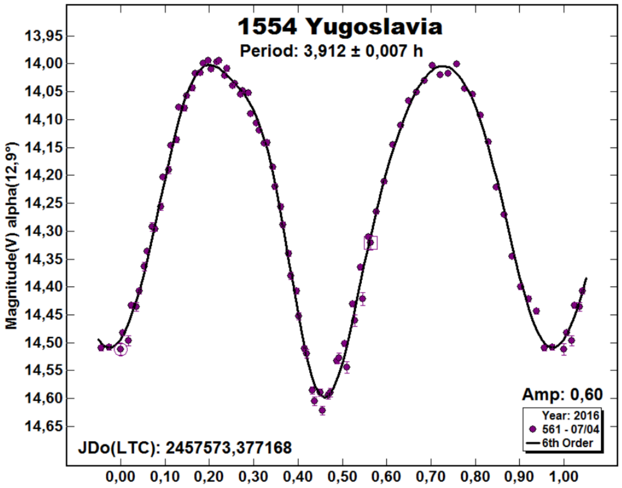
1264 Letaba. Stephens (2003) found a period 32.16 h; this is consistent with our result of 32.742 ± 0.018 h.



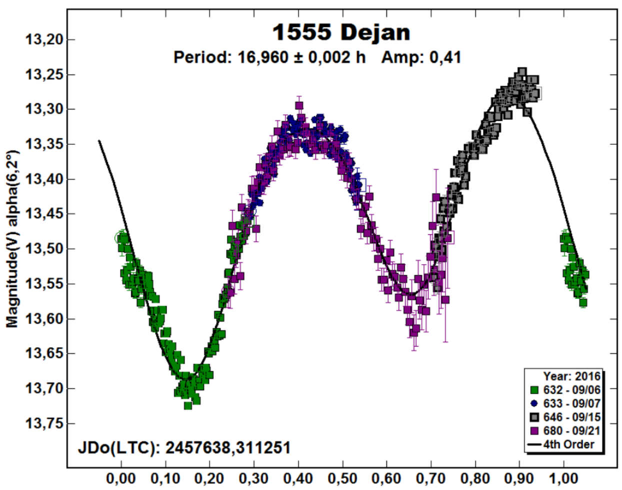
1497 Tampere. Our analysis found a period of 3.638 ± 0.046 h. Waszczak et al. (2015) and Chang et al. (2015) both found a period very close to 3.3 h.



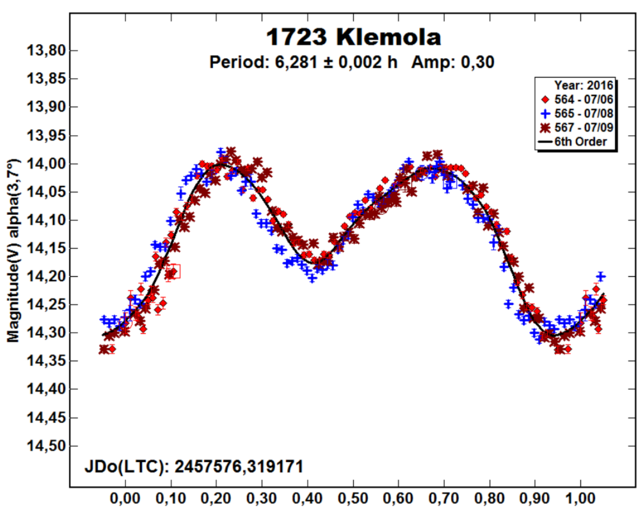
1554 Yugoslavia. Benishek (2013) and Ruthroff (2013) each found a period of about 3.89 h. Our result of 3.912 ± 0.007 h is consistent with those earlier results.



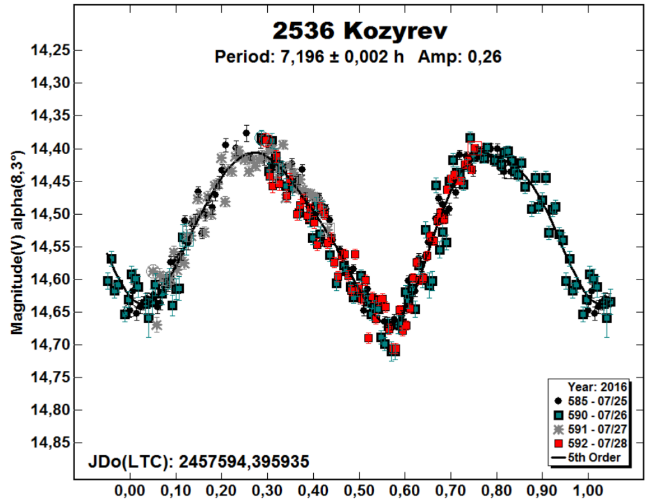
1555 Dejan. We found a period of 16.960 ± 0.002 h. There no previous results found in the asteroid lightcurve database (LCDB; Warner et al., 2009).



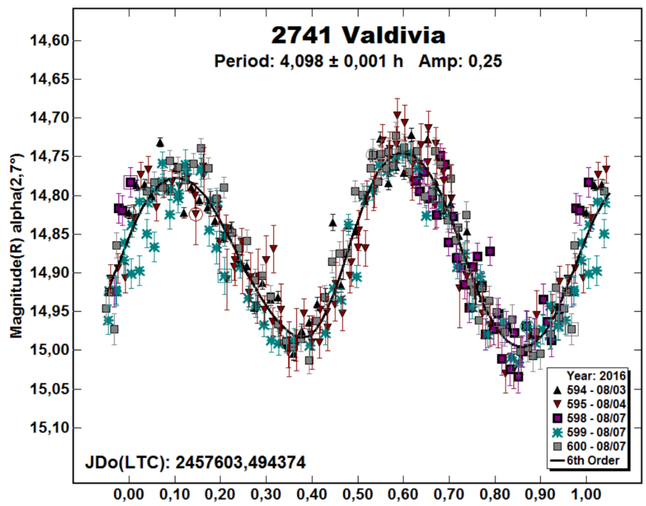
1723 Klemola. Our period of 6.281 ± 0.002 h is consistent with Durech (2016; 6.25609 h *sidereal*) and Waszczak et al. (2015; 6.255 h).



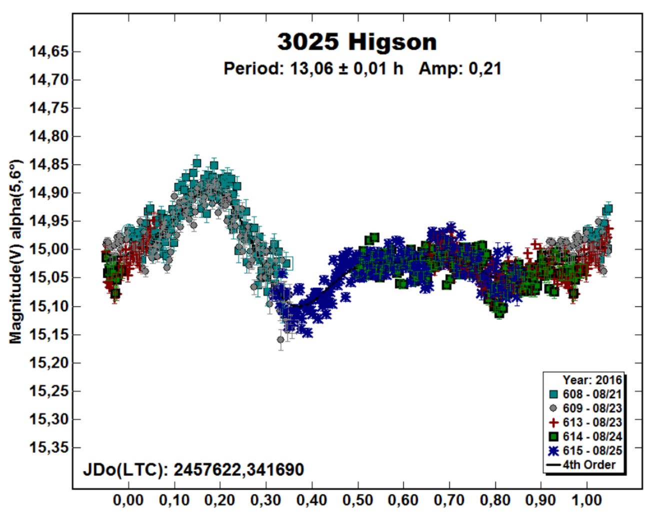
2536 Kozyrev. Skiff (2011) reported a period of 7.188 h; our result of 7.196 ± 0.002 h is consistent with that earlier result.



2741 Valdivia. We found a period of 4.098 ± 0.001 h. This is consistent with Pray (2004; 4.096 h), Hanus (2016; 4.096 h), and Waszczak et al. (2015; 4.096 h).



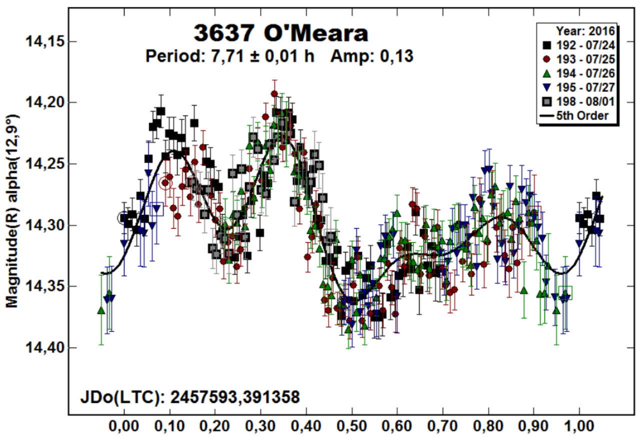
3025 Higson. Our period of 13.060 ± 0.010 h is not consistent with Behrend (2010), who found a period of 10.8 h.



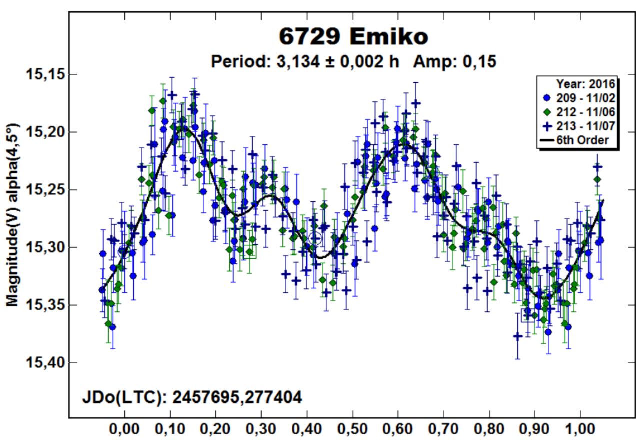
Number	Name	2016 mm/dd	Pts	Phase	LPAB	BPAB	Period(h)	P.E.	Amp	A.E.	Grp
478	Tergeste	09/16-09/21	1237	5.5,6.0	350	14	16.101	0.007	0.24	0.005	MB-O
895	Helio	07/10-07/16	372	9.1,8.2	308	21	9.347	0.002	0.13	0.003	MB-O
949	Hel	08/23-09/21	338	0.8,10.2	329	2	8.215	0.001	0.13	0.001	MB-O
999	Zachia	09/01-09/28	1221	8.2,12.6	345	11	22.837	0.001	0.22	0.001	MB-M
1108	Demeter	06/21-06/26	247	14.8,16.7	261	20	9.870	0.012	0.11	0.010	PHO
1245	Calvinia	07/04-07/04	68	1.2,1.2	283	3	4.727	0.040	0.35	0.036	KOR
1264	Letaba	07/17-07/27	1077	15.1,14.5	306	31	32.742	0.020	0.28	0.018	MB-O
1497	Tampere	06/26-06/26	65	2.1,2,1	279	1	3.638	0.050	0.42	0.046	KOR
1554	Yugoslavia	07/04-07/04	87	12.9,12.9	299	16	3.912	0.011	0.60	0.007	EUN
1555	Dejan	09/06-09/21	439	6.1,5.2	352	5	16.960	0.002	0.41	0.002	MB-M
1723	Klemola	07/06-07/09	267	3.8,3.6	287	9	6.281	0.003	0.30	0.002	EOS
2536	Kozyrev	07/25-07/28	313	7.7,6.2	312	313	7.196	0.002	0.26	0.002	FLOR
2741	Valdivia	08/03-08/07	387	2.7,3.3	311	5	4.098	0.001	0.25	0.001	MB-M
3025	Higson	08/21-08/25	787	5.5,6.0	326	15	13.060	0.010	0.21	0.010	MB-O
3637	O'Meara	07/24-08/01	326	12.8,14.8	289	20	7.710	0.012	0.13	0.010	EUN
6729	Emiko	11/02-11/07	221	4.4,5.3	40	8	3.134	0.010	0.15	0.002	EUN

Table II. Observing circumstances and results. Pts is the number of data points. The phase angle values are for the first and last date. LPAB and BPAB are the approximate phase angle bisector longitude and latitude at mid-date range (see Harris et al., 1984). Grp is the asteroid family/group (Warner et al., 2009).

3637 O'Meara. The period of 5.49 h reported by Behrend (2008) is not consistent with our period of 7.710 ± 0.010 h.



6729 Emiko. Our period of 3.134 ± 0.002 h is not consistent with Behrend (2008), who found 5.49 h.



Acknowledgements

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3792 PRESTON: ANOTHER TWO-PERIOD CASE

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Photometric observations of the main-belt asteroid 3792 Preston during its 2016 apparition carried out from Europe and North America clearly revealed the existence of a secondary rotational lightcurve component. Although certain shallow attenuations that could represent satellite mutual eclipse/occultation events were detected on several occasions, the attempts to determine a unique orbital period from the available data were unsuccessful.

The main-belt (Phocaea family) asteroid 3792 Preston was discovered on 1985 March 22 at Palomar by C. S. Shoemaker. At a rather favorable photometric target (an estimated magnitude of V ~ 15.7 at its brightest on 2016 Feb 8), it was selected by Benishek from the Potential Lightcurve Targets list for 2016 February (*http://www.minorplanet.info/PHP/call_OppLCDBQuery.php*) to be observed at the Sopot Astronomical Observatory (SAO). The goal was to verify the only known rotation period at that time of 2.93 hours (Behrend, 2009) and rated U = 2+ in the asteroid lightcurve database (LCDB; Warner et al., 2009). The first photometric observations at the SAO started on 2016 January 20 using a 0.35-m S-C telescope operating at f/6.3 and a SBIG ST-8XME CCD without filters.

The initial SAO data showed lightcurve deviations that raised a suspicion about the existence of a secondary lightcurve component. Furthermore, possible shallow mutual events (eclipse/occultation) were observed on a few occasions, which raised further interest in verifying the existence of a satellite and possible determination of its orbital period. An analysis of the initial data performed by Petr Pravec confirmed that 3792 Preston might be a binary candidate.

To ensure effective continuation of data gathering, a call for collaboration among observers was made by Pravec and Benishek through the Photometric Survey for Asynchronous Binary Asteroids website. Frederick Pilcher from the Organ Mesa Observatory in New Mexico, USA, Romain Montaigut and Arnaud Leroy from the OPERA Observatory in France, and Albino Carbognani from the Astronomical Observatory of the Aosta Valley Autonomous Region (OAVdA) in Italy accepted participation in the observing campaign. Pilcher used a 0.35-m Schmidt-Cassegrain telescope (SCT) with a SBIG STL-1001E CCD camera and clear filter. Montaigut and Leroy used a 0.20-m *f*/3.8 Newtonian telescope and ATIK 314L CCD camera without filters. Carbognani used an *f*/7.8 0.81-m Bowen-Waughan reflector and FLI-1001E CCD camera with a Cousins R photometric filter.

Differential aperture photometry with up to five comparison stars of near solar color ($0.5 \leq$ B-V ≤ 0.9) was performed by Benishek, Carbognani, and Pilcher using the Comparison Star Selector (CSS) feature in *MPO Canopus* (Warner, 2016) by selecting the Johnson V magnitudes (Pilcher and Benishek) from the AAVSO Photometric All-Sky Survey catalog (APASS; Henden *et al.*, 2009) and the Cousins R magnitudes (Carbognani) taken from the MPOSC3 hybrid catalog. The MPOSC3 catalog contains BVRcIc magnitudes derived from 2MASS J and K magnitudes by the formulae developed by Warner (2007). PSF photometry with elliptical Gaussian shapes and 10 comparison stars similar in color to the asteroid was carried out in PRISM software by Montaigut and Leroy, who used the R-band magnitudes from the USNO-A2.0 catalog to calibrate the measurements. Due to the apparent inconsistencies in the magnitude calibration procedures among the authors, it was necessary to adjust further the zero-points of particular data sets to achieve the best alignment in terms of minimum RMS residuals in Fourier analysis.

As of 2016 March 28, a total of 27 data sets (*sessions*) has been obtained: 19 by Benishek, 6 by Pilcher, 1 by Montaigut and Leroy and 1 by Carbognani.

The period analysis of the overall data and lightcurve plot production were performed by Pravec using his custom period analysis software. Due to the large time span of more than two months in which the observations were carried out and, therefore, changes in the viewing geometry and the lightcurve shape, the total combined data set was divided into two subsets that were analyzed separately. The first subset comprised the data obtained from 2016 January 23 through February 25; the second subset contained data obtained from 2016 March 1-28. Some of the sessions were excluded from the analysis due to their short duration and/or noisy data.