

**TWELVE MAIN BELT ASTEROIDS, ONE NEAR EARTH
AND ONE POTENTIALLY HAZARDOUS ASTEROID
LIGHTCURVES AT ASTEROIDS OBSERVERS
(OBAS) – MPPD: 2017 MAY- 2019 JAN**

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We report on the photometric analysis result of twelve main-belt asteroids (MBA), one near-Earth asteroid (NEA) and one potentially hazardous asteroid (PHA) by Asteroids Observers (OBAS). This work is part of the Minor Planet Photometric Database effort that was 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 results for twelve asteroids analyzed under the Minor Planet Photometric Database project (<http://www.minorplanet.es>). The data and results were made possible thanks to the collaboration of the Astronomical Center Alto Turia (CAAT) observatory located in Aras de los Olmos and operated by members of the Valencia Astronomy Association (AVA) (<http://www.astroava.org>). This database shows graphic results of the data, mainly lightcurves, with the plot phased to a given period.

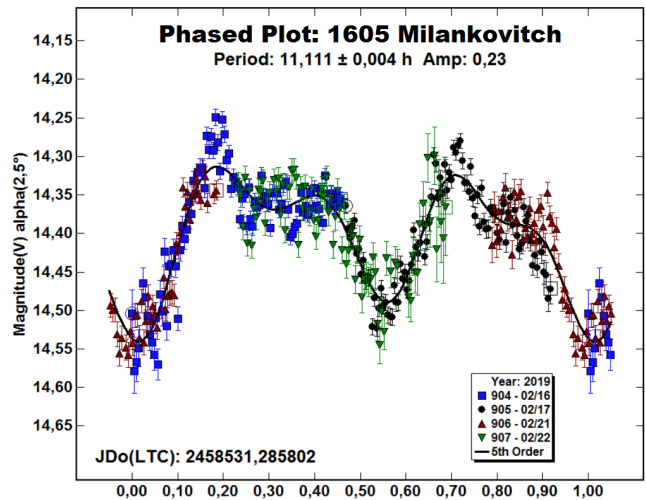
Observatory	Telescope (meters)	CCD
C.A.A.T.	0.45 DK	SBIG STL-11002
Zonalunar	0.20 NW	ATIK 314L
Vallbona	0.20 NW	ATIK414EX

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

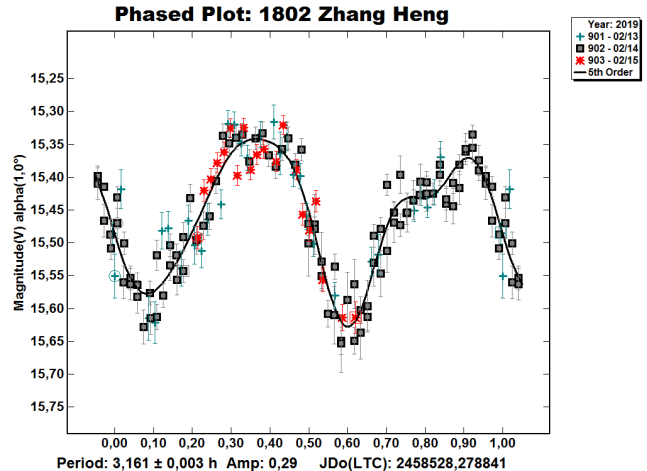
Table I shows the equipment at observatories that participated in this work. We concentrated on asteroids with no reported period and those where the reported period was poorly established and needed confirmation. All the targets were selected from the Collaborative Asteroid Lightcurve (CALL) website at (<http://www.minorplanet.info/call.html>) and Minor Planet Center (<http://www.minorplanet.net>)

Images were measured using *MPO Canopus* (Bdw Publishing) with a differential photometry technique. The comparison stars were restricted to near solar-color to avoid introducing color dependences, especially at larger air masses. The lightcurves give the synodic rotation period. The amplitude (peak-to-peak) that is shown is that for the Fourier model curve and not necessarily the true amplitude.

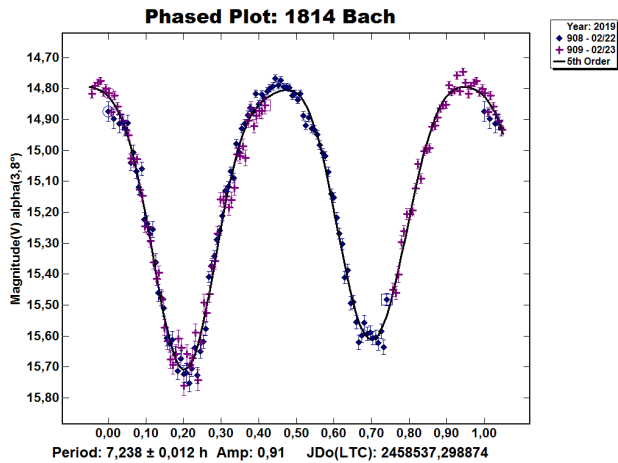
1605 Milankocith. This outer main-belt asteroid was discovered on 1936 April 13 by Petar Đurković from the Royal Observatory of Belgium, Uccle. The OBAS group made observations on 2019 Feb 16-22. From our data we derive a rotation period of 11.111 ± 0.004 h and amplitude of 0.23 mag. Cooney 2005 found a period of 11.6 h and Behrend 2006 web found 11.63 h.



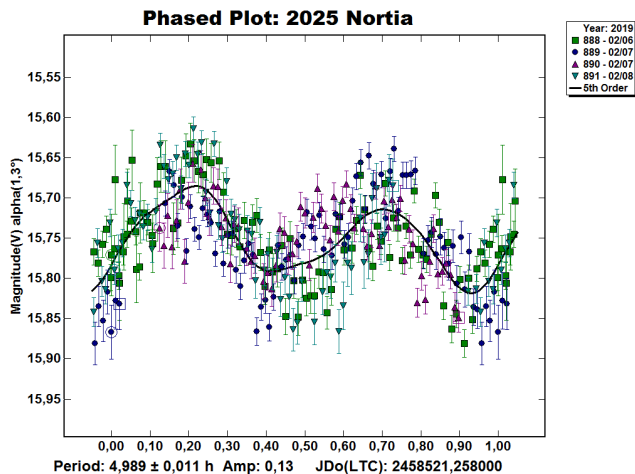
1802 Zhang Heng. This main-belt asteroid (outer) was discovered on 1964 Oct 14 by the Purple Mountain Obs., Nanking, China. The OBAS group made observations on 2019 Feb 13-15. From our data we derive a rotation period of 3.161 ± 0.003 h and amplitude of 0.29 mag. Simpson 2013 found a period of 3.162 h and Waszczak et al. (2015) found 3.160 h.



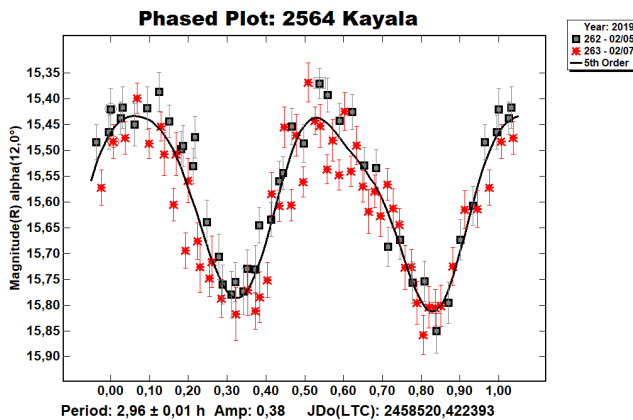
1814 Bach. This inner main-belt asteroid was discovered on 1931 Oct 9 by Karl Wilhelm Reinmuth at Heidelberg-Königstuhl Observatory, Deutschland. The OBAS group made observations on 2019 Feb 22-23. From our data we derive a rotation period of 7.238 ± 0.012 h and amplitude of 0.91 mag. Durech et al. (2016) found a period of 7.24 h and Pravec et al. (2019, website) found 7.24 h.



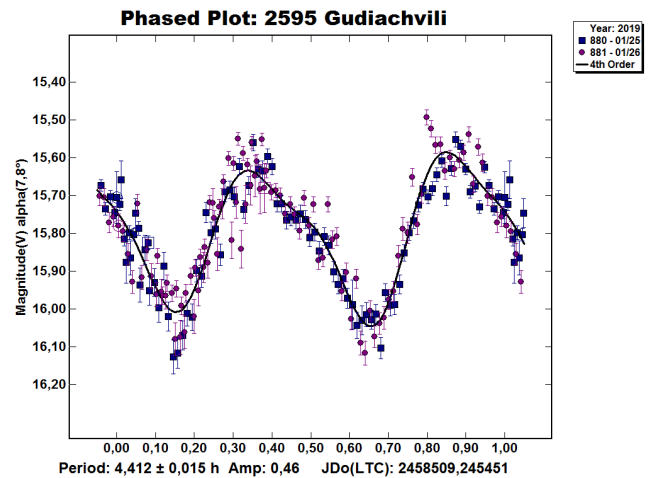
2025 Nortia. This outer main-belt asteroid was discovered on 1953 Jun 06 by Joseph Churms at Union Observatory, Johannesburg, Southafrica. The OBAS group made observations on 2019 Feb 06-08. From our data we derived a rotation period of 4.989 ± 0.011 h and amplitude of 0.13 mag. The LCDB (Warner et al., 2009) did not list any previous period results.



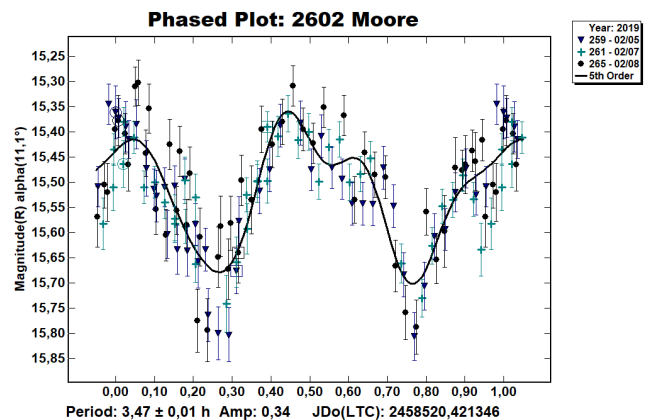
2564 Kayala. This inner main-belt asteroid was discovered on 1977 Aug 19 by Nikolái Stepánovich Chernyj at Crimea astrophysical observatory. The OBAS group made observations in 2019 Feb 05 and 07. From our data we derived a rotation period of 2.96 ± 0.01 h and amplitude of 0.38 mag. Chang et al. (2016) found a period of 2.95 h.



2595 Gudiachvili. This Main Belt asteroid (middle) was discovered on 1979 May 19 by R. M. West at La Silla observatory, Chile The OBAS group made observations from 2019 Jan 25-26. From our data we derived a rotation period of 4.412 ± 0.015 h and amplitude of 0.46 mag. DeGraff (1998-2003) found 4.72 h.



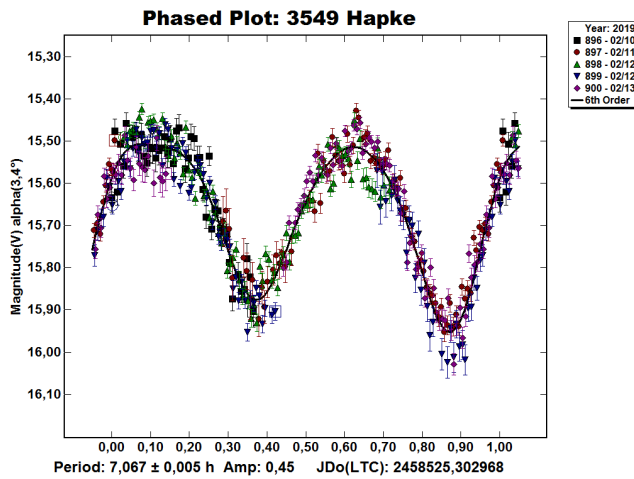
2602 Moore. This inner main-belt asteroid was discovered on 1982 Jan 24 by Edward. Bowell at Anderson Mesa, Arizona. The OBAS group made observations in 2019 Feb 5-8. From our data we derived a rotation period of 3.47 ± 0.01 h and amplitude of 0.34 mag. We have not found previous data about this asteroid.



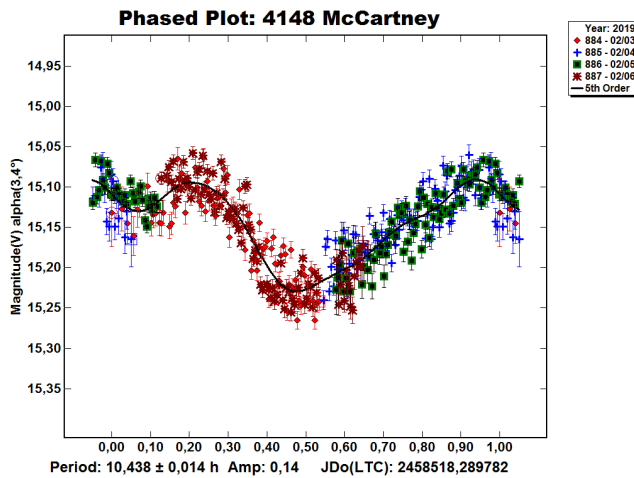
3549 Hapke. This inner main-belt asteroid was discovered on 1981 Dec 30 by Edward. Bowell at Anderson Mesa, Arizona. We observed it from 2019 Feb 10 to 13. Data analysis found a rotation period of 7.07 ± 0.005 h and amplitude of 0.45 mag. Waszczak et al. (2015) found a period of 7.071 h too.

Number	Name	20xx mm/dd	Phase	LPAB	BPAB	Period(h)	P.E.	Amp	A.E.	Grp
1605	Milankovitch	16/02/16-02/22	2.4, 2.9	149	-6	11.111	0.004	0.23	0.05	MB-O
1802	Zhang Heng	19/02/13-02/15	1.3, 1.9	141	0	3.161	0.003	0.29	0.02	MB-O
1814	Bach	19/02/23-02/23	3.4, 3.3	157	4	7.238	0.012	0.91	0.05	MB-I
2025	Nortia	19/02/06-02/08	1.5, 1.9	133	2	4.989	0.011	0.13	0.05	MB-O
2564	Kayala	19/02/05-02/07	11.9, 10.9	157	0	2.96	0.01	0.38	0.02	MB-I
2595	Gudiachvili	19/01/25-01/26	8.2	110	-7	4.412	0.015	0.46	0.02	MB-M
2602	Moore	19/02/05-02/08	11.1, 10.1	157	-1	3.47	0.01	0.34	0.03	MB-I
3549	Hapke	19/02/10-02/13	3.6, 4.3	139	-6	7.070	0.005	0.45	0.02	MB-I
4148	McCartney	19/02/03-02/06	2.8, 1.5	139	1	10.438	0.014	0.14	0.03	MB-I
6161	Vojno-Yasenetsky	19/01/15-01/17	7.4, 6.8	127	-5	7.983	0.005	0.9	0.02	MB-O
7081	Ludibunda	18/09/29-10/01	4.1, 4.3	9	7	2.885	0.006	0.08	0.02	MB-M
18348	1990 BM1	19/01/13-01/15	3.4, 2.8	116	-4	7.520	0.009	0.29	0.03	MB-I
162082	1998 HL1	19/10/01-01/09	81.0, 77.8	11	49	3.024	0.003	0.28	0.05	NEA

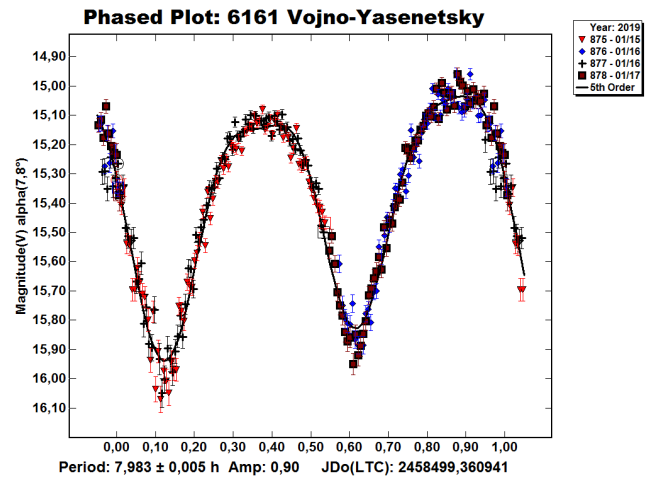
Table I. Observing circumstances and results. Pts is the number of data points. The phase angle values are for the first and last date. LPAB and BPAB are the approximate phase angle bisector longitude and latitude at mid-date range (see Harris et al., 1984). Grp is the asteroid family/group (Warner et al., 2009). ERI: Erigone; EUN: Eunomia; MB-I/O: Main-belt inner/outer; MC: Mars-crosser; NEA: near-Earth; THM: Themis; TRJ: Jupiter Trojan.



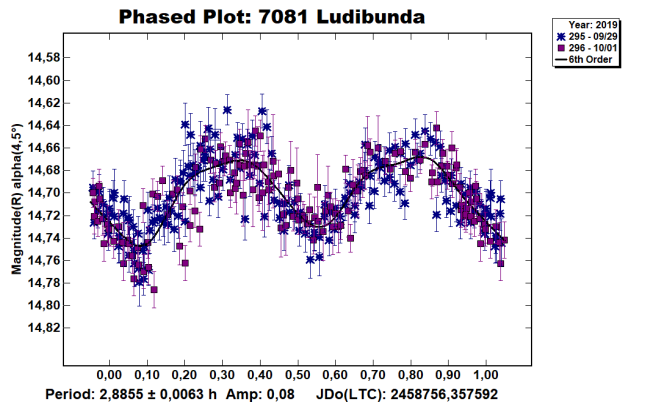
4148 McCartney. This inner main-belt asteroid was discovered on 1983 Jul 11 by Edward Bowell at Anderson Mesa, Arizona. The OBAS group observed it from 2019 Feb 3-6. From our data we derived a rotation period of 10.438 ± 0.014 h and amplitude of 0.14 mag. We have not found previous data about this asteroid.



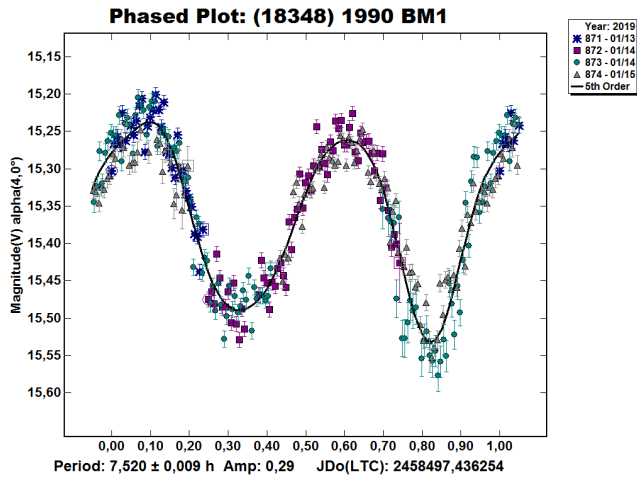
6161 Vojno-Yasenetsky. This Main Belt (outer) asteroid was discovered on 1971 Oct 14 by Liudmila Chernyj from Crimea observatory at Crimea. Our observations were made from 2019 Jan 15-17. Data analysis found a rotation period of 7.983 ± 0.005 h and amplitude of 0.9 mag. Durech et al. (2016) found a period of 7.98 h.



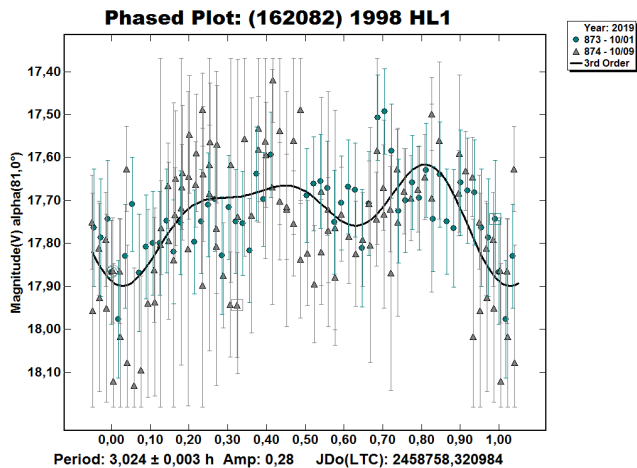
7081 Ludibunda. This middle main-belt asteroid was discovered on 1987 Aug 30, by Paul Wild at Berna - Zimmerwald Observatory. We observed it from 2019 Sep 9 to Nov 1. From our data we derived a rotation period of 2.885 ± 0.0063 h and amplitude of 0.08 mag. We have not found previous data about this asteroid.



(18348) 1990 BM1. This inner main-belt asteroid was discovered on 1990 Jan 22, by Eleanor Francis Helin at Palomar Observatory. We observed it from 2019 Jan 13-15. We derived a rotation period of 7.52 ± 0.009 h and amplitude of 0.29 mag. Pravec et al. (2019 website) found a period of 7.54 h and Klinglesmith (2019) found 7.53 h.



(162082) 1998 HL1. This Apollo - PHA asteroid was discovered on 1998 Apr 18, by LINEAR at Socorro Observatory. We observed it from 2019 Oct 01-09. We derived a rotation period of 3.024 ± 0.003 h and amplitude of 0.28 mag. We have not found previous data about this asteroid.



Acknowledgements

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References

- Behrend, R. (2006). Observatoire de Geneve web site, http://obswww.unige.ch/~behrend/page_cou.html
- Chang, C.-K.; Lin, H.-W.; Ip, W.-H.; Prince, T.A.; et al. (2016). *Astrophys. J. Sup. Ser.* **227**, A20.
- Cooney, W.R. (2005). *Minor Planet Bull.* **32**, 15-16.
- DeGraff, D.R.; Robbins, A.M.; Gutermuth, R.A. (1998). *Bull. Amer. Astron. Soc.* **30**, 1390.
- Durech, J.; Hanus, J.; Oszkiewiecz, D.; Vanco, R. (2016). *Astron. Astrophys.* **587**, A48.
- Harris, A.W.; Young, J.W.; Scaltriti, F.; Zappala, V. (1984). "Lightcurves and phase relations of the asteroids 82 Alkmene and 444 Gypsis." *Icarus* **57**, 251-258.
- Klinglesmith III, D.A.; Lovato, E.A. (2019). *Minor Planet Bull.* **46**, 81-82.
- Pravec, P.; Wolf, M.; Sarounova, L. (2019) <http://www.asu.cas.cz/~ppravec/neo.htm>
- Simpson, G.; Chong, E.; Gerhardt, M.; Gorsky, S.; et al. (2013). *Minor Planet Bull.* 146-151.
- Warner, B.D.; Harris, A.W.; Pravec, P. (2009). "The Asteroid Lightcurve Database." *Icarus* **202**, 134-146. <http://www.minorplanet.info/lightcurvedatabase.html>
- Waszczak, A.; Chang, C.-K.; Ofeck, E.O.; Laher, F.; et al. (2015). *Astron. J.* **150**, A75.