# TWENTY-ONE ASTEROID LIGHTCURVES AT ASTEROIDS OBSERVERS (OBAS) - MPPD: NOV 2016 - MAY 2017

Vicente Mas, G. Fornas
CAAT, Centro Astronómico del Alto Turia, SPAIN
gfornas@minorplanet.es

Juan Lozano
Elche Observatory, Alicante, SPAIN

Onofre Rodrigo
Bétera Observatory, Valencia, SPAIN

A. Fornas
Oropesa Observatory, Castellón, SPAIN

A. Carreño
Zonalunar Observatory,Valencia, SPAIN

Enrique Arce
Vallbona Observatory, Valencia, SPAIN

Pedro Brines
TRZ Observatory, Valencia, SPAIN

David Herrero
Serra Observatory, Valencia, SPAIN

(Received: 2017 Oct 15 Revised: 2017 Nov 9)

We report on the analysis of photometric observations of 21 main-belt asteroids (MBA) done by Asteroids Observers (OBAS). This work is part of the Minor Planet Photometric Database task 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 of the analysis of photometric data for 21 asteroids observed under the Minor Planet Photometric Database project (*http://www.minorplanet.es*). Our efforts are aimed at building a database of main-belt asteroid lightcurves 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 is Schmidt-Cassegrain. R-C is Ritchey-Chrétien. DK is Dall-Kirkham. NW is Newton.

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 methods and techniques used, see Aznar Macias et al. (2015). Table II lists the individual results along with the range of dates for the observations and the number of nights that observations were made.

589 Croatia, Observed on nine nights from 2016 Nov to 2017 Jan. Period: 24.73 ± 0.013 h. Amplitude: 0.47 mag. This result is consistent with Behrend (2013), who found 24.821 h, but not with Waszczak et al. (2015) who found 16.385 h.

593 Titania. Observed during five nights 2017 Apr. Period: 9.930 ± 0.009 h. Amplitude: 0.21 mag. This period is consistent with Zappala (1983, 9.89 h), Harris (1989, 9.899 h), and Behrend (2017, 9.8968 h).

728 Leonisis. Observed on two nights in 2017 March-April. Period: 5.58 ± 0.01 h. Amplitude: 0.13 mag. Previous results include Waszczak et al. (2015, 5.71 h), Galad (2010, 5.5789 h), and Pilcher (2010, 5.5783 h).

784 Pickeringia. Observed during eight nights in 2017 Jan. Period: 13.144 ± 0.005 h. Amplitude: 0.17 mag. Hanus et al. (2011, 2016) and Durech et al. (2016) found sidereal rotation periods of about 13.1670 h as part of shape modeling. Behrend (2004) found a synodic period of 13.17 h. Our period is consistent with those earlier results.

888 Parysatis Observed on two nights in 2017 April. Period: 5.931 ± 0.003 h. Amplitude: 0.23 mag. This result is consistent with Fleenor (2007, 5.933 h), Benishek and Protitch-Benishek (2008, 5.9314 h), and Behrend (2003, 5.928 h).

897 Lisystrata. Observed on five nights in 2016 Nov. Period: 11.275 ± 0.009 h. Amplitude: 0.11 mag. This result is consistent with Kim et al. (2014, 11.26 h) and Behrend (2004, 11.26 h).

1155 Aenna. Observed during four nights in 2017 Feb. Period: 7.907 ± 0.011 h. Amplitude: 0.19 mag. This result is consistent with Behrend (2015) who found 8.07 h.

1591 Baize. Observed on four nights from 2017 Jan-Feb. Period: 7.794 ± 0.001 h. Amplitude: 0.23 mag. Garlitz (2013) found 7.78 h and Barucci et al. (1994) reported 10 h.

1674 Groeneveld. Observed on three nights in 2017 Jan. Period: 8.02 ± 0.01 h. Amplitude: 0.24 mag. Tedesco (1971) found a period of 8.1 h.

2504 Gaviola. Observed on seven nights from 2017 Mar-Apr. Period: 8.738 ± 0.004 h. Amplitude: 0.25 mag. Waszczak et al. (2015) found 8.751 h as did Hayes-Gehrke et al. (2017a).

2847 Parvati. Observed during 3 nights 2017 May. Period: 2.64 ± 0.003 h. Amplitude: 0.11 mag. We didn't find any previous results for Parvati.

3956 Caspar. Observed on two nights in 2017 March. Period: 2.783 ± 0.047 h. Amplitude: 0.21 mag. Previous results include

| Number | Name | 20xx/mm/dd | Pts | Phase | $L_{PAB}$ | $B_{PAB}$ | Period(h) | P.E. | Amp | A.E. | Grp |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 589 | Croatia | 17/04/11-05/01 | 470 | 8.8,14 | 176 | 1 | 24.734 | 0.013 | 0.47 | 0.03 | MB-O |
| 593 | Titania | 17/04/09-04/11 | 423 | 9.6,9.8 | 193 | 19 | 9.930 | 0.009 | 0.21 | 0.04 | MB-O |
| 728 | Leonisis | 17/03/29-04/02 | 180 | 15.1,16.9 | 164 | 6 | 5.58 | 0.01 | 0.13 | 0.05 | FLOR |
| 784 | Pickeringia | 17/01/08-01/15 | 2288 | 4.5,5 | 108 | 14 | 13.144 | 0.005 | 0.17 | 0.05 | MB-O |
| 888 | Parysatis | 17/04/07-04/08 | 275 | 6.4 | 199 | 16 | 5.931 | 0.003 | 0.23 | 0.03 | EUN |
| 897 | Lysistrata | 16/11/15-11/18 | 513 | 5.7,6.6 | 45 | 10 | 11.275 | 0.009 | 0.11 | 0.02 | EUN |
| 1155 | Aenna | 17/02/26-02/28 | 298 | 4.6,4.3 | 161 | 8 | 7.907 | 0.011 | 0.19 | 0.03 | MB-I |
| 1591 | Baize | 17/01/28-02/15 | 341 | 12.5,12.6 | 140 | 25 | 7.794 | 0.001 | 0.23 | 0.03 | PHO |
| 1674 | Groeneveld | 17/01/16-01/17 | 336 | 3,3.2 | 109 | 1 | 8.02 | 0.010 | 0.24 | 0.03 | MB-O |
| 2504 | Gaviola | 17/03/29-04/03 | 345 | 0.3,2.7 | 188 | 0 | 8.738 | 0.004 | 0.25 | 0.02 | FLOR |
| 2847 | Parvati | 17/05/07-05/08 | 200 | 0.9,1.0 | 226 | -1 | 2.64 | 0.003 | 0.11 | 0.03 | FLOR |
| 3956 | Caspar | 17/03/10 | 58 | 14.3 | 203 | -5 | 2.783 | 0.047 | 0.21 | 0.04 | FLOR |
| 3983 | Sakiko | 17/02/28-03/03 | 260 | 1.0,0.9 | 161 | -1 | 10.52 | 0.01 | 0.55 | 0.02 | EOS |
| 4202 | Minitti | 17/04/12-04/13 | 225 | 5.3,5.6 | 193 | 10 | 5.005 | 0.027 | 0.50 | 0.05 | EOS |
| 4404 | Enirac | 17/03/21-03/28 | 182 | 19.3,20.9 | 180 | 29 | 2.997 | 0.001 | 0.26 | 0.03 | MB-M |
| 5399 | Awa | 16/12/28-17/01/09 | 972 | 4.3,2.2 | 105 | -1 | 41.16 | 0.01 | 0.79 | 0.04 | MB-O |
| 5405 | Neverland | 17/04/03-04/04 | 122 | 1.3,1.8 | 191 | 1 | 3.149 | 0.025 | 0.14 | 0.03 | MB-M |
| 5605 | Kushida | 17/04/07-04/08 | 192 | 3.7,4.3 | 191 | 0 | 3.328 | 0.047 | 0.07 | 0.03 | FLOR |
| 9671 | Hemera | 17/04/04-04/07 | 208 | 4.2,2.6 | 198 | -3 | 2.531 | 0.001 | 0.15 | 0.03 | M-C |
| 10041 | Parkinson | 17/04/08-04/09 | 113 | 11.4,11 | 205 | 14 | 2.592 | 0.024 | 0.12 | 0.02 | PHO |
| 11213 | 1999 HF8 | 17/04/14-04/18 | 186 | 4.3,6.2 | 196 | 0 | 5.621 | 0.004 | 0.12 | 0.03 | MB-O |

Table II. Observing circumstances and results. Pts is the number of data points. The phase angle values are for the first and last date. $L_{PAB}$ and $B_{PAB}$ 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): MB-I/M/O = Main-belt Inner/Middle/Outer, FLOR = Flora, EUN = Eunomia, PHO = Phocaea

Chiorny et al. (2011, 2.77113 h) and Pravec et al. (2008, 2.77120 h).

3983 Sakiko. Observed on three nights in 2017 Feb-March. Period: 10.52 ± 0.01 h. Amplitude: 0.55 mag. This result is consistent with Waszczak et al. (2015, 10.510 h) and Pravec et al. (2017. 10.526 h).

4202 Minitti. Observed on three nights in 2017 April. Period: 5.005 ± 0.027 h. Amplitude: 0.5 mag. We found no other reported periods.

4404 Enirac. Observed on three nights in 2017 March. Period: 2.997 ± 0.001 h. Amplitude: 0.26 mag. This result is consistent with Klinglesmith et al. (2014, 2.998 h), Behrend (2017, 2.9983 h), and Hayes-Gehrke et al. (2017b, 2.9979 h).

5399 Awa. Observed on nine nights from 2016 Dec to 2017 Jan. Period: 41.16 ± 0.010 h. Amplitude: 0.79 mag. This result is consistent with Papini et al. (2017), who reported 41.215 h.

5405 Neverland. Observed on two nights in 2017 April. Period: 3.149 ± 0.025 h. Amplitude: 0.14 mag. Waszczak et al. (2015) measured 3.181 h and Behrend (2017) got 7.1414 h.

5605 Kushida. Observed on two nights in 2017 April. Period: 3.328 ± 0.047 h. Amplitude: 0.07 mag. Pravec et al. (2017) found a period of 5.7 h.

9671 Hemera. Observed on four nights in 2017 April. Period: 2.531 ± 0.001 h. Amplitude: 0.15 mag. This result is consistent with Skiff (2017, 2.53144 h), Salvaggio et al. (2017, 2.532 h), and Brincat (2017, 2.532 h).

10041 Parkinson. Observed on two nights in 2017 April. Period: 2.592 ± 0.024 h. Amplitude: 0.12 mag. This result is consistent with Behrend (2017, 2.5647 h), Pravec et al. (2017, 2.56428 h), and Ruthroff (2017, 5.69 h).

(11213) 1999 HF8. Observed on four nights in 2017 April. Period: 5.621 ± 0.004 h. Amplitude: 0.12 mag. We did not find a previously reported period.

Acknowledgements

We would like to express our gratitude to Brian Warner for supporting the CALL web site and his suggestions made to OBAS group.

References

Aznar Macias, A., Carreno Garcerain, A., Arce Mansego, E., Brines Rodriguez, P., Lozano de Haro, J., Fornas Silva, A., Fornas Silva, G., Mas Martinez, V., Rodrigo Chiner, O. (2015). Twenty-three Asteroids Lightcurves at Observadores de Asteroides (OBAS): 2015 October – December." *Minor Planet Bull.* **43**, 174-181.

Barucci, M.A., Di Martino, M., Dotto, E., Fulchignoni, M., Rotundi, A., Burchi, R. (1994). "Rotational properties of small asteroids: Photoelectric observations of 16 asteroids." *Icarus* **109**, 267-273.

Behrend, R. (2004, 2005, 2006, 2007, 2011, 2015). Observatoire de Geneve web site. *http://obswww.unige.ch/~behrend/page_cou.html*

Benishek, V., Protitch-Benishek, V. (2008). "CCD Photometry of Seven Asteroids at the Belgrade Astronomical Observatory." *Minor Planet Bull*. **35**, 28-30.

Benishek, V. (2013). "Lightcurves for 366 Vincentina, 592 Bathseba, and 1544 Yugoslavia from Belgrade Astronomical Observatory." *Minor Planet Bull.* **40**, 100-101.

Chang, C.-K., Ip, W.-H., Lin, H.-W., Cheng, Y.-C., Ngeow, C.-C., Yang, T.-C., Waszczak, A., Kulkarni, S.R., Levitan, D., Sesar, B., Laher, R., Surace, J., Prince, T.A. (2015). "Asteroid Spin-rate Study Using the Intermediate Palomar Transient Factory." *Ap. J. Suppl. Ser.* **219**, A27.

Chiorny, V., Galad, A., Pravec, P. Kusnirak, P., Hornoch, K., Gajdos, S., Kornos, L., Vilagi, J., Husarik, M., Kanuchova, Z., and 9 coauthors (2011). "Absolute photometry of small main-belt asteroids in 2007-2009." *Planet. Space Sci.* **59**, 1482-1489.

Ďurech, J., Hanuš, J., Oszkiewicz, D., Vančo, R. (2016). "Asteroid models from the Lowell photometric database." *Astron. Astrophys.* **587**, A48.

Fleenor, M.L. (2007). "Asteroid Lightcurve Analysis from Volunteer Observatory December 2006 to April 2007." *Minor Planet Bull*. **34**, 66-67.

Galad, A. (2010). "Accuracy of calibrated data from the SDSS moving object catalog, absolute magnitudes, and probable lightcurves for several asteroids." *Astron. Astrophys.* **514**, A55.

Hanus, J., Durech, J., Broz, M., Warner, B.D., Pilcher, F., Stephens, R., Oey, J., Bernasconi, L., Casulli, S., Behrend, R., and 9 coauthors. (2011). "A study of asteroid pole-latitude distribution based on an extended set of shape models derived by the lightcurve inversion method." *Astron. Astrophys.* **530**, A134.

Hanus, J., Durech, J., Oszkiewicz, D.A., Behrend, R., Carry, B., Delbo, M., Adam, O., Afonina, V., Anquetin, R., Antonini, P., and 159 coauthors. (2016). "New and updated convex shape models of asteroids based on optical data from a large collaboration network." *Astron. Astrophys.* **586**, A108.

Harris, A.W., Young, J.W. (1989). "Asteroid lightcurve observations from 1979-1981." *Icarus* **81**, 314-364.

Hayes-Gehrke, M., Linko, D., Bhasin, R., Johnson, J., Bermudez, B., Fedorenko, I., Tillis, K., Vilar, N. (2017a). "Lightcurve and Rotation Period for Minor Planet 2504 Gaviola." *Minor Planet Bull*. **44**, 308.

Hayes-Gehrke, M., Caffes, R., Gibson, A., Honer, A., Hunter, R., Paul, T., Quimby, C., Riffe, T., Roberts, M., Schemmel, J., Unaegbu, U., Wilton, Z. (2017b). "Lightcurve for Asteroid 4404 Enirac." *Minor Planet Bull*. **44**, 309.

Kim, M.-J., Choi, Y.-J., Moon, H.-K., Byun, Y.-I., Brosch, N., Kaplan, M., Kaynar, S., Uysal, O., Guzel, E., Behrend, R., and 6 coauthors. (2014). "Rotational Properties of the Maria Asteroid Family." *Astron. J.* **147**, A56.

Papini, R., Marchini, A., Salvaggio, F. (2017). "Rotation Period Determination of Asteroids 5059 Saroma and 5399 Awa." *Minor Planet Bull*. **44**, 153-155.

Pilcher, F. (2010). "Period Determinations for 11 Parthenope, 35 Leukothea, 38 Leda, 111 Ate, 194 Prokne, 262 Valda, 728 Leonisis, and 747 Winchester." *Minor Planet Bull*. **37**, 119-122.

Pravec, P., Wolf, M., Sarounova, L. (2008, 2017). *http://www.asu.cas.cz/~ppravec/neo.htm*

Pray Donald P. (2004). "Lightcurve analysis of asteroids 1225, 1301, 2134, 2741, and 3974." *Minor Planet Bull*. **31**, 6-8.

Polakis, T., Skiff, Brian A. (2016). "Lightcurve Analysis for Asteroids 895 Helio and 1108 Demeter." *Minor Planet Bull*. **43**, 310.

Ruthroff, J.C. (2013). "Lightcurve Analysis of Main Belt Asteroids 1115 Sabauda 1554 Yugoslavia, 1616 Filipoff, 2890 Vilyujsk, (5153) 1940 GO, and (31179) 1997 YR2." *Minor Planet Bull*. **40**, 90-91.

Skiff, B.A. (2017) Posting on CALL web site. *http://www.minorplanet.info/call.html*

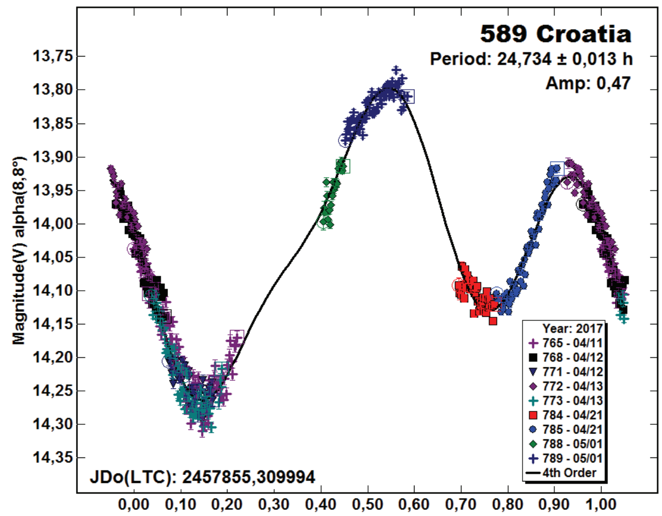
Stephens, R.D. (2003). "Photometry of 430 Hybris, 798 Ruth, 1264 Letaba, and 3786 Yamada." *Minor Planet Bull*. **30**, 1-2.

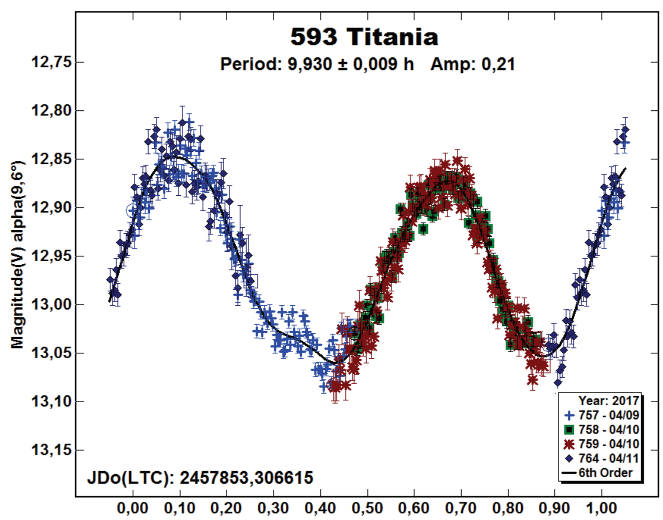
Tedesco, E.F. (1979). PhD Dissertation, New. Mex. State Univ. 280pp.

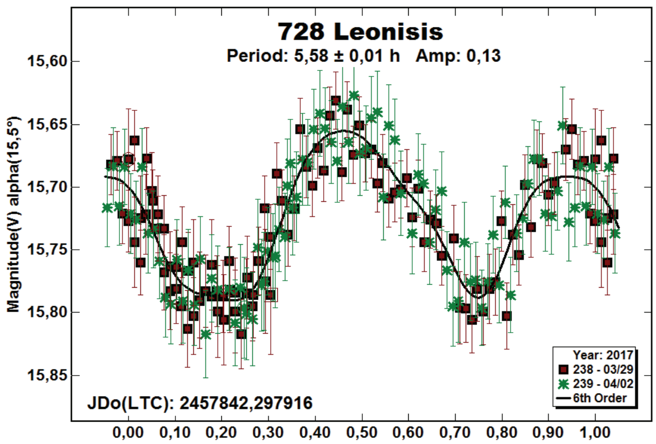
Warner, B. (2000). "Asteroid Photometry at the Palmer Divide Observatory." *Minor Planet Bull*. **27**, 4-6.

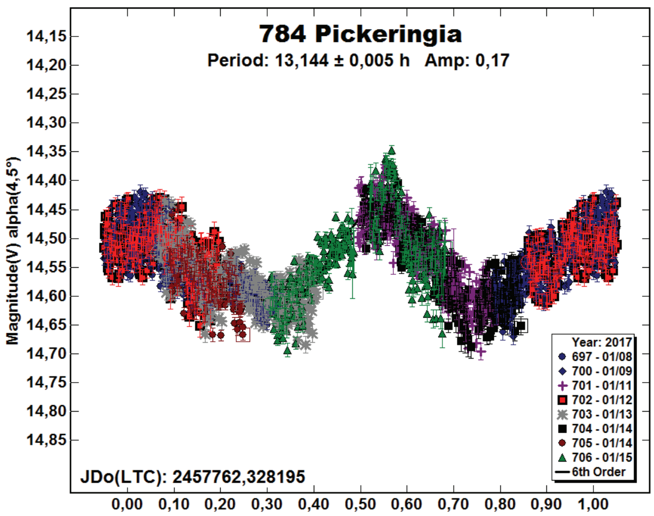
Waszczak, A., Chang, C.-K., Ofek, E.O., Laher, R., Masci, F., Levitan, D., Surace, J., Cheng, Y.-C., Ip, W.-H., Kinoshita, D., Helou, G., Prince, T.A., Kulkarni, S. (2015). "Asteroid Light Curves from the Palomar Transient Factory Survey: Rotation Periods and Phase Functions from Sparse Photometry." *Astron. J.* **150**, A75.

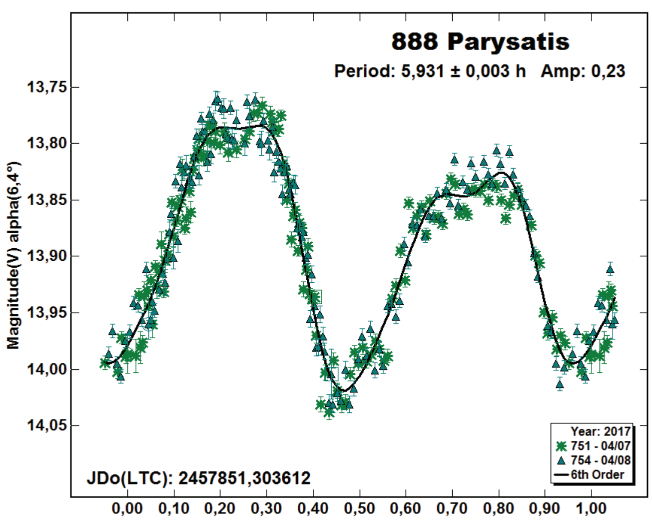
Zappala, V., Scaltriti, F., Di Martino, M. (1983). "Photoelectric photometry of 21 asteroids." *Icarus* **56**, 325-344.

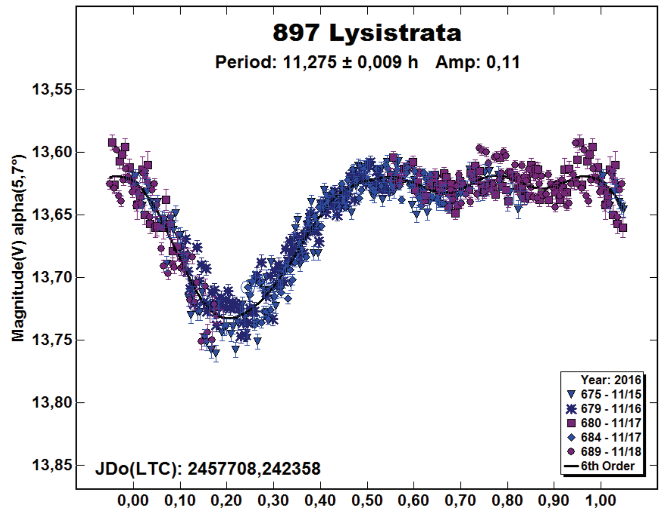


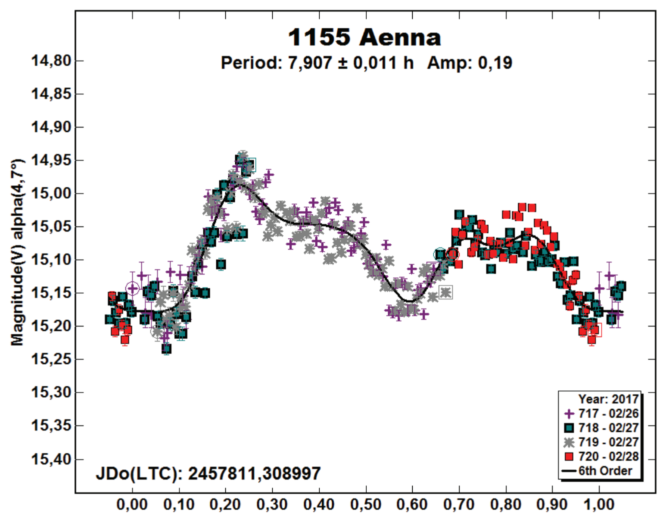



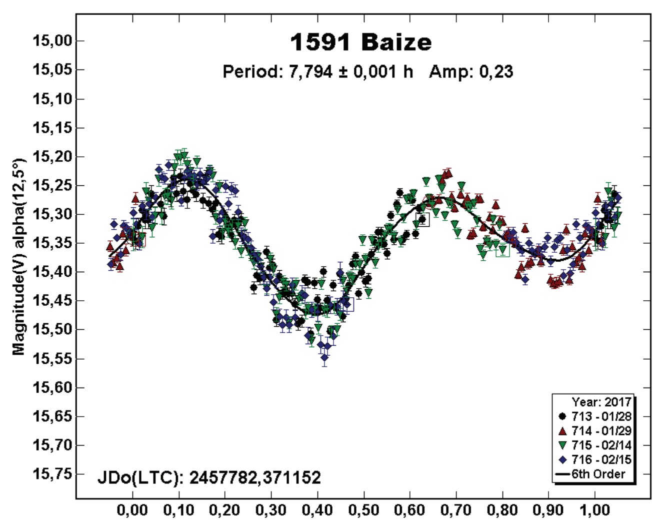

728 Leonisis
Period: 5,58 ± 0,01 h Amp: 0,13
Magnitude(V) alpha(15,5°)
JDo(LTC): 2457842,297916
Year: 2017
238 - 03/29
239 - 04/02
6th Order

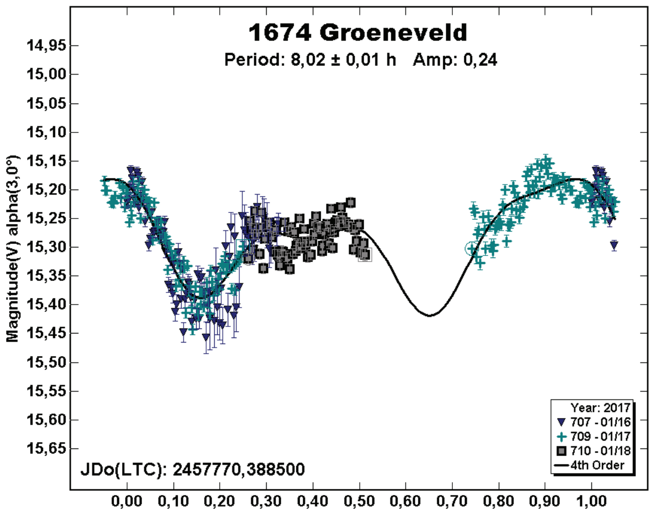

784 Pickeringia
Period: 13,144 ± 0,005 h Amp: 0,17
Magnitude(V) alpha(4,5°)
JDo(LTC): 2457762,328195
Year: 2017
697 - 01/08
700 - 01/09
701 - 01/11
702 - 01/12
703 - 01/13
704 - 01/14
705 - 01/14
706 - 01/15
6th Order

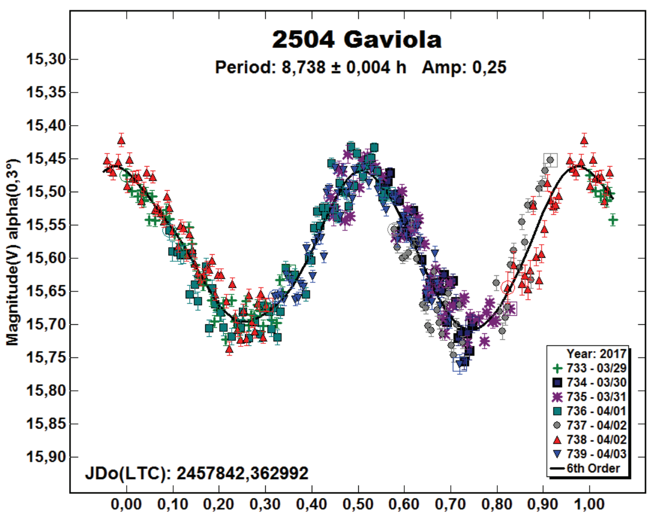

888 Parysatis
Period: 5,931 ± 0,003 h Amp: 0,23
Magnitude(V) alpha(6,4°)
JDo(LTC): 2457851,303612
Year: 2017
751 - 04/07
754 - 04/08
6th Order

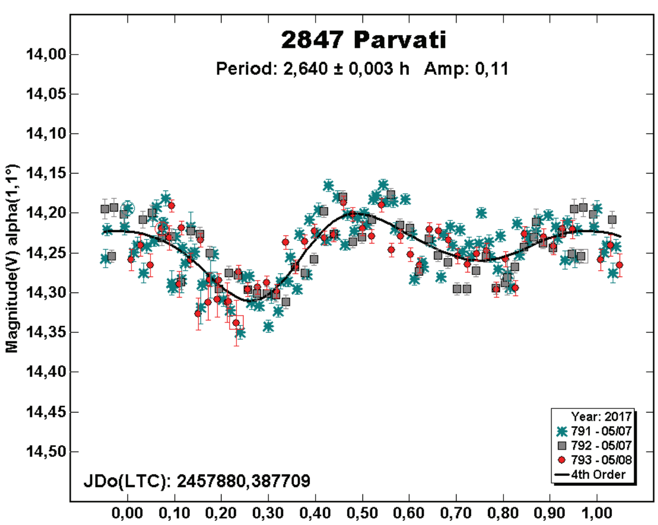

897 Lysistrata
Period: 11,275 ± 0,009 h Amp: 0,11
Magnitude(V) alpha(5,7°)
JDo(LTC): 2457708,242358
Year: 2016
675 - 11/15
679 - 11/16
680 - 11/17
684 - 11/17
689 - 11/18
6th Order

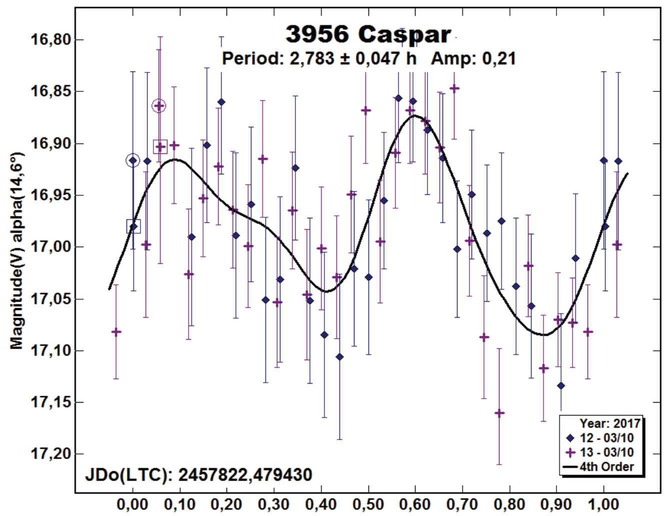

1155 Aenna
Period: 7,907 ± 0,011 h Amp: 0,19
Magnitude(V) alpha(4,7°)
JDo(LTC): 2457811,308997
Year: 2017
717 - 02/26
718 - 02/27
719 - 02/27
720 - 02/28
6th Order

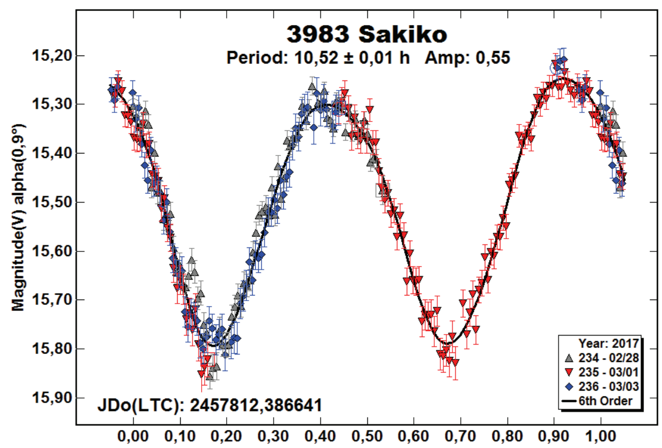

1591 Baize
Period: 7,794 ± 0,001 h Amp: 0,23
Magnitude(V) alpha(12,5°)
JDo(LTC): 2457782,371152
Year: 2017
713 - 01/28
714 - 01/29
715 - 02/14
716 - 02/15
6th Order

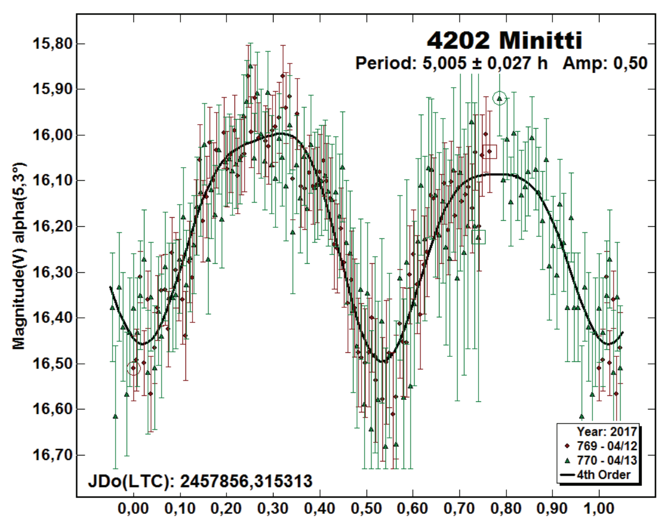

1674 Groeneveld
Period: 8,02 ± 0,01 h Amp: 0,24
Magnitude(V) alpha(3,0°)
Year: 2017
707 - 01/16
709 - 01/17
710 - 01/18
4th Order
JDo(LTC): 2457770,388500

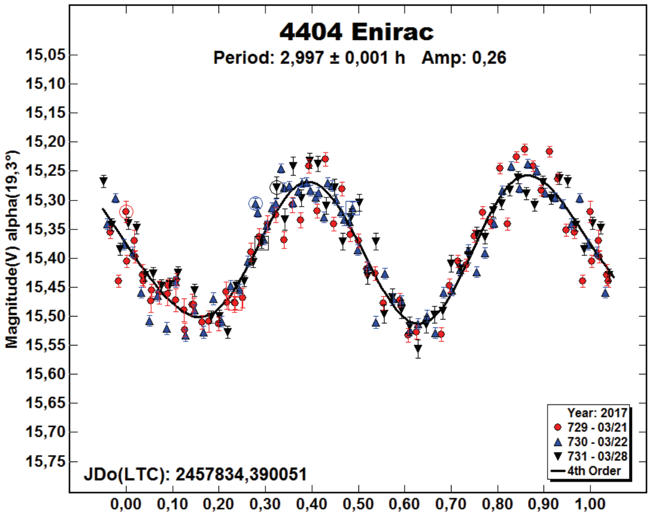

2504 Gaviola
Period: 8,738 ± 0,004 h Amp: 0,25
Magnitude(V) alpha(0,3°)
Year: 2017
733 - 03/29
734 - 03/30
735 - 03/31
736 - 04/01
737 - 04/02
738 - 04/02
739 - 04/03
6th Order
JDo(LTC): 2457842,362992

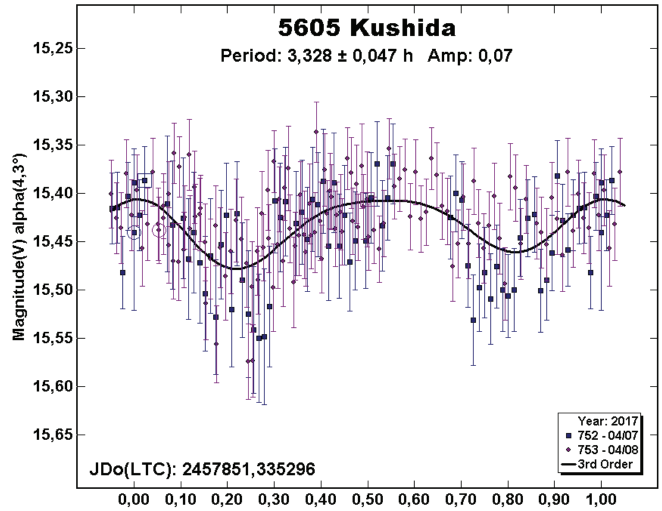

2847 Parvati
Period: 2,640 ± 0,003 h Amp: 0,11
Magnitude(V) alpha(1,1°)
Year: 2017
791 - 05/07
792 - 05/07
793 - 05/08
4th Order
JDo(LTC): 2457880,387709

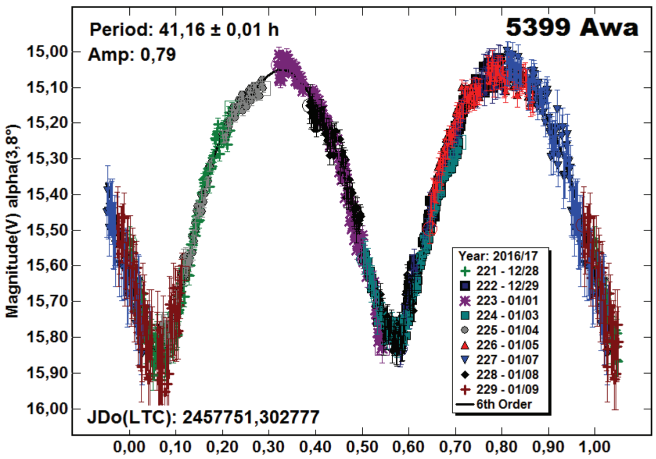

3956 Caspar
Period: 2,783 ± 0,047 h Amp: 0,21
Magnitude(V) alpha(14,6°)
Year: 2017
12 - 03/10
13 - 03/10
4th Order
JDo(LTC): 2457822,479430

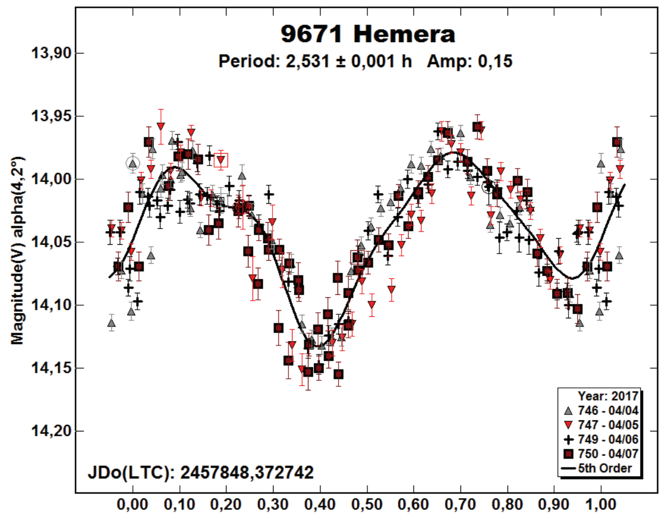

3983 Sakiko
Period: 10,52 ± 0,01 h Amp: 0,55
Magnitude(V) alpha(0,9°)
Year: 2017
234 - 02/28
235 - 03/01
236 - 03/03
6th Order
JDo(LTC): 2457812,386641

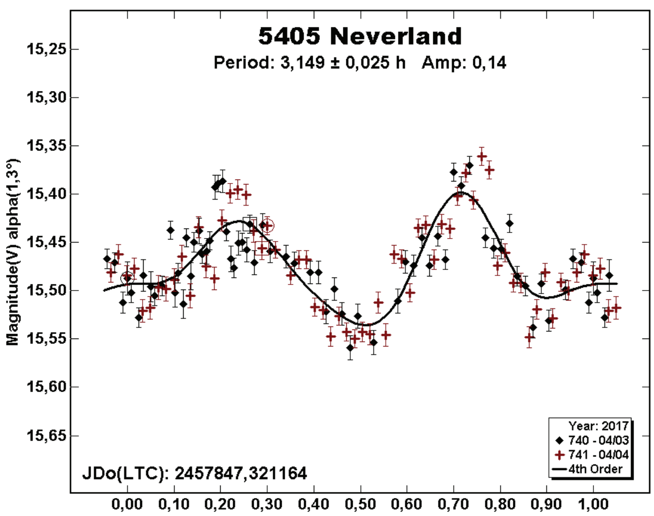

4202 Minitti
Period: 5,005 ± 0,027 h Amp: 0,50
Magnitude(V) alpha(5,3°)
Year: 2017
769 - 04/12
770 - 04/13
4th Order
JDo(LTC): 2457856,315313

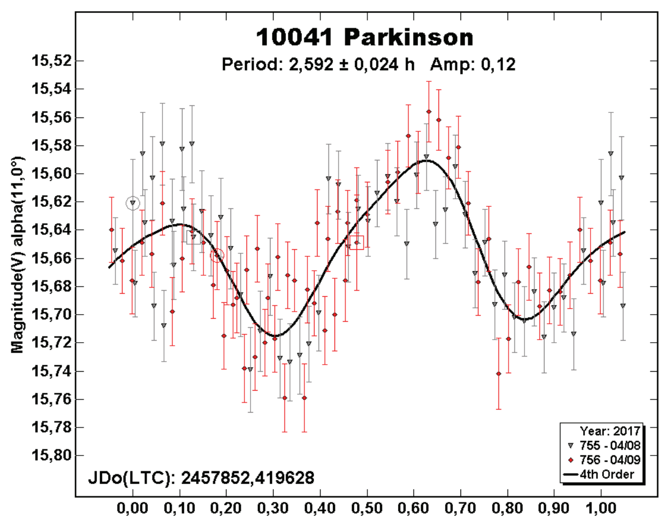

4404 Enirac
Period: 2,997 ± 0,001 h Amp: 0,26
Magnitude(V) alpha(19,3°)
Year: 2017
729 - 03/21
730 - 03/22
731 - 03/28
4th Order
JDo(LTC): 2457834,390051

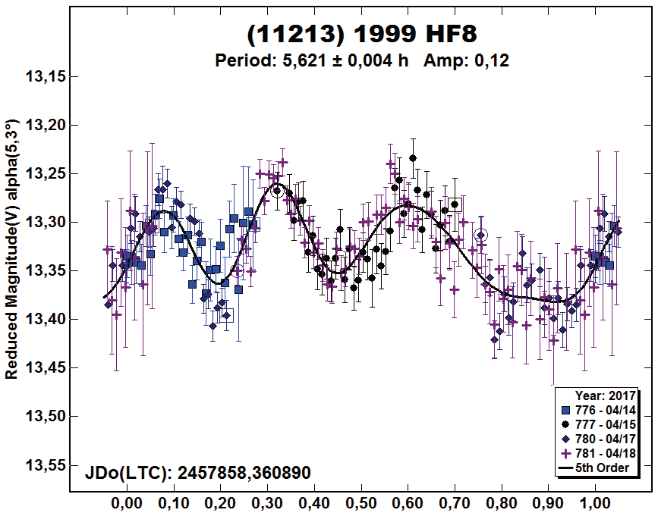

5605 Kushida
Period: 3,328 ± 0,047 h Amp: 0,07
Magnitude(V) alpha(4,3°)
Year: 2017
752 - 04/07
753 - 04/08
3rd Order
JDo(LTC): 2457851,335296


Period: 41,16 ± 0,01 h
Amp: 0,79
5399 Awa
Magnitude(V) alpha(3,8°)
Year: 2016/17
221 - 12/28
222 - 12/29
223 - 01/01
224 - 01/03
225 - 01/04
226 - 01/05
227 - 01/07
228 - 01/08
229 - 01/09
6th Order
JDo(LTC): 2457751,302777


9671 Hemera
Period: 2,531 ± 0,001 h Amp: 0,15
Magnitude(V) alpha(4,2°)
Year: 2017
746 - 04/04
747 - 04/05
749 - 04/06
750 - 04/07
5th Order
JDo(LTC): 2457848,372742


5405 Neverland
Period: 3,149 ± 0,025 h Amp: 0,14
Magnitude(V) alpha(1,3°)
Year: 2017
740 - 04/03
741 - 04/04
4th Order
JDo(LTC): 2457847,321164


10041 Parkinson
Period: 2,592 ± 0,024 h Amp: 0,12
Magnitude(V) alpha(11,0°)
Year: 2017
755 - 04/08
756 - 04/09
4th Order
JDo(LTC): 2457852,419628




## LIGHTCURVE AND ROTATION PERIOD DETERMINATIONS FOR 29 ASTEROIDS

Vladimir Benishek
Belgrade Astronomical Observatory
Volgina 7, 11060 Belgrade 38, SERBIA
vlaben@yahoo.com

(Received: 2017 Oct 15)

CCD photometric observations of 29 asteroids were conducted from 2017 January through October. A review of the data analysis results is presented.

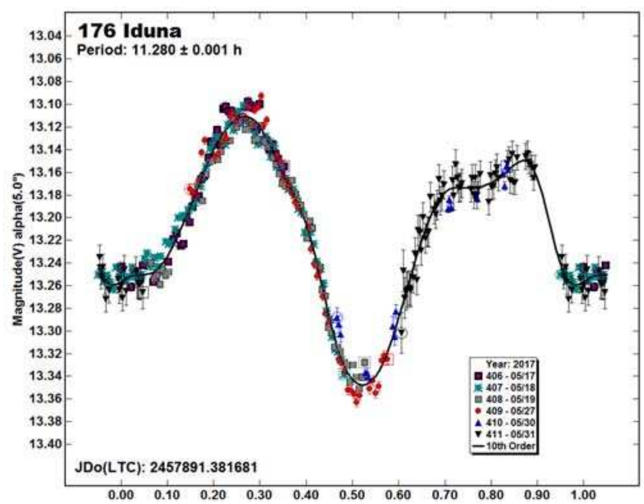
Photometric observations of 29 asteroids were conducted at Sopot Astronomical Observatory (SAO) between 2017 February-October in order to determine the asteroids' synodic rotation periods. For this purpose, two 0.35-m *f*/6.3 Meade LX200GPS Schmidt-Cassegrain telescopes were employed. The second telescope at the SAO was commissioned in autumn 2016 and regular photometric observations with it were launched in the early spring of 2017. The telescopes were equipped with a SBIG ST-8 XME CCD camera and an old SBIG ST-8 parallel port anti-blooming gate (ABG) chip CCD camera in temporary use. To avoid the non-linear response of the ABG camera, the target and comparison stars were kept below 50% saturation. This compromise reflected in reduced signal-to-noise ratio for those asteroids observed using the ABG camera. The exposures were unfiltered and unguided for all targets. Both cameras were operated in 2x2 binning mode, which an image scale of 1.66 arcsec/pixel. Prior to measurements, all images were corrected using dark and flat field frames.

Photometric reduction, lightcurve construction, and period analysis were conducted using *MPO Canopus* (Warner, 2016). Differential photometry with up to five comparison stars of near solar color ($0.5 \leq$ B-V $\leq 0.9$) was performed using the Comparison Star Selector (CSS) utility. This helped ensure a satisfactory quality level of night-to-night zero point calibrations and correlation of the measurements within the standard magnitude framework. Depending on a case-by-case basis, primarily on the coverage quality of a certain sky zone by a particular catalog, field comparison stars were calibrated using standard magnitudes from one of three catalogs: 1) Johnson V magnitudes from the AAVSO Photometric All-Sky Survey catalog (APASS; Henden *et al.*, 2009) Data Release 9, 2) Johnson V magnitudes from MPOSC3 hybrid catalog, where BVRI magnitudes were derived from J and K 2MASS catalog magnitudes by applying formulae developed by Warner (2007), or 3) Cousins R magnitudes derived from the Carlsberg Meridian Catalog 15 (VizieR, 2017) Sloan r' magnitudes using the formula R = r'–0.22 . All data sets for a given target were calibrated using the same catalog. In some cases, small zero-point adjustments were necessary in order to achieve the best match between individual data sets in terms of minimum RMS residual of a Fourier fit. Table I gives the observing circumstances and results.

Some of the targets presented in this paper were observed within the Photometric Survey for Asynchronous Binary Asteroids (BinAstPhot Survey) under the leadership of Petr Pravec from Ondrejov Observatory, Czech Republic.

### Observations and results

176 Iduna. A number of synodic rotation period results were published previously on this outer main-belt asteroid, the vast majority of which are consistent with one another: Hansen and Arentoft (1997, 11.289 h); Riccioli et al. (2001, 5.630 h,); Behrend (2006, 11.29 h; 2007, 11.2875 h); Krajewski (2008, 11.2877 h); Warner (2008a, 11.309 h); Aton (2008, 11.2880 h); Shevchenko et al. (2016, 11.287 h); and by Oey et al. (2017, 11.2928 h). The observations carried out at SAO in 2017 May resulted in six data sets with 333 data points and yielded an unambiguous bimodal lightcurve phased to a period of $P$ = 11.280 ± 0.001 h and amplitude of 0.24 mag. This result is in a good agreement with the most of the previously found results.




594 Mireille. A search of the asteroid lightcurve database (LCDB; Warner et al., 2009) found two previous results: Wisniewski (1991, 4.966 h) and by Polakis and Skiff (2017, 4.9671 h). Observations conducted over two nights at SAO in 2017 April lead to a bimodal period result of 4.9688 ± 0.0008 h, which agrees with the earlier works.