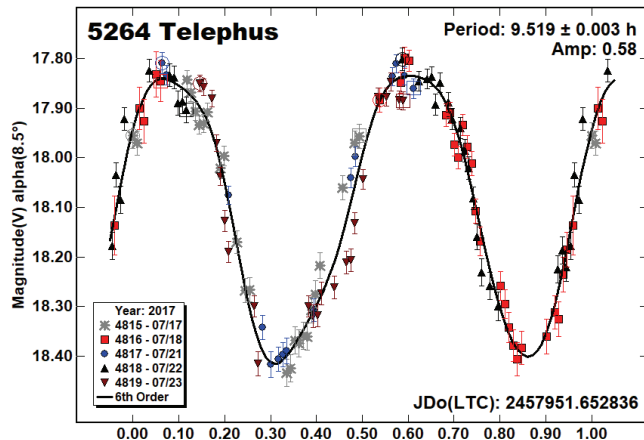


Number	Name	2017 mm/dd	Pts	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.
1583	Antiloehus	07/27-08/10	353	7.6, 9.0	274	26	15.889	0.005	0.12	0.02
1868	Thersites	06/30-07/17	185	6.4, 8.5	248	15	10.412	0.003	0.16	0.02
3793	Leonteus	07/13-07/16	161	5.0, 5.3	276	22	5.682	0.004	0.17	0.02
5264	Telephus	07/17-07/23	121	4.5, 5.3	277	16	9.519	0.003	0.58	0.02

Table II. Observing circumstances and results. Pts is the number of data points. Phase is the solar phase angle for the first and last date. If there are three values, the middle value is the minimum phase angle. L_{PAB} and B_{PAB} are, respectively, the approximate phase angle bisector longitude and latitude at mid-date range (see Harris et al., 1984).



Acknowledgements

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References

- AstDys (2017). Asteroids – Dynamic web site. <http://hamilton.dm.unipi.it/astdys2/>
- ALCDEF (2017). Asteroid Lightcurve Data Exchange Format web site. <http://www.alcdef.org/>
- Harris, A.W., Young, J.W., Scaltriti, F., Zappala, V. (1984). "Lightcurves and phase relations of the asteroids 82 Alkmene and 444 Gyptis." *Icarus* **57**, 251-258.
- 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., Zeigler, K.W. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.
- Harris, A.W., Pravec, P., Galád, B., Skiff, B., Warner, B., Világi, J., Gajdoš, S., Carbognani, A., Hornoch, K., Kušnirák, P., Cooney, W., Gross, J., Terrell, D., Higgins, D., Bowell, E., Koehn, B. (2014). "On the maximum amplitude of harmonics of an asteroid lightcurve." *Icarus* **235**, 55-59.
- Henden, A.A., Terrell, D., Levine, S.E., Templeton, M., Smith, T.C., Welch, D.I. (2009). <http://www.aavso.org/apass>

Kassalain, M., Torppa J. (2001a). "Optimization Methods for Asteroid Lightcurve Inversion. I. Shape Determination." *Icarus* **153**, 24-36.

Kassalain, M., Torppa J., Muinonen, K. (2001b). "Optimization Methods for Asteroid Lightcurve Inversion. II. The Complete Inverse Problem." *Icarus* **153**, 37-51.

Mottola, S., Di Martino, M., Erikson, A., Gonano-Beurer, M., Carbognani, A., Carsenty, U., Hahn, G., Schober, H., Lahulla, F., Delbò, M., Lagerkvist, C. (2011). "Rotational Properties of Jupiter Trojans. I. Light Curves of 80 Objects." *Astron. J.* **141**, A170.

Stephens, R.D., Coley, D.R., French, L.M. (2016a). "Large L5 Jovian Trojan Asteroid Lightcurves from the Center for Solar System Studies." *Minor Planet Bul.* **43**, 15-22.

Stephens, R.D., Coley, D.R., Warner, B.D., French, L.M., (2016b). "Lightcurves of Jovian Trojan Asteroids from the Center for Solar System Studies: L4 Greek Camp and Spies." *Minor Planet Bul.* **43**, 323-331.

Warner, B.D., Harris, A.W., Pravec, P. (2009). "The Asteroid Lightcurve Database." *Icarus* **202**, 134-146. Updated 2017 Sept. <http://www.minorplanet.info/lightcurvedatabase.html>

ASTERIODS OBSERVED FROM CS3: 2017 JULY - SEPTEMBER

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(Received: 2017 Oct 12)

CCD photometric observations of 11 Main Belt asteroids were obtained from the Center for Solar System Studies from 2017 July to September.

The Center for Solar System Studies "Trojan Station" (CS3, MPC U81) has two telescopes which are normally used in program asteroid family studies. During the 3rd quarter of 2017 the Jovian Trojans and Hildas which are normally studied were mostly out of season, so targets of opportunity amongst the Main Belt families were selected.

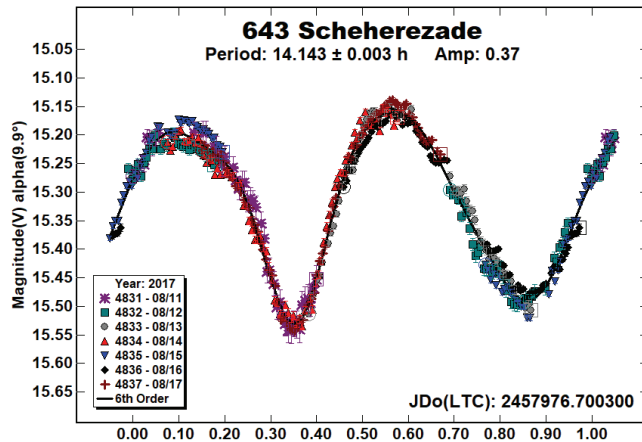
All images were made with a 0.4-m or a 0.35-m SCT using an FLI ML-Proline 1001E or FLI ML-Microline 1001E CCD camera. Images were unbinned with no filter and had master flats and darks applied. Image processing, measurement, and period analysis were done using MPO Canopus (Bdw Publishing), which incorporates the Fourier analysis algorithm (FALC) developed by Harris (Harris et al., 1989). Night-to-night calibration (generally <

± 0.05 mag) was done using field stars from the CMC-15 catalog or APASS (Henden *et al.*, 2009). The Comp Star Selector feature in *MPO Canopus* was used to limit the comparison stars to near solar color.

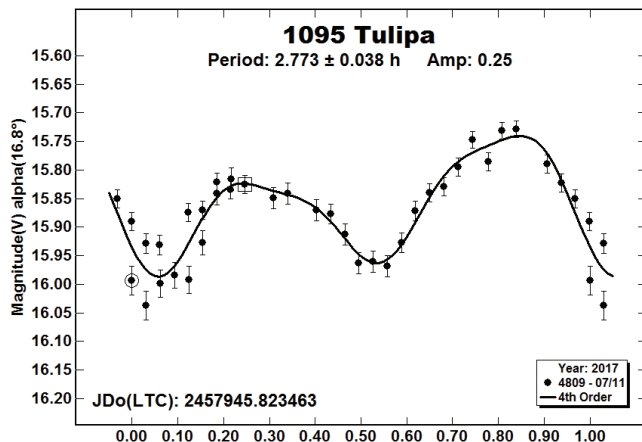
In the lightcurve plots, the “Reduced Magnitude” is Johnson V corrected to a unity distance by applying $-5 \cdot \log(r\Delta)$ to the measured sky magnitudes with r and Δ being, respectively, the Sun-asteroid and the Earth-asteroid distances in AU. The magnitudes were normalized to the phase angle given in parentheses using $G = 0.15$. The X-axis rotational phase ranges from -0.05 to 1.05.

The amplitude indicated in the plots is the amplitude of the Fourier model curve and not necessarily the adopted amplitude of the lightcurve. For brevity, only some of the previously reported rotational periods may be referenced. A complete list is available at the lightcurve database (LCDB; Warner *et al.*, 2009).

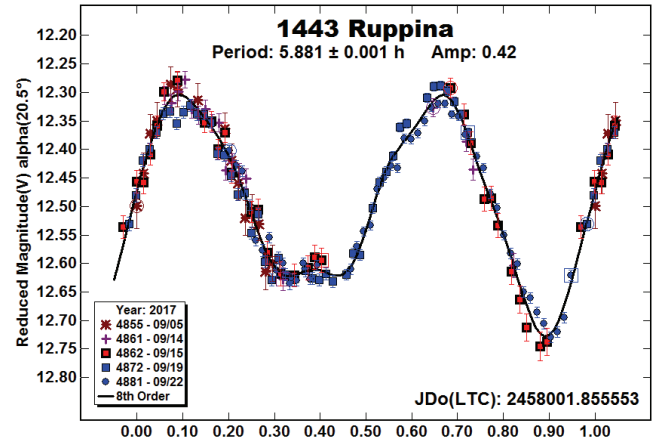
643 Scheherezade. Behrend (2005 and 2007) and Warner (2016) both reported a rotational period near 14.2 h. The result from this opposition is in good agreement with those results.



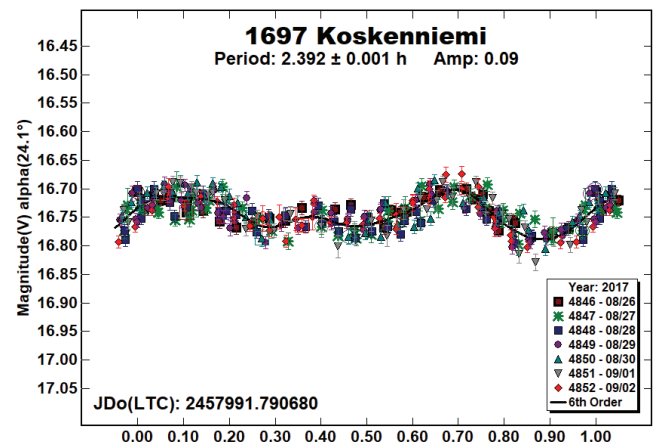
1095 Tulipa. This member of the EOS family been well studied Behrend (2005 and 2006), Benishek (2015) and Klinglesmith (2017) all found periods near 2.78 h. The result found this year is in good agreement with those findings. After these observations were obtained, Durech *et al.* (2017) published a sidereal rotational period of 2.78715 h.



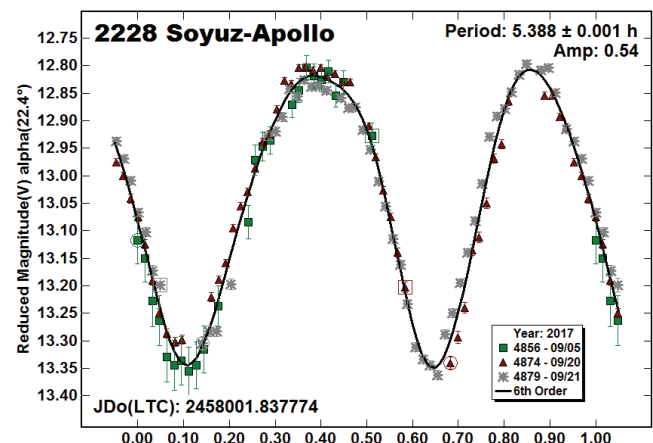
1443 Ruppina. This Koronis family member has been previously observed by Neugent and Slivan (2008) and Arredondo *et al.* (2014) each finding a rotational period near 5.89 h. This year's result is in good agreement with those findings.



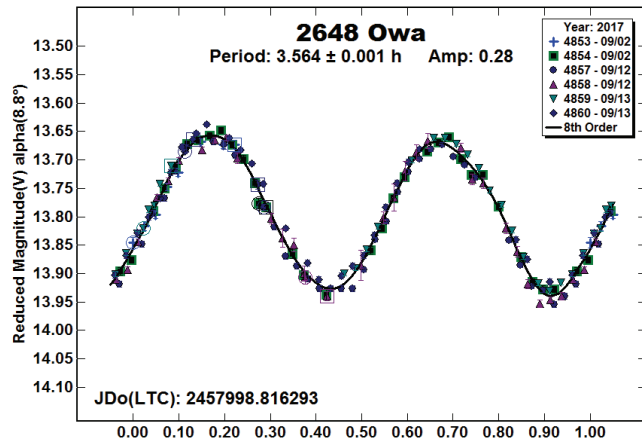
1697 Koskenniemi. No previous rotational periods could be found for this Vestoid in the Lightcurve Database (Warner *et al.* 2009). Don Prey independently observed it a few days later. Parvec (2017) combined the two datasets for the Photometric Survey for Asynchronous Binary Asteroids, and reported a rotational period of 2.392 h.



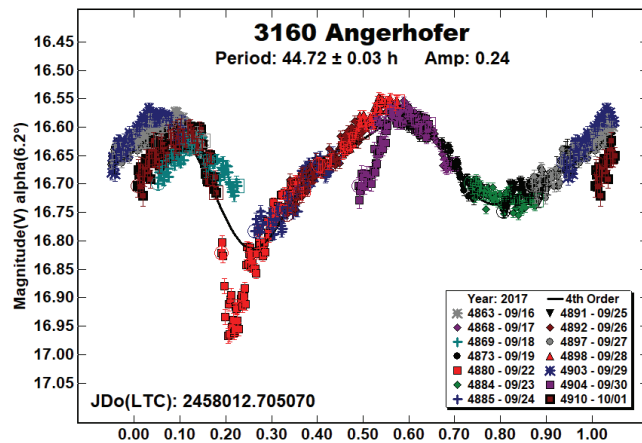
2228 Soyuz-Apollo. Behrend (2007 and 2008) reported periods near 5.4 h. The result found this year is in good agreement with those findings.



2648 Owa. Parvec (2017) reported a rotational period of 3.5641 h from the Photometric Survey for Asynchronous Binary Asteroids. Behrend (2007) reported a period of 3.567 h. Johnson *et al.* (2008) reported a period of 3.563 h. This result agrees with those determinations.

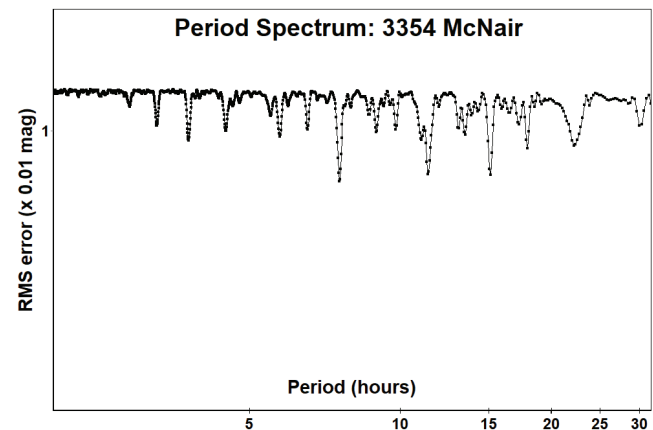
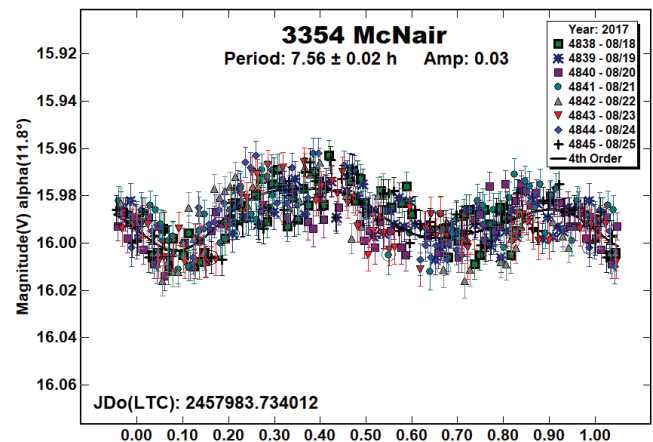
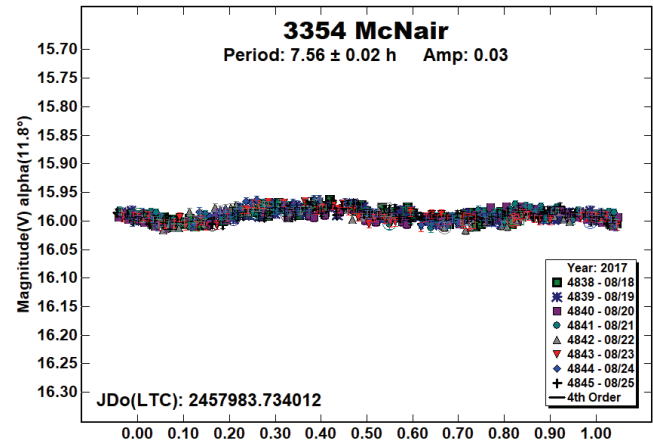


3160 Angerhofer. No previous rotational periods could be found for this Vestoid in the Lightcurve Database (Warner *et al.* 2009). The shape and slope of the lightcurve suggests a long rotational period near twice the Earth's rotational period, creating difficulty in obtaining full coverage. In addition, on four nights the sessions significantly deviated from the Fourier line suggesting the asteroid was tumbling. However, according the 'rule of thumb' for tumblers, a period of 45 h is a little short for an asteroid of this size to be tumbling. However, that rule is just a guideline. Given the primary frequency is that of a slow rotator, it is unlikely a single station can obtain enough data in an observing window to determine any secondary frequencies. This project was concluded a hopefully a future campaign can be organized to determine the nature of this Vestoid.



3354 McNair. No entry for this Vestoid could be found in the Lightcurve Database (Warner *et al.* 2009). Usually lightcurve plots are displayed using a Y-axis scale set to a standard 0.6 mag. so as to not over empathize the amplitude and give greater confidence than deserved to the quality of the lightcurve. In the case of McNair, the amplitude of the lightcurve in 2017 was only 0.03 mag., almost flat. However, since the formal error bars of the data are less than 0.01 mag., a second lightcurve plot is presented with the Y-axis scale set to 0.14 mag. to give a better idea as to the shape of the resulting bimodal lightcurve.

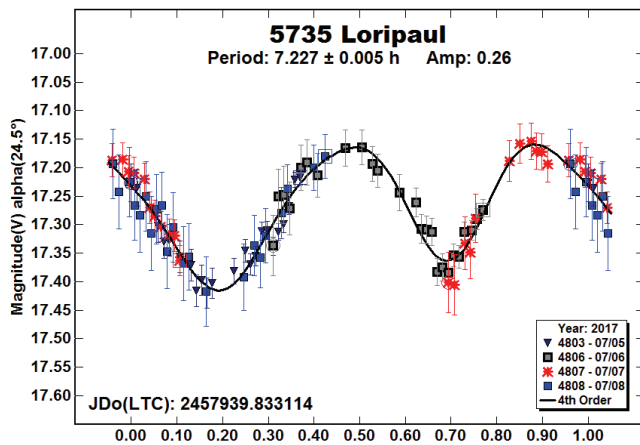
The Period Spectrum shows several aliases, the strongest being a 1.5 and 2 times the period shown here which cannot be ruled out. With such low magnitudes, it is possible that a lightcurve could have only a single extremum, or three or more extrema (Harris *et al.* 2014).



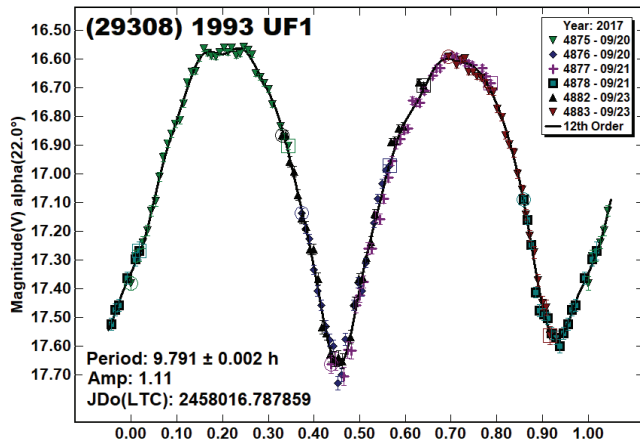
Number	Name	mm/dd	Pts	Phase	LPAB	BPAB	Period	P.E.	Amp	A.E.	Grp
643	Scheherezade	08/11-08/17	471	9.9, 8.6	346	16	14.143	0.003	0.370	0.02	MB-O
1095	Tulipa	07/11-07/12	62	16.8, 16.6	342	5	2.776	0.003	0.21	0.02	EOS
1443	Ruppina	09/05-09/22	157	20.5, 19.1	58	-2	5.881	0.001	0.42	0.01	MB-O
1697	Koskenniemi	08/26-09/02	294	24.1, 22.6	23	5	2.392	0.001	0.09	0.02	V
2228	Soyuz-Apollo	09/20-09/21	123	20.9, 20.8	54	-2	5.388	0.001	0.54	0.02	THM
2648	Owa	09/12-09/13	161	4.9, 4.7	352	7	3.564	0.001	0.28	0.01	FLOR
3160	Angerhofer	09/16-10/01	970	6.2, 3.2, 4.2	3	6	44.72	0.003	0.32	0.05	V
3354	McNair	08/18-08/25	450	11.8, 8.3	345	3	7.56	0/02	0.03	0.01	V
5735	Loripaul	07/05-07/08	92	24.5, 23.6	325	4	7.227	0.005	0.26	0.02	V
29308	1993 UF1	09/20-09/23	167	22.0, 20.4	25	-12	9.791	0.002	1.11	0.02	H
33325	1998 RH3	09/16-09/18	211	17.3, 16.5	13	13	3.355	0.001	0.57	0.01	H

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).

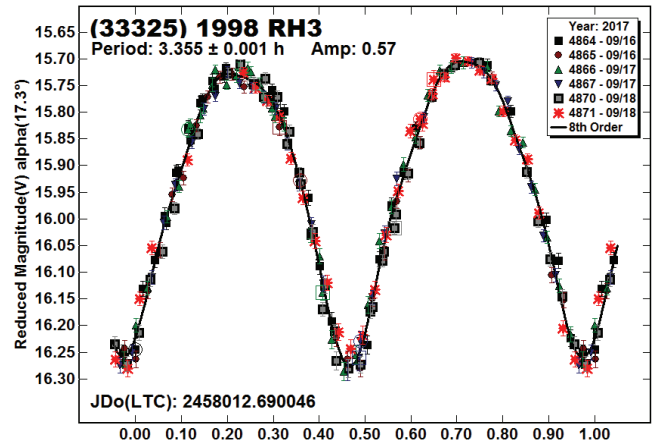
5735 Loripaul. No entry for this Vestoid could be found in the Lightcurve Database (Warner et al. 2009).



(29308) 1993 UF1. Warner (2010, 2013) determined a rotational period for this Hungaria twice in the past both times with a rotational period near 9.8 h. This year's result agrees with those past findings.



(33325) 1998 RH3. No entry for this member of the Hungaria family could be found in the Lightcurve Database (Warner et al. 2009).



Acknowledgements

This research was made possible in part based on data from CMC15 Data Access Service at CAB (INTA-CSIC) (<http://svo2.cab.inta-csic.es/vocats/cmc15/>). The purchase of a FLI-1001E CCD cameras was made possible by a 2013 Gene Shoemaker NEO Grants from the Planetary Society.

References

- Arredondo, A., Hartt, A.-M., Yazdi, S. (2014). "Rotation Periods and R Magnitudes of Three Koronis Family Members." *Minor Planet Bul.* **41** 252-254.
- Behrend, R. (2005). Observatoire de Geneve web site, http://obswww.unige.ch/~behrend/page_cou.html.
- Benishek, V. (2015). "Rotation Period Determinations for 1095 Tulipa, 1626 Sadeya 2132 Zhukov, and 7173 Sepkoski." *Minor Planet Bul.* **42**, 75-76.
- Durech, J., Hanus, J., Broz, M., Lehky, M., Behrend, R., Antonini, P., Charbonnel, S., Crippa, R., Dubreuil, P., Farroni, G., Kober, G., Lopez, A., Manzini, F., Oey, J., Poncy, R., Rinner, C., Roy, R. "Shape models of asteroids based on lightcurve observations with BlueEye600 robotic observatory." *ArXiv*: 1707.03637.
- 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., Zeigler, K.W. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.

Harris, A.W., Young, J.W., Scaltriti, F., Zappala, V. (1984). "Lightcurves and phase relations of the asteroids 82 Alkmene and 444 Gyptis." *Icarus* **57**, 251-258.

Harris, A.W., Pravec, P., Galád, B. Skiff, B., Warner, B., Világi, J., Gajdoš, S., Carbognani, A., Hornoch, K., Kušnirák, P., Cooney, W., Gross, J., Terrell, D., Higgins, D., Bowell, E., Koehn, B. (2014). "On the maximum amplitude of harmonics of an asteroid lightcurve." *Icarus* **235**, 55-59.

Johnson, T., Pech, K., van Schilfgaarde, R., Chase, M., Burns, M. (2008). *Minor Planet Bul.* **35**, 151-152.

Klinglesmith, D. (2017). "Asteroid Photometry Results from Etsorn Observatory." *Minor Planet Bul.* **44**, 69-72.

Neugent, K., Slivan, S. (2008). "Rotation Periods and H Magnitudes of Two Koronis Family Members." *Minor Planet Bul.* **35** 116-118.

Parvec, P. (2017). Photometric Survey for Asynchronous Binary Asteroids web site.
<http://www.asu.cas.cz/~asteroid/binastphotosurvey.htm>.

Stephens, R.D. (2002). "Photometry of 973 Aralia, 1189 Terentia, 1040 Klumpkea, and 1998 Titius." *Minor Planet Bul.* **29**, 47-48.

Warner, B.D. (2006). "Asteroid lightcurve analysis at the Palmer Divide Observatory: July-September 2005." *Minor Planet Bul.* **33**, 35-39.

Warner, B.D. (2010). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2009 September-December." *Minor Planet Bul.* **37**, 57-64.

Warner, B.D. (2013). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2013 January - March." *Minor Planet Bul.* **40**, 137-145.

Warner, B.D. (2016). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2015 June-September." *Minor Planet Bul.* **43**, 57-65

Warner, B.D., Harris, A.W., Pravec, P. (2009). "The Asteroid Lightcurve Database." *Icarus* **202**, 134-146. Updated 2017 Sept.
<http://www.minorplanet.info/lightcurvedatabase.html>

LIGHTCURVE AND ROTATION PERIOD DETERMINATION FOR 4975 DOHMOTO

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(Received: 2017 Oct 11)

Photometric observations of 4975 Dohmoto conducted in 2017 August and September yielded a bimodal lightcurve phased to a rotational period of 6.9618 ± 0.0001 h and amplitude of 0.87 mag.

Prior to our work, the only rotation period result for 4975 Dohmoto was by Waszczak et al. (2015; 7.553 h), obtained from the sparsely sampled photometry within the Palomar Transient Factory Survey. An uncertainty flag of $U = 2$ (Warner et al., 2009) was assigned to this result, indicating a high degree of its uncertainty. In late 2017 August, we were involved in the systematic photometric follow-up of the minor planet 10132 Lummelunda, which turned out to be a new asynchronous binary asteroid (Benishek et al., 2017). Since 4975 Dohmoto was close to Lummelunda at the beginning of the observing campaign, i.e. within the same CCD field of view, and the apparent motions of both asteroids were fairly uniform in almost parallel paths, it was agreed to begin systematic photometric observations of Dohmoto in order to test the previously reported rotation period.

Observations were started on 2017 Aug 26 at a pre-opposition solar phase angle of 7.35 degrees and ended on 2017 Sep 16 at a post-opposition solar phase angle of 2.62 degrees. The collaborative observations produced seven independent data sets with a total of 991 data points. Four data sets were obtained by Benishek and three by Pilcher. At the Sopot Astronomical observatory, Benishek used a 0.35-m $f/6.3$ Meade LX-200GPS Schmidt-Cassegrain (SCT) and SBIG ST-8XME CCD. Pilcher, at the Organ Mesa Observatory, employed a 0.35-m $f/10$ Meade LX-200GPS telescope and SBIG STL-1001E CCD camera. The exposures for both observers were unfiltered and unguided.

We used *MPO Canopus* (Warner, 2016) for photometric measurements and period analysis. The Comparison Star Selector (CSS) utility within *MPO Canopus* was employed to select up to five comparison stars of near solar-color ($0.5 \leq B-V \leq 0.9$) for differential aperture photometry. For the night-to-night calibration purpose and linking the individual data sets, the comparison stars magnitudes were calibrated using the R-band magnitudes taken from the Carlsberg Meridian Catalog 15 (CMC15; VizieR, 2017).

The period analysis on our densely sampled combined data set gave several harmonically related solutions of rather equal RMS errors.

Given the fact of the large lightcurve amplitude (0.87 mag) in the range of low solar phase angles, we have considerable confidence in choosing a bimodal solution with $P = 6.9618 \pm 0.0001$ h as being most likely correct (see Harris et al., 2014). Obviously, our solution differs significantly from the period found by Waszczak et al. (2015) when using only sparse photometric data.

The composite lightcurve plot is obtained by binning 3 data points that are separated in time by no more than 6 minutes in order to reduce the number of points and make them easier to read.

Number	Name	2017 mm/dd	Pts	Phase	L_{PAB}	B_{PAB}	Period (h)	P.E.	Amp	A.E.	Grp
4975	Dohmoto	08/26-09/15	991	7.4, 1.8, 2.6	349	4	6.9618	0.0001	0.87	0.02	MB-O

Table I. Observing circumstances and results. Pts is the number of data points. Phase is the solar phase angle given at the start and end of the date range, the middle value is the minimum solar phase angle. L_{PAB} and B_{PAB} are the average phase angle bisector longitude and latitude. Grp is the asteroid family/group (Warner et al., 2009). MB-O = Main-belt, outer.