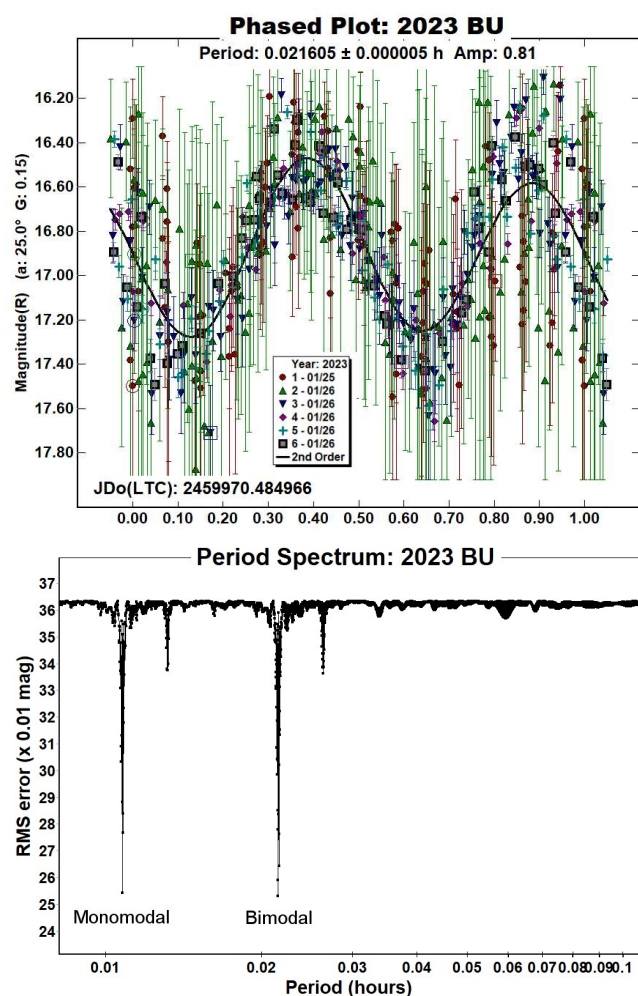




References

- Buchheim, R.K. (2010). "Methods and Lessons Learned Determining the H-G Parameters of Asteroid Phase Curves." *Society for Astronomical Sciences Annual Symposium* **29**, 101-115.
- Bus, S.J.; Binzel, R.P. (2002). "Phase II of the Small Main-Belt Asteroid Spectroscopic Survey - A Feature-Based Taxonomy." *Icarus* **158**, 146-177.
- Harris, A.W.; Young, J.W.; Scaltriti, F.; Zappala, V. (1984). "Lightcurves and phase relations of the asteroids 82 Alkeme and 444 Gyptis." *Icarus* **57**, 251-258.
- Shevchenko, V.G.; Lupishko, D.F. (1998). "Optical properties of Asteroids from Photometric Data." *Solar System Research* **32**, 220-232.
- Tholen, D.J. (1984). "Asteroid taxonomy from cluster analysis of Photometry." Doctoral Thesis. University Arizona, Tucson.
- UAI (2023). "Unione Astrofili Italiani" web site. <https://www.uai.it>
- Warner, B.D.; Harris, A.W.; Pravec, P. (2009) "The asteroid lightcurve database." *Icarus* **202**, 134-146. Updated 2023 April 9 <https://minplanobs.org/alcdef/index.php>
- Warner, B.D. (2021). MPO Software, MPO Canopus v10.8.5.0. Bdw Publishing. <http://minorplanetobserver.co>

ROTATIONAL PERIOD AND LIGHTCURVE DETERMINATION FOR FIVE MINOR PLANETS

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Photometric measurements of CMOS observations for five main-belt asteroids were made from 2022 December through 2023 February. Phased lightcurves were created for each one. Three of the asteroids have no prior published period solutions. All the data have been submitted to the ALCDEF database.

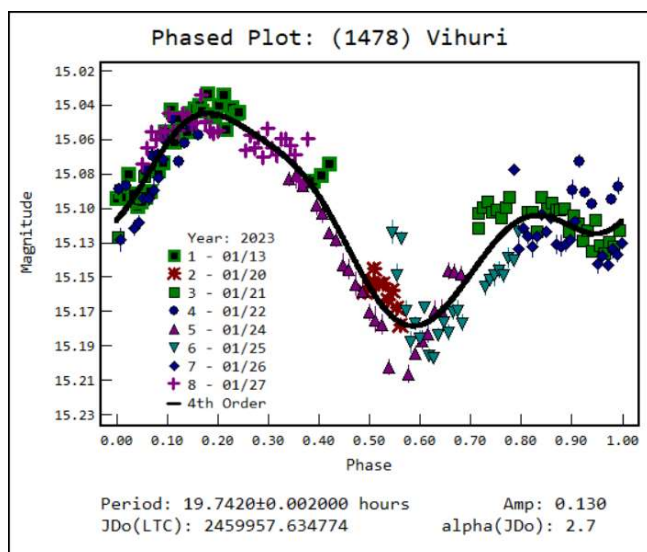
CMOS observations of five main-belt asteroids were performed at NAC Observatory (MPC U98) in Benson, AZ. Images were taken using a 0.35m *f*/7.2 Corrected Dall-Kirkham telescope, Moravian C5A-100M CMOS camera featuring a Sony IMX-461 sensor. Images were captured at a scale of 1.21"/pixel after binning 4×4. Table I shows observing circumstances and results. All images for these observations were obtained between 2022 December and 2023 February.

Data reduction and period analysis were done using *Tycho* (Parrott, 2023). The CMOS sensor provides a 58'×44' field of view, enabling the use of the same field center for three to four consecutive nights. The asteroid and five or more comparison stars were measured. Comparison stars were selected with colors within the range of $0.5 < B-V < 0.95$ to correspond with color ranges of asteroids.

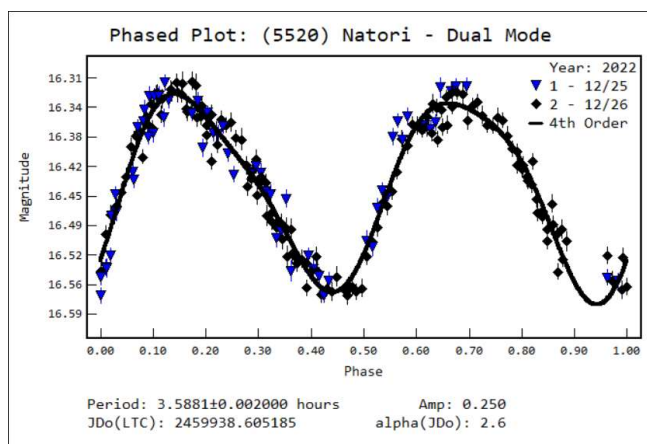
Comparison star magnitudes were obtained from the ATLAS catalog (Tonry et al., 2018), which is incorporated directly into *Tycho*. A 10-pixel (12.2 arcsec) diameter measuring aperture was used for asteroids and comp stars. Interference from field stars resulted in the exclusion of affected observations. Period determination was done using *Tycho*.

Asteroids were selected from the CALL website (Warner, 2011), either for having uncertain periods or no reported period at all. In this set of observations, three of the five asteroids had no previous period analysis and two had $U = 1$ (likely wrong). The Asteroid Lightcurve Database (LCDB; Warner et al., 2009) was consulted to locate previously published results. All new data for these asteroids have been submitted to the ALCDEF database.

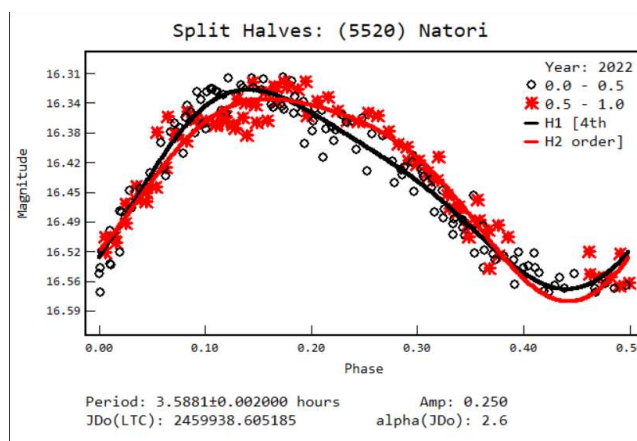
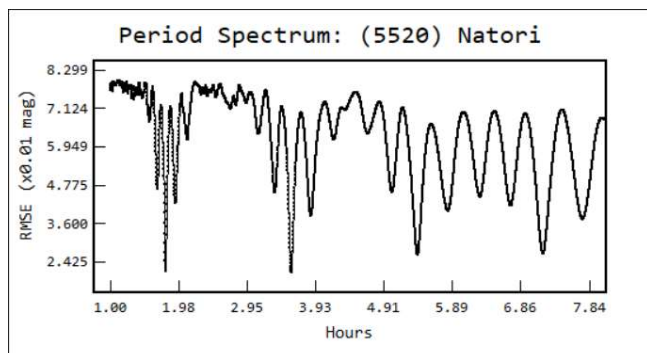
1478 Vihuri was discovered in 1938 by Vaisala at Turku. A period solution published by Binzel (1987) of 19.5 hours is the only listed value in the LCDB. A total of 203 observations were made over the course of eight nights in 2023 January. These data were used to calculate a period of $19.742 \text{ h} \pm 0.002 \text{ h}$, longer than Binzel's period solution by 0.242 hours. The amplitude of the lightcurve is $0.13 \pm 0.02 \text{ mag}$.



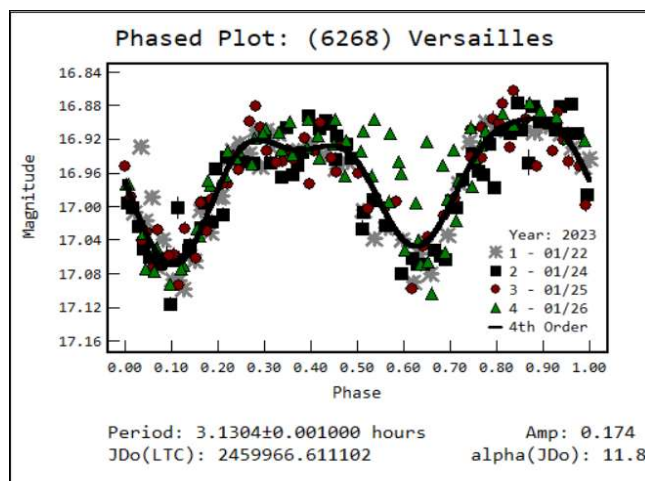
5520 Natori is an Eos family asteroid discovered at Oohira in 1990 by T. Urata. Pál et al. (2020) published a period of 3.58549 ± 0.00005 h. During a two-night interval, 232 images were obtained. Photometric measurements yield a rotation period of 3.587 ± 0.001 h, which agrees with Pál's period. The amplitude is 0.26 mag and the RMS error on the fit is 0.018 mag.



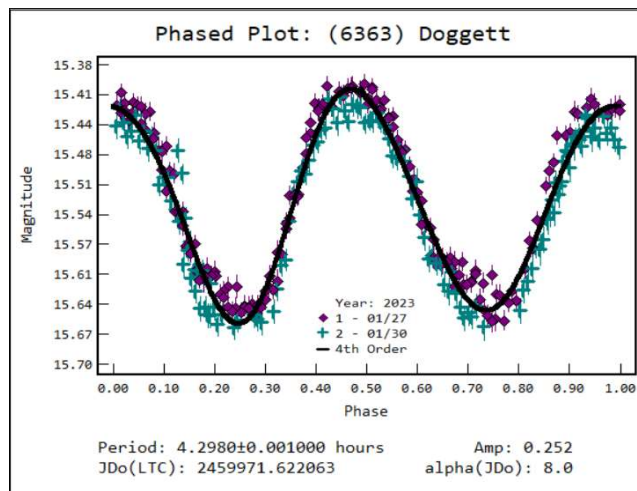
The periodogram indicates that a single mode rotational period of 1.795 ± 0.002 h, being half of the bimodal period, gives an equally good match. A split-halves plot of the shorter period shows distinct separation of multiple segments of the curve in each half, so the bimodal solution is preferred.



6268 Versailles is a Euterpe-family asteroid without a published period solution in the LCDB. It was discovered in 1990 by E.W. Elst at La Silla. A total of 317 observations were made over four nights in 2023 January to create an initial lightcurve. Due to interference from field stars, 62 of those observations were excluded from the final dataset. A period of 3.1304 ± 0.001 h was calculated with the data. The amplitude is 0.17 ± 0.03 mag.



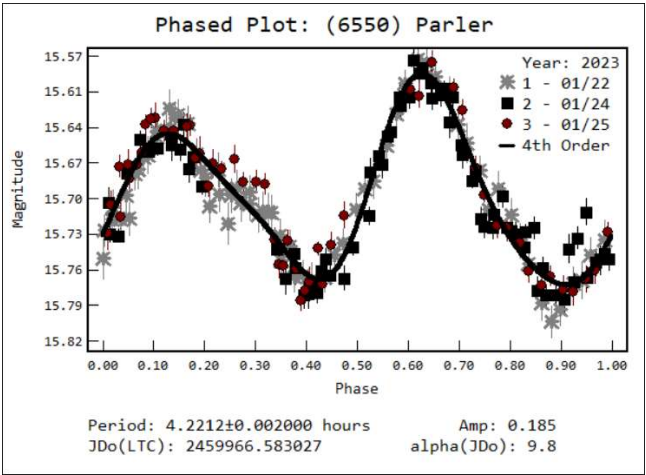
6363 Doggett is an inner main-belt asteroid discovered by E. Bowell at Flagstaff in 1981. No periods are shown in the LCDB. During two nights, 304 images were gathered, leading to a period solution of 4.298 ± 0.001 h with an amplitude of 0.25 ± 0.02 mag.



Number	Name	yyyy mm/dd	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
1478	Vihuri	2023 01/13-01/27	2.7, 7.7	113	4	19.742	0.002	0.13	0.01	MB-I
5520	Natori	2022 12/25-12/26	2.6, 2.9	88	4	3.588	0.002	0.25	0.02	EOS
6268	Versailles	2023 01/22-01/26	11.8, 14.0	104	1	3.130	0.001	0.17	0.03	410
6363	Doggett	2023 01/27-01/30	8.0, 9.4	117	8	4.298	0.001	0.25	0.02	MB-I
6550	Parler	2023 01/22-01/25	9.8, 11.3	109	8	4.221	0.002	0.18	0.02	MB-I

Table I. Observing circumstances and results. The phase angle is given for the first and last date. If preceded by an asterisk, the phase angle reached an extrema during the period. L_{PAB} and B_{PAB} are the approximate phase angle bisector longitude/latitude at mid-date range (see Harris et al., 1984). Grp is the asteroid family/group (Warner et al., 2009).

6550 Parler is an inner main-belt asteroid discovered by A. Mrkos in the Czech Republic in 1988. No period solutions appear in the LCDB. Over a period of three nights a total of 199 images were obtained and used to calculate a rotational period of 4.221 ± 0.002 h and amplitude of 0.19 ± 0.02 mag.



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References

Binzel, R.P. (1987). “A photoelectric survey of 130 asteroids.” *Icarus* **72**, 135-208.

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.

Pál, A.; Szakáts, R.; Kiss, C.; Bódi, A.; Bognár, Z.; Kalup, C.; Kiss, L.L.; Marton, G.; Molnár, L.; Plachy, E.; Sárneczky, K.; Szabó, G.M.; Szabó, R. (2020). “Solar System Objects Observed with TESS - First Data Release: Bright Main-belt and Trojan Asteroids from the Southern Survey.” *Ap. J.* **247**, A26.

Parrot, D. (2023). Tycho software. <https://www.tycho-tracker.com>

Tonry, J.L.; Denneau, L.; Flewelling, H.; Heinze, A.N.; Onken, C.A.; Smartt, S.J.; Stalder, B.; Weiland, H.J.; Wolf, C. (2018). “The ATLAS All-Sky Stellar Reference Catalog.” *Astrophys. J.* **867**, A105.

Warner, B.D.; Harris, A.W.; Pravec, P. (2009). “The Asteroid Lightcurve Database.” *Icarus* **202**, 134-146. Updated 2023 April. <http://www.minorplanet.info/lightcurvedatabase.html>

Warner, B.D. (2011). Collaborative Asteroid Lightcurve Link website. <http://www.minorplanet.info/call.html>