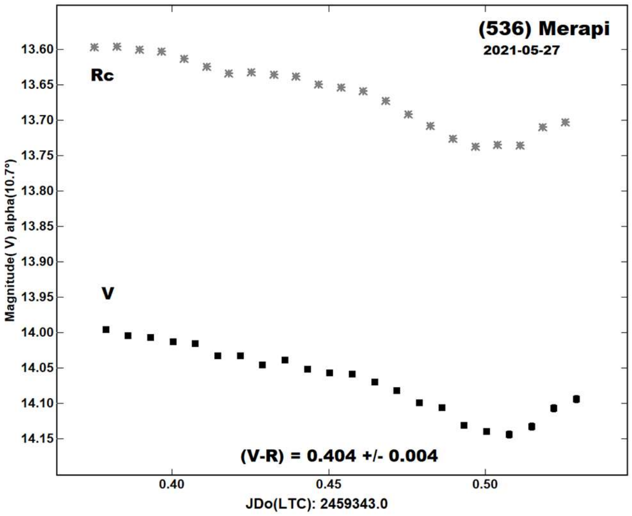

Figure 3. (V-R) raw plot of 536 Merapi.

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LIGHTCURVE AND SYNODIC ROTATION PERIOD FOR 2728 YATSKIV

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(Received: 2021 October 13)

A rotational lightcurve and a synodic rotation period were obtained for the first time on the main-belt asteroid 2728 Yatskiv from CCD photometric observations conducted over the time span 2021 June - September at two observatories widely separated in geographic longitude. As a result, a bimodal lightcurve phased to a period of 25.069 ± 0.006 h was established.

Prior to our work, there were no reports on synodic rotation period and lightcurve determinations for the inner main-belt asteroid 2728 Yatskiv. As a program target within the Photometric Survey for Asynchronous Binary Asteroids (*BinAstPhot Survey*) under the leadership of Dr. Petr Pravec from the Astronomical Institute of the Czech Academy of Sciences, 2728 Yatskiv was proposed for active photometric follow-up in 2021 June.

Benishek at Sopot Astronomical Observatory (SAO) in Serbia began photometric observations on 2021 June 13, employing a 0.35-m (f/6.3) Schmidt-Cassegrain telescope (SCT) equipped with a SBIG ST-8XME CCD camera operating in 2×2 binning mode. The first dense photometric datasets obtained by the end of June indicated not only a somewhat longer rotation period, and also its pronounced near commensurability with the Earth's rotation. Due to the parallel work on many other priority targets, and as the rather long rotation period for 2728 Yatskiv became apparent, a sparse data acquisition was implemented in some Benishek's datasets by taking one data point per half an hour.

These early datasets have yielded several harmonically related solutions (various multiples of the basic monomodal solution of somewhat over 12.5 hours). None of them could have been adopted as unequivocal one due to the rather limited amount of data and the shortness of of the observing runs, as well as the fact that progress in observational covering of a broader range of rotational phases from a single geographic longitude was very slow, since possible period solutions are near commensurate with the Earth's rotation.

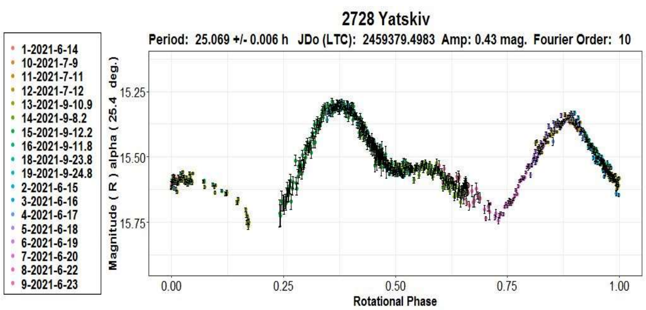
After a certain delay in the 2728 Yatskiv follow-up observations caused by a large number of other priority targets in the SAO observing schedule, Frederick Pilcher of the Organ Mesa Observatory in Las Cruces, USA was invited to contribute 2728 Yatskiv photometry from a significantly different geographic longitude to effectively resolve the existing period ambiguity. Pilcher kindly accepted the invitation and obtained his first dataset on 2021 September 08. Pilcher used a 0.35-m (f/10) SCT and a SBIG STL-1001E CCD camera. Two 2021 September long datasets by Pilcher were crucial to definitively determine a total amplitude of the combined lightcurve, which turned out to be greater than 0.4 magnitudes, and they also significantly covered a large gap in the lightcurve corresponding to a bimodal period solution of just over 25 hours.

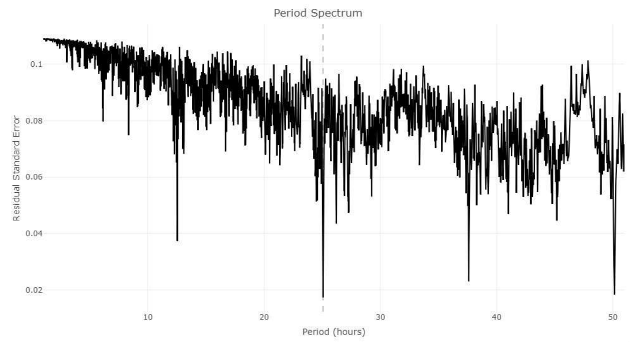
As of 2021 September 24, when the last data were taken, a total of 19 individual datasets were obtained.

Photometric reduction and differential photometry with up to five comparison stars of near solar color (0.5 ≤ B-V ≤ 0.9) was performed by both authors in *MPO Canopus* software (Warner, 2018). To ensure a high degree of uniformity of the magnitude zero points (up to a few hundreds of magnitude) both authors performed internal calibration of field comparison stars using standard Cousins R magnitudes derived from the Carlsberg Meridian Catalog 15 (VizieR, 2021) Sloan r' magnitudes by applying the formula: R = r' – 0.22.

Lightcurve construction and period analysis were performed with a custom-made program *Perfindia* developed by Benishek in the R statistical programming language (R Core Team, 2020). Among several possible period solutions, a bimodal solution of 25.069 ± 0.006 hours stands out for its minimal *residual standard error*. In addition, having in mind the rather large lightcrve amplitude corresponding to this bimodal solution (0.43 mag.) over the range of relatively low solar phase angles, it could be concluded with a high degree of reliability that the derived bimodal period is the most reliable value (Harris et al., 2014). An independent period analysis conducted by Pilcher over the same combined dataset in *MPO Canopus* gives almost the same period value of 25.064 hours.

The period error shown on the lightcurve plot represents so-called 2% error, i.e. an error that would cause the last data point in a combined data set by date order to be shifted by 2% (Warner, 2012) and represented by $\Delta P = (0.02 \cdot P^2) / T$, where P and T are the rotational period and the total time span of observations expressed in the same units, respectively.





Acknowledgements

Observational work at Sopot Astronomical Observatory is supported by a 2018 Gene Shoemaker NEO Grant from The Planetary Society.

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Number	Name	20yy/mm/dd	Phase	L_{PAB}	B_{PAB}	Period (h)	P.E.	Amp	A.E.	Grp
2728	Yatskiv	21/06/13-21/09/24	*25.4,20.9	318	4	25.069	0.006	0.43	0.02	MB-I

Table I. Observing circumstances and results. Phase is the solar phase angle given at the start and end of the date range. If preceded by an asterisk, the phase angle reached an extrema during the period. 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-I = main-belt inner.