LIGHTCURVE AND ROTATION PERIOD DETERMINATION FOR 2496 FERNANDUS, 2727 PATON, AND 69971 TANZI

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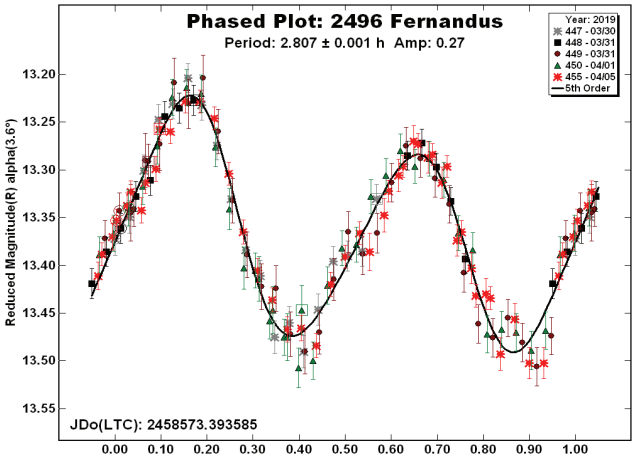
Photometric observations of the main-belt asteroids 2496 Fernandus, 2727 Paton, and 69971 Tanzi were made by the authors from 2019 January 3 to April 5. Analysis found bimodal lightcurves for each one. The most likely synodic periods are: 2496 Fernandus, 2.807 ± 0.001 h; 2727 Paton, 5.324 ± 0.001 h; and 69971 Tanzi, 32.540 ± 0.009 h.

Lightcurve analysis of three asteroids was performed using images taken at the Astronomical Observatory of the University of Siena (Italy) and at the Wild Boar Remote Observatory (K49). At the Astronomical Observatory of the University of Siena, data were obtained with a 0.30-m *f*/5.6 Maksutov-Cassegrain telescope, SBIG STL-6303E NABG CCD camera, and clear filter; the image scale was 2.26 arcsec in binning 2x2. Exposures were 300 s. At the Wild Boar Remote Observatory (K49), data were obtained with a 0.235-m *f*/10 (SCT) telescope, SBIG ST8-XME NABG CCD camera, and no filter; the image scale was 1.6 arcsec in binning 2x2. Exposures were 300 s. Table I lists the observing circumstances and analysis results.

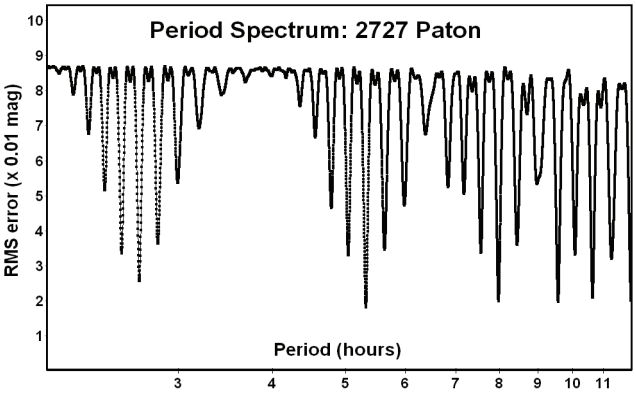
MPO Canopus (Warner, 2013) was used to measure the images, do Fourier analysis, and produce the lightcurves.

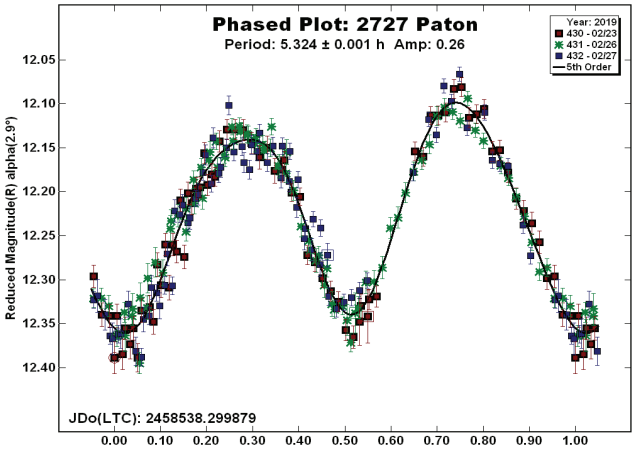
In the following, orbital data and discovery circumstances were taken from the JPL Small Bodies Node (JPL, 2017).

2496 Fernandus (1953 TC1) is a main-belt asteroid discovered on 1953 Oct 8 at the Goethe Link Observatory (Brooklyn). It's a typical main-belt asteroid with a semi-major axis of about 2.17 AU, eccentricity 0.033, and orbital period of about 3.20 yr. Observations were made from 2019 March 30 to April 5. They produced three sessions with a total of 147 data points. Analysis found a bimodal lightcurve with a synodic period of 2.807 ± 0.001 h and peak-to-peak amplitude of 0.27 ± 0.01 mag.



2727 Paton (1979 SO9) is a main-belt asteroid discovered on 1979 Sept 22 by N. Chernykh at Nauchnyj. The orbit has a semi-major axis of 2.61 AU, eccentricity 0.102, and period about 4.21 yr. We observed the asteroid from 2019 Feb 23-27. This resulted in three sessions with a total of 228 data points. Analysis found a bimodal lightcurve with a synodic period of 5.324 ± 0.001 h and amplitude of 0.26 ± 0.02 mag.

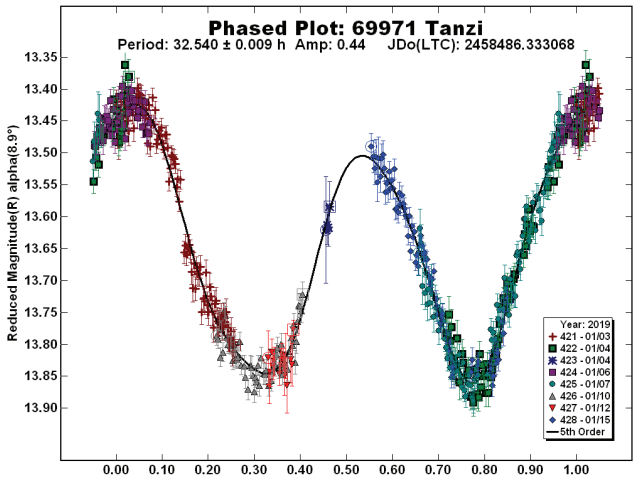




Number	Name	2019 mm/dd	Pts	Phase	L_{PAB}	B_{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
2496	Fernandus	03/30-04/05	147	2.7,3.7	196	1	2.807	0.001	0.27	0.01	EUN
2727	Paton	02/23-02/27	228	3.0,4.3	159	-3	5.324	0.001	0.26	0.02	EUN
69971	Tanzi	01/03-01/15	475	7.4,7.2	117	1	32.540	0.009	0.44	0.04	EUN

Table I. Observing circumstances and results. Pts is the number of data points. The phase angle is given 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).

69971 Tanzi (1998 WD2) is a main-belt asteroid discovered on 1998 Nov 18 by M. Cavagna at Sormano. The orbit has a semi-major axis of 2.91 AU, eccentricity 0.284, and period of about 4.96 yr. Our observations from 2019 January 2-15 produced 8 sessions and a total of 475 data points. The resulting bimodal lightcurve has a synodic period 32.540 ± 0.009 h and amplitude of 0.44 ± 0.04 mag.



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SYNODIC ROTATION PERIODS AND LIGHTCURVES FOR 13 ASTEROIDS: 2018 OCTOBER - 2019 MARCH

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Results on lightcurve and synodic rotation period determinations for 13 asteroids from data collected at Sopot Astronomical Observatory in the time span 2018 October - 2019 March are presented.

Photometric observations of 13 asteroids were conducted at Sopot Astronomical Observatory (SAO) between 2018 October - 2019 March 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 telescopes are equipped with a SBIG ST-8 XME and a SBIG ST-10 XME CCD cameras. The exposures were unfiltered and unguided for all targets. Both cameras were operated in 2x2 binning mode, which produces image scales of 1.66 arcsec/pixel and 1.25 arcsec/pixel for ST-8 XME and ST-10 XME cameras, respectively. 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, 2018). Differential photometry with up to five comparison stars of near solar color ($0.5 \leq B\text{-}V \leq 0.9$) 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. Field comparison stars were calibrated using standard Cousins R magnitudes derived from the Carlsberg Meridian Catalog 15 (VizieR, 2019) Sloan r' magnitudes using the formula: R = r' - 0.22 in all cases presented in this paper. In some instances, 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.

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

Table I gives the observing circumstances and results.

Observations and results

1266 Tone. Several fairly different previous rotation period determination results were found in the Asteroid Lightcurve Database (LCDB; Warner et al., 2009) prior to the 2019 SAO photometric observations of this main-belt asteroid (MBA). These are the results obtained by: Warner 2003, 11.82 h; Behrend 2005, 12.9 h; Warner 2010, 7.40 h and Montminy et al. 2018, 15.55 h. The observations at SAO were carried out over eight nights in the second half of 2019 February and resulted in a rather dense combined dataset with a total of 409 data points. Period analysis found a bimodal period of 15.605 ± 0.006 h as the most likely one, which is in good with the result by Montminy et al. (2018).