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LIGHTCURVE AND ROTATION PERIOD DETERMINATIONS FOR SEVEN ASTEROIDS

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CCD photometric observations of seven asteroids were conducted from 2018 January through June. A review of the results obtained for synodic rotation periods as well as the lightcurves established is presented here.

Photometric observations of seven asteroids were conducted at Sopot Astronomical Observatory (SAO) between 2018 January-June 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, 2018a). 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 three different 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); 3. Cousins R magnitudes derived from the Carlsberg Meridian Catalog 15 (VizieR, 2018) Sloan *r'* magnitudes using the formula: $R = r' - 0.22$. All data sets pertaining to a single target were consistently calibrated using a single catalog. 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.

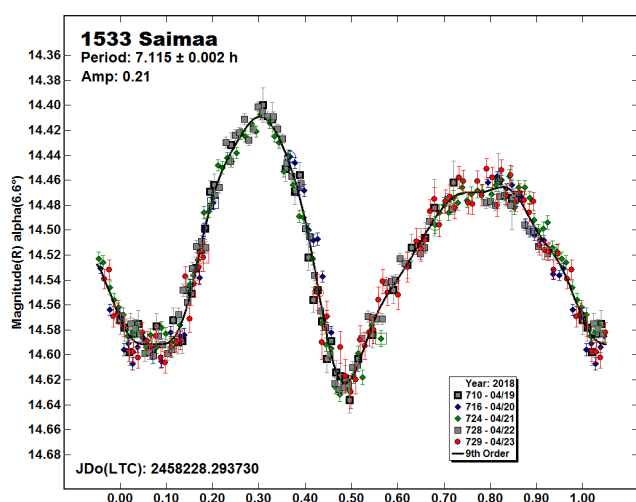
Table I gives the observing circumstances and results.

Number	Name	2018/mm/dd	Pts	Phase	L _{PAB}	B _{PAB}	Period (h)	P.E.	Amp	A.E.	Grp
1533	Saimaa	04/19–04/24	314	6.5, 7.9	196	9	7.115	0.002	0.21	0.01	MB-O
2764	Moeller	01/24–01/26	155	1.4, 2.1	122	-1	5.954	0.005	0.26	0.02	FLOR
2811	Stremchovi	01/24–01/26	129	2.4, 1.8	130	1	3.249	0.002	0.31	0.02	KOR
4221	Picasso	05/07–05/20	206	11.5, 10.3	239	18	3.1114	0.0002	0.27	0.02	MB-M
5518	Mariobotta	04/19–05/09	236	9.0, 17.9	202	11	108.84	0.05	0.55		FLOR
138847	2000 VE62	05/28–06/01	530	54.3, 54.8	222	34	7.601	0.004	0.35	0.03	NEA
	2018 EJ4	05/20–06/01	342	62.1, 58.4	231	30	3.7422	0.0006	0.30	0.03	NEA

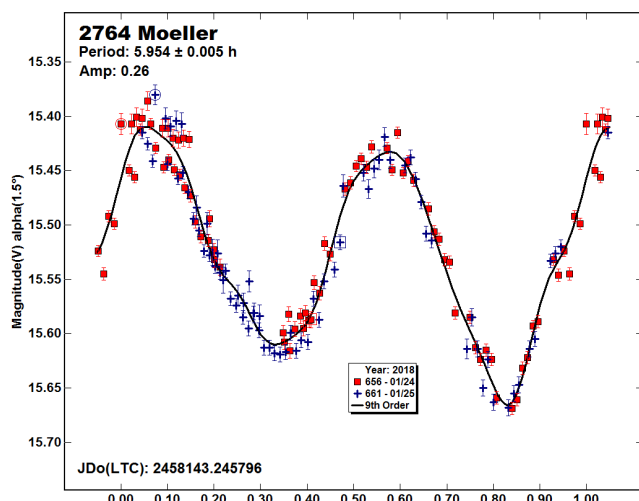
Table I. Observing circumstances and results. Pts is the number of data points. Phase is the solar phase angle given at the start and end of the date range. L_{PAB} and B_{PAB} are the average phase angle bisector longitude and latitude. Grp is the asteroid family/group (Warner *et al.*, 2009): FLOR = Flora, KOR = Koronis, MB-M/O = main-belt middle/outer, NEA = near-Earth asteroid.

Observations and results

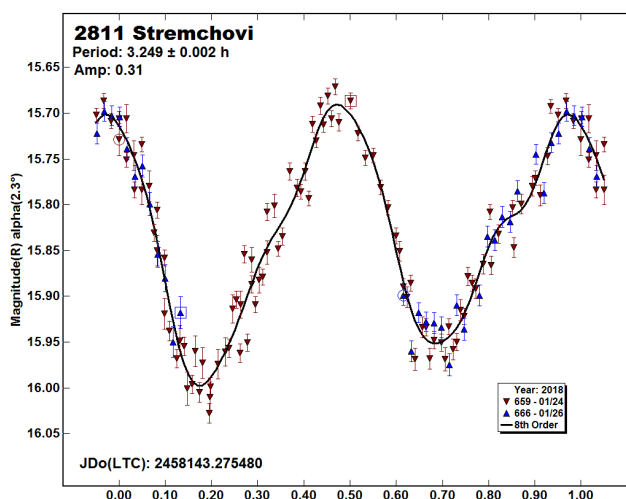
1533 Saimaa. Two previous rotation period determinations were known prior to SAO observations: by Binzel (1987; 7.08 h) and Behrend (2007; 7.1181 h). Photometric observations undertaken at SAO in 2018 April over 5 nights led to a bimodal lightcurve phased to a period of $P = 7.115 \pm 0.002$ h.



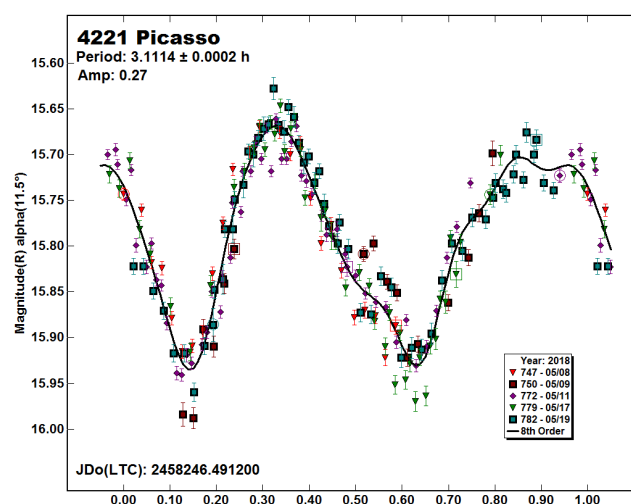
2764 Moeller. The only previous rotation period result was by Wasczak *et al.* (2015; 5.954 h) obtained within the Palomar Transient Factory Survey. The SAO observations of this BinAstPhot Survey target were carried out over two consecutive nights in 2018 January. The determined rotational period of 5.954 ± 0.005 h corresponds to the bimodal lightcurve with an amplitude of 0.26 mag. Pravec's analysis (Pravec, 2018) of the SAO data gave almost the same result for period (5.953 ± 0.004 h).



2811 Stremchovi. Previous results for synodic rotation period of this asteroid were from the Palomar Transient Factory Survey only: 3.25 h by Chang *et al.* (2014) and 3.248 h by Wasczak *et al.* (2015). Data collected over two nights at SAO led to an unambiguous bimodal result for period of $P = 3.249 \pm 0.002$ h.

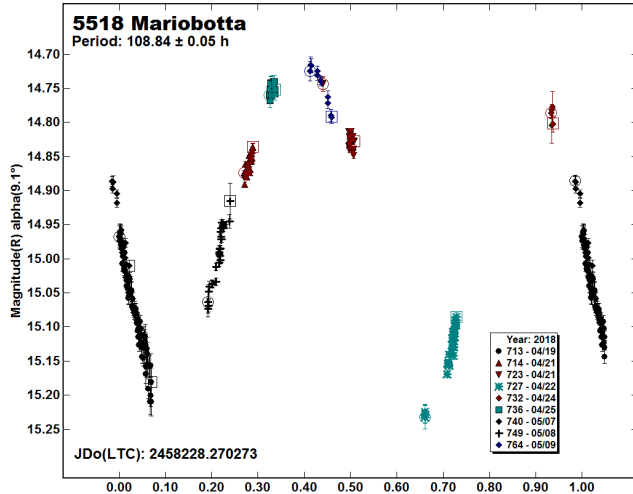


4221 Picasso. Another BinAstPhot Survey target worked at SAO over 5 nights in 2018 May. The period analysis led to a bimodal lightcurve phased to a period of $P = 3.1114 \pm 0.0002$ h. An analysis of SAO data conducted by Pravec (2018) found exactly the same period value (3.1114 ± 0.0001 h).

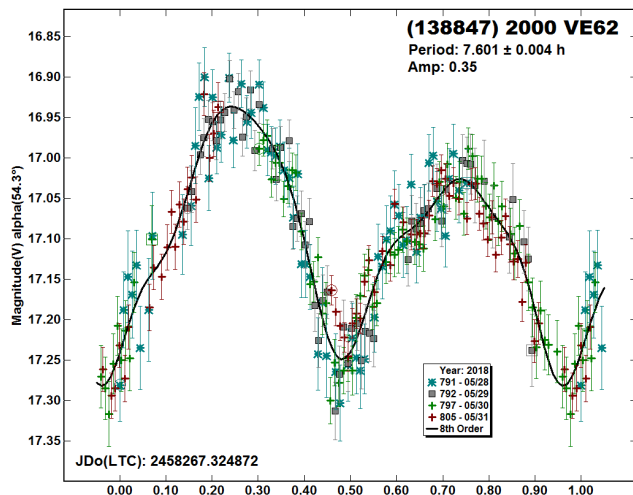


5518 Mariobotta. Two previously found rotational periods by Wasczak *et al.* (2015; 105.538 h and 109.236 h) already indicated a slow rotator. As a BinAstPhot Survey program target it was observed at SAO from 2018 April 19 through 2018 May 9. A total

of 9 individual data sets were obtained. Period analysis indicates a synodic rotation period of $P = 108.84 \pm 0.05$ h corresponding to a fairly large amplitude (~ 0.55 mag.) bimodal lightcurve. Such a result could be adopted with a great deal of uncertainty as data coverage of the full rotational cycle is partial and quite uneven. Period analysis of the SAO data done by Pravec (2018) shows somewhat different period value of 108.60 ± 0.04 h.



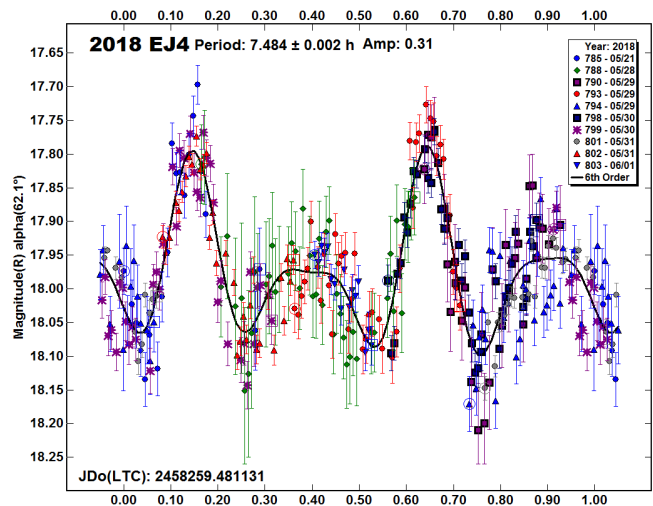
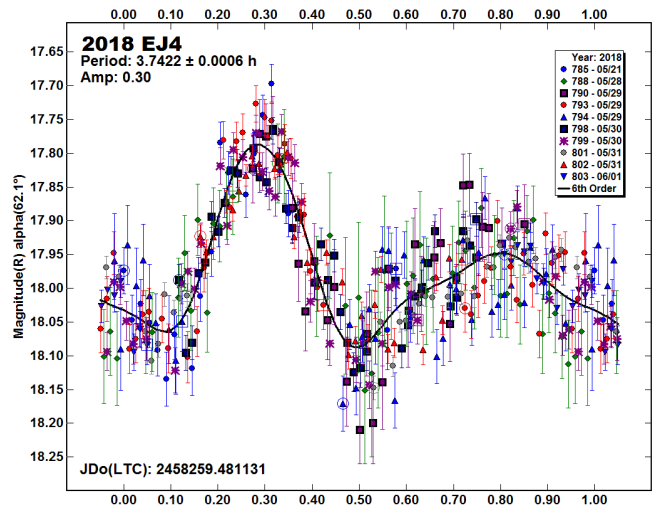
(138847) 2000 VE62. Monteiro et al. (2017) reported a value of 6.469 h for rotational period of this near-Earth asteroid. Dense photometric data were collected at SAO on four consecutive nights, from 2018 May 28 through 2018 June 1. Period analysis shows a bimodal period of 7.601 ± 0.004 h as a highly reliable result. A period of 6.55 h also quite distinctive in the period spectrum by its low RMS error and fairly close to the Monteiro et al. result by its value corresponds to the lightcurve with apparent discrepancies between the individual data sets. The period result for this asteroid recently published on the web by Warner (2018b; 7.600 h) is fully in favor of the result presented here.

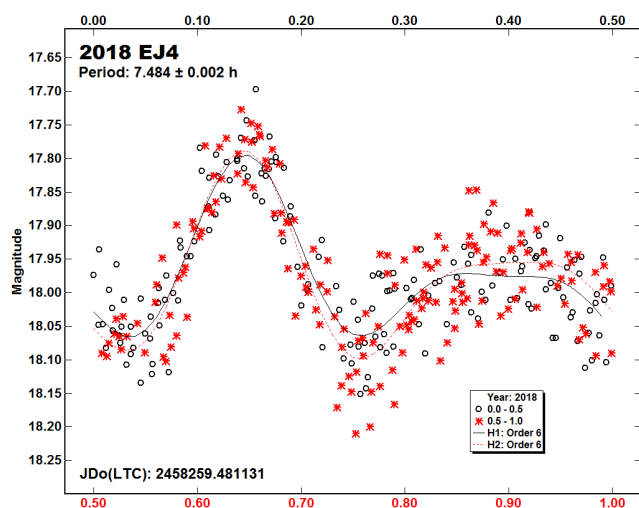


2018 EJ4. This Amor-type orbit near-Earth asteroid, also classified as a Potentially Hazardous Asteroid (PHA) was discovered by Mt. Lemmon Survey on 2018 March 13. The asteroid made a close approach to the Earth on 2018 June 10 at a distance of 0.014 AU.

To determine its rotation period photometric observations were started at SAO on 2018 May 20 and continued until 2018 June 1.

A total of 10 independent data sets with 342 data points were collected during this time interval. Due to the rapid apparent motion of the asteroid and fairly small CCD field of view it was common to obtain more individual data sets over a single night. Period analysis conducted upon the combined data set yielded several harmonically related solutions for period of which the most characteristic in the period spectrum are those of about 3.742 h and 7.484 h. The lightcurve that corresponds to the longer period shows two almost identical halves, which might favor the shorter period. Nonetheless, the longer period in no case should be ruled out since somewhat higher noise level present in the data could conceal certain minor characteristic features, which could make the two halves of the longer period lightcurve different. As a formal solution a period of $P = 3.7422 \pm 0.0006$ h is adopted in this paper.





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