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Lightcurve Analysis of Asteroids at the Astronomical Station Vidojevica for the first half of 2022

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Introduction

We present one part of our long-term photometry program, targeted at studying the shape and spin state of asteroids. The CCD photometric observations were carried out in the first half of 2022 with two telescopes at the Astronomical Station Vidojevica (Serbia): 1.4m Ritchey-Chrétien-Coude "Milanković" and the 60cm Cassegrain "Nedeljković" telescope.

In this work, lightcurves, the synodical periods of rotation, ellipsoid shape ratios a/b, and first assumptions on the shape of several main-belt asteroids are presented. Obtained results contribute to the database of rotational characteristics of the asteroids, enhancing the understanding of the creation of our planetary system.

Aperture photometry of the asteroids and the comparison stars was performed using the *CCDPHOT* program [1]. For lightcurve analysis, we used software package *MPO LCInvert* v11 [2].

The Astronomical Station (AS) Vidojevica is an observation site founded by the Astronomical Observatory of Belgrade. AS Vidojevica is located on the Vidojevica mountain near Prokuplje, at 1150m altitude.

Fig.1a New pavilion for 1.4m telescope Milanković

Fig.1b Telescope Milanković - 140 cm mirror

Fig.1c Telescope Nedeljković - 60 cm mirror

2525 O'Steen is the first asteroid we observed from the AS Vidojevica [3]. It is a 30 km sized member of the asteroid family Themis located in the outer part of the main belt. O'Steen has a low albedo of 0.07, which indicates a dark surface, meaning that it is one of the carbonaceous (C-type) asteroids. We observed this asteroid for 2.15h on 5th April this year with the 1.4m telescope, after its opposition at the phase angle of 15.7°. Although the observations lasted slightly longer than its half-period, the obtained partial lightcurve (LC) in combination with our other LCs will be valuable for calculating the pole coordinates and shape of this asteroid.

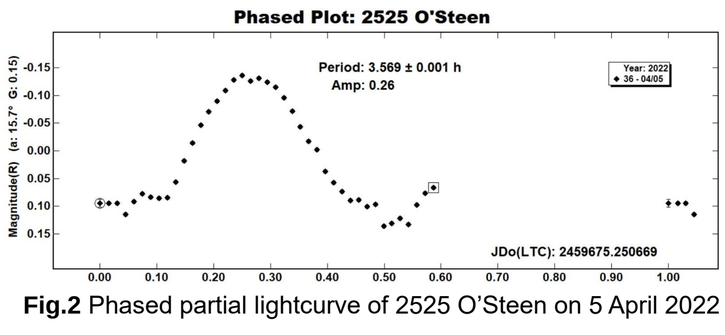


Fig.2 Phased partial lightcurve of 2525 O'Steen on 5 April 2022

4528 Berg is a 9.3 km asteroid located in the inner part of the main belt. Our 2022 observations of Berg were carried out in two nights: 5th April with the 1.4m telescope and 3rd May with the 60cm telescope. During the observation, the solar phase angle increased from 14.6° to 22.4°. In the first night, the observations covered the whole rotational period, whereas in the second night the lightcurve was interrupted by unfavorable weather conditions. Berg has a period of 3.5634±0.0005h. The amplitude of the composite lightcurve (with Fourier fit of order 9) is 0.34 mag. The estimated lightcurves show small differences in sharpness and depth of the minima, which reveals a slightly unsymmetrical shape of the asteroid. Photometric observations from Benishek et al 2021, revealed that Berg is a binary system with an orbital period of 35.02 +/- 0.02 h.

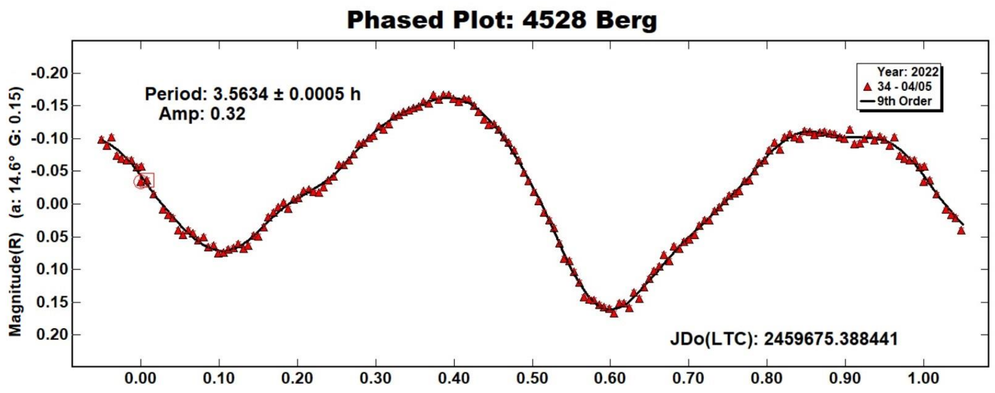


Fig.3 Phased lightcurve of 4528 Berg on 5th April 2022

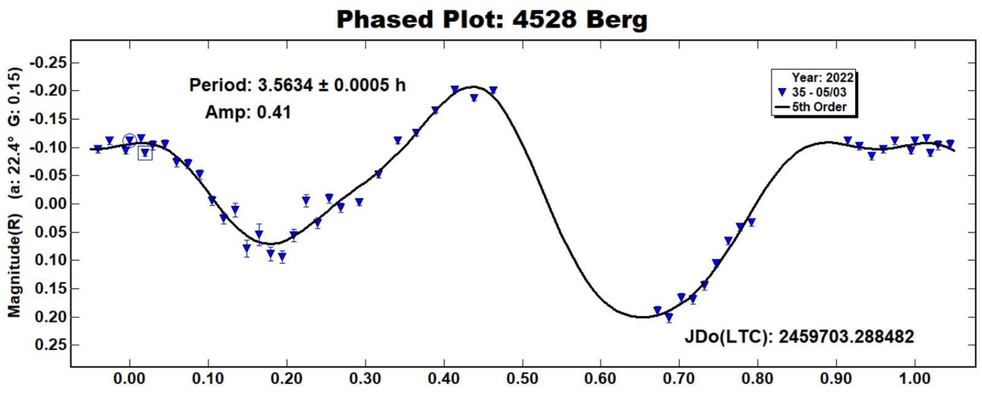


Fig.4 Phased lightcurve of 4528 Berg on 3th May 2022

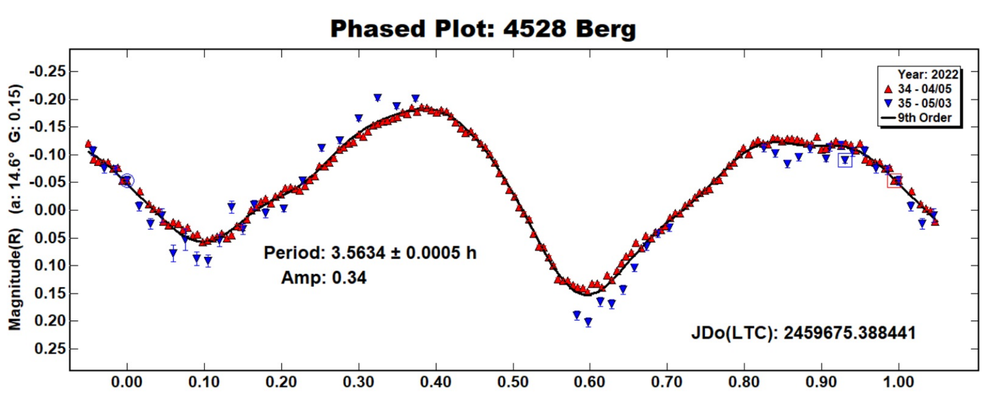


Fig.5 Composite lightcurve of 4528 Berg from observations on 5th April and 3rd May 2022

4940 Polenov is a 17.7 km sized carbonaceous (C-type) asteroid located in the outer part of the main belt. It belongs to the asteroid family Themis. Polenov was observed with the 1.4 m telescope in two consecutive nights on 5th and 6th April 2022, after its opposition on 30th March. Fourier fit of order 6 reveals an approximately symmetric shape of the lightcurve with period of 4.161±0.001h and amplitude of 0.33 mag.

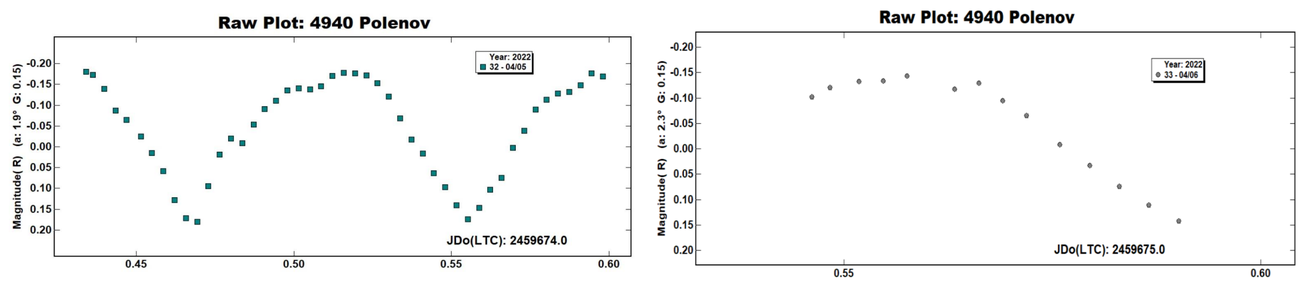


Fig.7 Partial raw lightcurves of 4940 Polenov on 5 (left) and 6(right) of April 2022

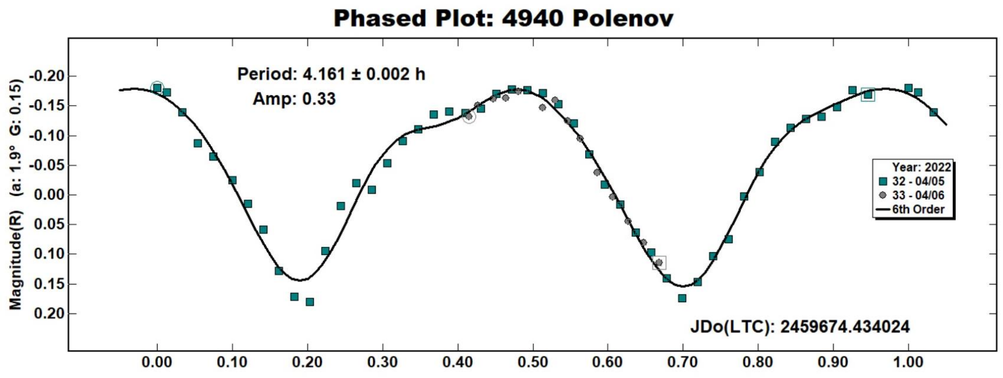
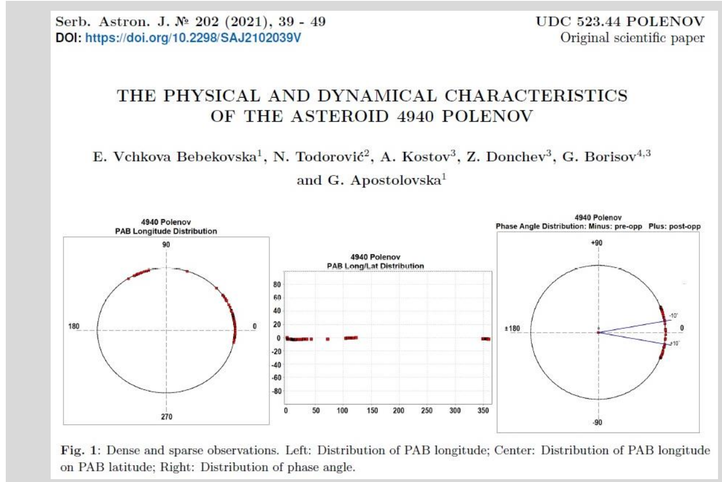


Fig.8 Composite lightcurve of 4940 Polenov from observations on 5th and 6th April 2022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Original scientific paper

THE PHYSICAL AND DYNAMICAL CHARACTERISTICS OF THE ASTEROID 4940 POLENOV

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Fig. 1: Dense and sparse observations. Left: Distribution of PAB longitude; Center: Distribution of PAB longitude on PAB latitude; Right: Distribution of phase angle.

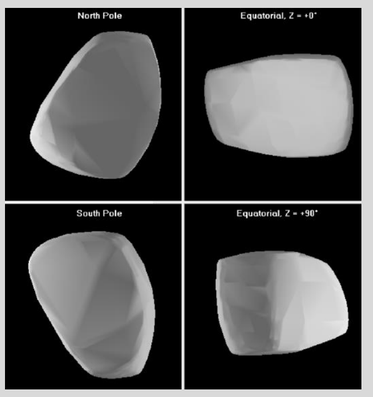

Fig.9 The three-dimensional shape model of 4940 Polenov [5].

CONCLUSION

The periods and amplitudes of the three presented asteroids are consistent with the previously published results in Ďurech et al 2010. Considering that asteroid shapes are approximated with triaxial ellipsoids with *a* > *b* > *c, and that* they rotate around the *c*-axis, we could calculate the a/b ratio [6]. The amplitude of 0.32 mag for 4528 Berg and 0.33 mag for 4940 Polenov imply their a/b ratios are a/b ≥ 1.34 and a/b ≥ 1.36 respectively. The amplitude of 0.26 mag for 2525 O'Steen indicates that a/b ≥ 1.27. Calculated ratios suggest that the three asteroids do not have elongated shapes, although their true a/b ratios depend on the maximum amplitudes and determined shape. In order to reconstruct the asteroid shape and spin axis direction using the lightcurve inversion method [7], we need a set of dense lightcurves obtained at different geometric conditions during several oppositions (i.e. several years of observations). A search through the Asteroid Lightcurve Database [8] and DAMIT [9] show that prior to the present work, there are no reported results for the pole and shape for the three presented asteroids.

REFERENCES:

1. M. W. Buie, CCDPHOT - An IDL widget based CCD photometry reduction system, ASP Conference Series 101, edited by G. H. Jacoby and J. Barnes, (1996)

2. B. D.Warner, *MPO Canopus* software, (Bdw Publishing, 2016) *http://www.MinorPlanetObserver.com*

3. N. Todorović, G. Apostolovska, and E. Bebekovska, Lightcurve Photometry of (2525) O'Steen with the new "Milanković" 1.4 m telescope. *Proceedings of the IAU, 14*(A30), 39-39. (2018).

4. V. Benishek et al. (4528) Berg is a binary asteroid. Electronic Telegram, 5123 IAU MPC (2022).

5. E. Vchkova Bebekovska et al. The physical and dynamical characteristics of the asteroid 4940 Polenov, *Serb. Astron. J.*, **202**, pp. 39-49 (2021)

6. J. A. Burns and E. F. Tedesco, *Asteroids,* edited by T. Gehrels, (Univ. Arizona Press, Tucson, 1979), 494-527.

7. M. Kaasalainen, J. Torppa, and K. Muinonen, *Icar* **153**, 37- 51 (2001)

8. B. Warner, A. Harris, and P. Pravec, *Icar* **202**, 134-146 (2009). Updated 2021 January. https://www.minorplanet.info/php/lcdb.php

9. Ďurech J. et al. *DAMIT: a database of asteroid models*, A&A, 513, A46 (2010), http://astro.troja.mff.cuni.cz/projects/damit

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