

Photometry and polarimetry of near-Earth asteroids (3200) Phaethon and (155140) 2005 UD

Yurij N. Krugly (1), Irina N. Belskaya (1), Sofiia S. Mykhailova (1), Zahari Donchev (2), Raguli Ya. Inasaridze (3,4), Alexey V. Sergeev (1), Ivan G. Slyusarev (1), Vasilij G. Shevchenko (1), Vasilij G. Chiorny (1), Vasilij V. Rumyantsev (5), Artem O. Novichonok (6,7), Vova Ayvazian (3,4), Givi Kapanadze (3,4), Otari I. Kvaratskhelia (3,4), Tanyu Bonev (2), Galin Borisov (8,2), Igor E. Molotov (6), Victor A. Voropaev (6)
(1) Institute of Astronomy, V. N. Karazin Kharkiv National University, Kharkiv, Ukraine, (krugly@astron.kharkov.ua); (2) Institute of Astronomy and NAO, Bulgarian Academy of Sciences, Sofia, Bulgaria; (3) Kharadze Abastumani Astrophysical Observatory, Iliia State University, Georgia; (4) Samtskhe-Javakheti State University, Akhaltsikhe, Georgia; (5) Armagh Observatory and Planetarium, Armagh, UK; (6) Crimean Astrophysical Observatory, RAS, Nauchny, Russia; (6) Keldysh Institute of Applied Mathematics, RAS, Moscow, Russia; (7) Petrozavodsk State University, Petrozavodsk, Russia; (8) Armagh Observatory and Planetarium, Armagh, UK

Abstract

Photometric and polarimetric observations of the near-Earth asteroids (3200) Phaethon in 2017 and 2018 oppositions, and (155140) 2005 UD during its appearance in 2018 are presented. The rotation periods, color lightcurves, phase angle dependences were obtained.

1. Introduction

The near-Earth asteroid (3200) Phaethon is an unusual Apollo-type asteroid identified as possible dormant or extinct cometary nucleus, but it has a Tisserand parameter $T_J = 4.5$ (not cometary object). The asteroid was classified as F- or B-type and probably originated from main-belt comets or from the Pallas family [6,3]. It has a very elongated orbit that crosses orbits of all inner Solar system planets and approaches the Sun at a distance of about 21 million km. That is why the surface temperature can reach up to 800°C. A possible meteoritic analogue of Phaethon's surface can be the dehydrated CI/CM chondrites [10]. The asteroid is a potentially hazardous object and considered as a parent body of the Geminid stream. Phaethon is also associated with another Apollo asteroid (155140) 2005 UD which was probably formed by splitting the primary body of Phaethon [9].

In 2022 JAXA plans a launch of the DESTINY+ mission to flyby the asteroid (3200) Phaethon. The asteroid 2005 UD is considered as the second flyby target of the mission.

Here we present results of our photometric and polarimetric observations of Phaethon and 2005 UD obtained in 2017 and 2018.

2. Observations

Photometric observations of Phaethon were made during 12 nights in Nov-Dec 2017 and Oct-Dec 2018, and 2005 UD was observed during 22 nights from Sep 27 up to Nov 09 in 2018. Five telescopes were involved in the observations: the 60 cm telescope of the Rozhen Observatory (MPC code 071); the 70 cm telescope at the Abastumani Observatory (119); the 70-cm telescope at the Chuguev Observatory (121); the 1-m telescope at the Simeiz Observatory (094); and the 2.6-m telescope at the Crimean Astrophysical Observatory (095).

Polarimetric observations of these asteroids were done with the 2 m telescope of the Rozhen Observatory during 3 nights in Dec 2017 for Phaethon and on Oct 09, 2018 for 2005 UD.

3. Results

(3200) Phaethon. We confirmed the rotation period of $P=3.604$ hrs. In 2017 the lightcurve's amplitude was changed from 0.07 mag up to 0.17 mag due to aspect changes. The phase angles were in the range of 20–48°. A significant increase of the amplitude to 1.3 mag at the phase angle 135° was observed on Dec 26, 2017. The observations of Phaethon in *BVRI* passbands showed no color variations with rotation. In 2018 photometry of Phaethon was made in phase-angle range 9–20° and the linear phase-angle coefficient $k_R = 0.037$ mag deg⁻¹ was obtained.

Polarimetry of Phaethon was made at phase angles 47–116° in Dec 15–21, 2017 and showed the extremely high linear polarization up to 44% [4,1]. The obtained values are well-consistent with measurements of other authors in the same

opposition [11], polarimetry of Phaethon in 2016 [5] show much higher polarization at large phase angles. It can be explained by large variations of polarization degree over the surface (both found with rotation at the same aspect [1] and for different aspects in 2016 and 2017). Polarization phase-angle dependences of Phaethon in comparison with other low-albedo NEAs [2,8] are shown in Figure 1.

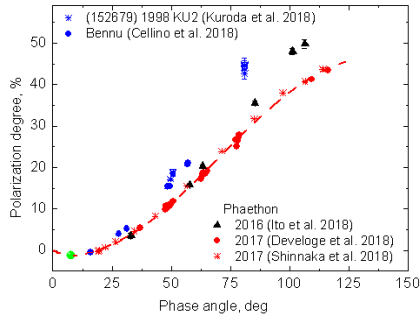


Figure 1: Phase-angle dependence of polarization for Phaethon (red dots) and 2005 UD (green dot).

(155140) 2005 UD. Photometric observations of 2005 UD carried out in 2018 have given the rotation period of 5.237 ± 0.001 hrs (Figure 2) and linear phase-angle coefficient $k_R = 0.043 \text{ mag deg}^{-1}$ in a good agreement with [6,7].

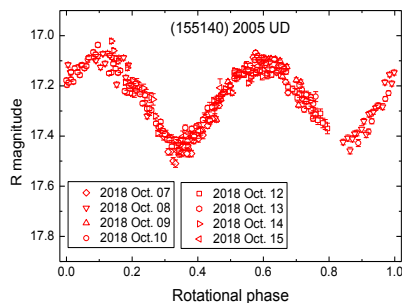


Figure 2: Composite lightcurve of 2005 UD observed in October 2018.

The obtained $B-V$ color lightcurve of 2005 UD showed noticeable variations, which may be due to the surface heterogeneity [6].

Polarimetry of 2005 UD was made at a single phase angle 7.7° on Oct. 9, 2018 (Figure 1). Obtained value of negative polarization is typical for the B-type asteroids.

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