STRANGE ASTEROID (152) ATALA. V. G. Shevchenko[1,2], O. I. Mikhalchenko[1,2], I. G. Slyusarev[1,2], I. N. Belskaya[1,2], A. N. Rublevsky[3], E. A. Sergeeva[3], K. A. Antonyuk[3], N. N. Kiselev[3], [1]Astronomical Institute of V. N. Karazin Kharkiv National University, Sumska Str. 35, Kharkiv 61058, Ukraine, [2]Department of Astronomy and Space Informatics of V. N. Karazin Kharkiv National University, Svobody sq. 4, Kharkiv 61022, Ukraine, shevchenko@astron.kharkov.ua, [3]Crimean Astrophysical Observatory, Nauchnij, Crimea.

Introduction: Albedo values obtained from the WISE and AKARI infrared surveys [1, 2] indicate a presence of the moderate albedo asteroids in the outer part of the main belt where majority of asteroids have low albedo surfaces. In addition, an estimation based on SDSS color indices and albedo [3] suggests up to 30% of moderate albedo asteroids in the outer part of main belt. Since SDSS color indices and radiometric albedo may have rather large observational errors, as it was pointed out in [4, 5], an independent check of the taxonomic classification of such objects should be made. For example, Kasuga et al. [6, 7] performed spectral observations of some high albedo outer-belt asteroids and suggested that the presence of some amorphous Mg pyroxenes or orthopyroxenes might explain the high albedos of their surfaces. At present, a question about the sources of origin of the high albedo asteroids in the outer-belt is still open.

As it was shown in [8, 9], the compositional classification of asteroids can be made using their phase dependence of brightness. The aim of present work is to check the taxonomical classifications of the outer-belt asteroid (152) Atala. Below we present new photometric observations of this asteroid, which allow us to measure its magnitude-phase dependence and to provide an independent check of the taxonomic type of this asteroid.

Observations: The asteroid (152) Atala has an orbit with an eccentricity of 0.079 and semimajor axis of 3.14 AU. The obtained albedo of this asteroid from WISE and AKARI data is 0.22 and 0.27 with the diameter of t 61 km and 57 km, respectively [1, 2]. The visible spectra of the surface of this asteroid has a slope of 10.6 %/10^3 Å and an absorption band at a wavelength of about 0.90 μm, that is characterizing a substance consisting predominantly with pyroxenes, so it was classified as S-asteroid [10]. However, the polarimetric properties of (152) Atala differ from typical ones for the S-type [11] and more close to the A-type [12], which is also referred to moderate albedo asteroids. In addition, on 2006, May 7 at 3.703 UT, the star TYC 5558-01048-1 was covered by the asteroid that was allowed to calculate its diameter at the time of occultation, which is equal to 66.4 km [13]. To estimate the albedo using this diameter, the correct determination of the absolute magnitude at the times of the occultation is needed. Previous photometric observations of (152) Atala were performed in [14-16] to determine its rotational properties.

We made new photometric observations of the asteroid in April-June 2017 during 12 nights to measure the magnitude-phase dependence. The CCD photometry was carried out in the VR bands using the 0.7-m reflector of the Astronomical Institute of V. N. Karazin Kharkiv National University and 1.25-m and 0.5-m reflectors of the Crimean Astrophysical Observatory. We were able to cover both the linear region of the magnitude phase dependence and the area of the opposition effect down to 1.4 degree of the phase angle. The lightcurve variations, that is equal to 0.30 mag, were taken into account.

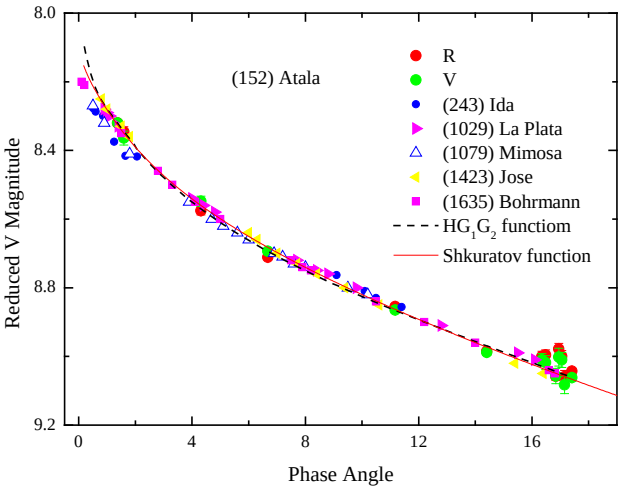

Fig. 1. Magnitude-phase dependence of (152) Atala in the VR bands. The magnitude-phase dependences of Koronis family asteroids (243) Ida [17], (1029) La Plata [18], (1423) Jose [18], and (1635) Bohrmann [18] were plotted for comparison.

Results: The phase dependence of (152) Atala in the two standard bands V and R is shown in Figure 1. We have not found any noticeable differences between the phase curves measured in the V and R bands and have shifted our V and R data in the Figure 1 on the average value of a color index V-R=0.49 mag. The dashed line represents the approximation of the phase dependence of HG_1G_2-function [19, 20] with the parameters: H = 8.055 ± 0.015 mag, G_1 = 0.30 ± 0.03, G_2 = 0.29 ± 0.01. The solid line represents the approxima-

tion of Shkuratov function [21] with the parameters: $H = 8.074 \pm 0.015$ mag, $\tau = 1.87 \pm 0.04$. There are small differences in the values of absolute magnitudes obtained with these approximations, but Shkuratov function gives better fit of the observational data. It should be noted that our estimates of absolute magnitude are different from the value given in the MPC ($H = 8.33$). The linear phase coefficient (0.031 ± 0.002 mag/deg) and the amplitude of the opposition effect (0.36 ± 0.05 mag) have typical values for moderate albedo asteroids. The magnitude-phase dependence of (152) Atala is very similar to the phase dependencies of the Koronis family asteroids (see Figure 1), that are also belonging to the S-type asteroids and located in the outer part of the main belt. Using the value of the linear coefficient and the new calibrated relation between linear coefficient and albedo [8] the albedo of asteroid of 0.21 ± 0.04 was obtained that confirms moderate albedo surface of this asteroid.

Our observations in 2017 were carried out at a similar aspect as in 2006 where the occultation diameter was measured [13]. The occultation profile indicates that this phenomenon occurred at the maximum of the lightcurve. Using the value of the absolute magnitude obtained in this work, we calculated the value of albedo equals to 0.24 ± 0.02, which is in good agreement with the radiometric albedos obtained from the data of the WISE and AKARI satellites [1,2].

Conclusions: The photometric observations of asteroid (152) Atala in April-June 2017 were carried out and the magnitude-phase angle dependence down to the phase angle of 1.4 deg in the V and R bands was obtained. The phase curve is typical for moderate albedo asteroids. It is very similar to the magnitude phase dependences measured for the Koronis family asteroids. We confirmed moderate albedo of (152) Atala based on the phase curve dependence. We also defined accurate absolute magnitude of this asteroid at the time of occultation [13] and calculated occultation albedo equals to 0.24 ± 0.02. All these data confirm that the outer-belt asteroid (152) Atala belongs to the moderate albedo asteroids.

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