PHOTOMETRY OF ASTEROIDS: DETECTION OF THE YORP EFFECT. Yu. N. Krugly[1], N. M. Gaftonyuk[2], J. Durech[3], D. Vokrouhlicky[3], M. Kaasalainen[4], V. G. Shevchenko[1], M. A. Ibrahimov[5], A. L. Marshalkina[5], V.V. Rumyantsev[2], I. E. Molotov[6]. [1]Institute of Astronomy of Kharkiv National University, Kharkiv 61022, Sumska str. 35, Ukraine, krugly@astron.kharkov.ua. [2]SRI "Crimean Astrophysical Observatory", Crimea, Ukraine. [3]Astronomical Institute, Charles University, Prague, Czech Republic. [4]Department of Mathematic and Statistic, Rolf Nevanlinna Institute, University of Helsinki, Finland. [5] Ulugh Beg Astronomical Institute, Uzbek Academy of Sciences, Tashkent, Uzbekistan. [6]Keldysh Institute of Applied Mathematics, Moscow, Russia

Introduction: We present results of photometric lightcurve observations of asteroids carried out with the goal to detect the Yarkovsky–O'Keefe–Radzievskii–Paddack (YORP) effect. For an irregularly shaped asteroid the YORP can change the rotation period and the pole direction [1, 2]. The first detection of the YORP effect has been achieved for two near-Earth asteroids (NEAs): 54509 YORP [3, 4] (with diameter D = 0.1 km) and 1862 Apollo [5] (D = 1.4 km). Our observational program includes both NEAs and main-belt asteroids (MBAs). NEAs are the primary aim because of their close passage to the Earth and the Sun. This gives us a good possibility to observe these small bodies, which can acquire a remarkable change of rotation period caused by YORP effect during short enough time interval of several or tens years. The YORP detection for the NEAs requires enough photometry data to allow shape modeling and pole determination. Our observations include well-investigated NEAs with unusual lightcurves, which imply irregular shapes of the bodies, and they could be good candidates for YORP detection. We also started observations of NEAs with orbital periods close to the Earth's one, named "coorbitals", which can be observed every year in the same season and under the similar observational circumstances. The advantage is that we could acquire lightcurve annualy for several years, a good pre-requisite to detect the period change caused by the YORP effect. Young family members, which are small MBAs with diameters less 10 km and age less than 1 Myr, are also in our program. It has been shown that the observed spin rate and obliquity values of the Koronis family asteroids could be explained by means of the YORP effect [6, 7, 8]. Here we, however, do not expect immediate detection of the YORP effect but to determine rotation state (rotation period and pole distributions) right after disruption of the parent body.

Observations: The CCD-observations have been carried out in standard Johnson-Cousins BVRI photometric system with 70-cm telescope at Chuguev Observing Station (Kharkiv, Ukraine), 1-m and 2.6-m telescopes at Crimean Astrophysical Observatory (Simeiz/Nauchnij, Crimea, Ukraine), 60-cm and 1.5-m telescopes at Maidanak Observatory (Uzbekistan). Images are reduced in the standard way [9]. The photometry is usually done in R band with accuracy 0.02-0.03 mag or better. The primary aim of our lightcurve observations is to determine rotation period of asteroids. An asteroid is observed during each apparition on maximal interval of its visibility to obtain its rotation period with a high precision.

Results: We present results of lightcurve observations of NEAs: 1620 Geographos, 1862 Apollo, 1980 Tezcatlipoca, 3103 Eger, 4954 Eric, 138175 2000 EE104; and young family members: 1270 Datura, 14627 Emilkowalski, and 21509 Lucascavin. The rotation periods, lightcurve amplitudes and reduced magnitudes of these asteroids have been obtained. In result, the YORP effect has been confirmed for 1862 Apollo [10] and newly detected for 1620 Geographos (Durech et al., in preparation). Short details of three of them are presented below.

1862 Apollo. This asteroid is one of two NEAs which lightcurve observations have shown increasing sidereal rotation period that was explained by means of the YORP effect [5]. Our new observations at Kharkiv (70-cm telescope), Simeiz (1-m), and Maidanak (60-cm) in April 2007 have confirmed influence of the YORP effect on the rotation period of Apollo [10]. The composite lightcurve (Fig.1) constructed with period 3.0646 hrs shows an asymmetrical shape with some depression at one of maxima. The amplitude of the asteroid brightness variations is 0.26 mag.

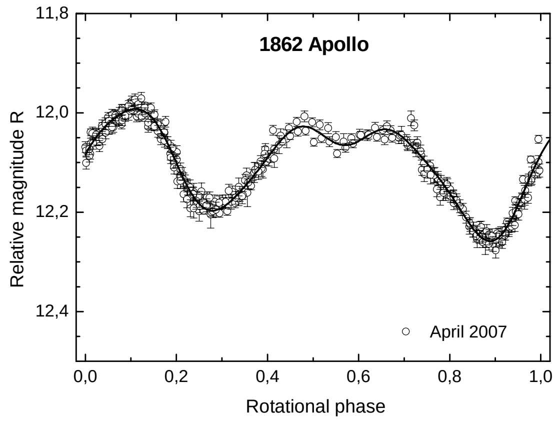

Fig.1. Composite lightcurve of Apollo in April 2007.

1620 Geographos. This Earth-crossing asteroid was well studied during its apparitions in 1972 and 1993/94. We observed Geographos during 7 nights in January-March 2008 at Simeiz and Kharkiv. The composite lightcurve obtained in February 2008 is showed in Fig. 2. The rotation period 5.2224 hrs is determined. Magnitudes are reduced to zero phase angle with parameter G = 0.15. The amplitude of the lightcurve obtained at the phase angle 15 deg is 1.32 mag. With these new data, Geographos' rotation modeling reveals the YORP acceleration of the rotation period (Durech et al., in preparation).

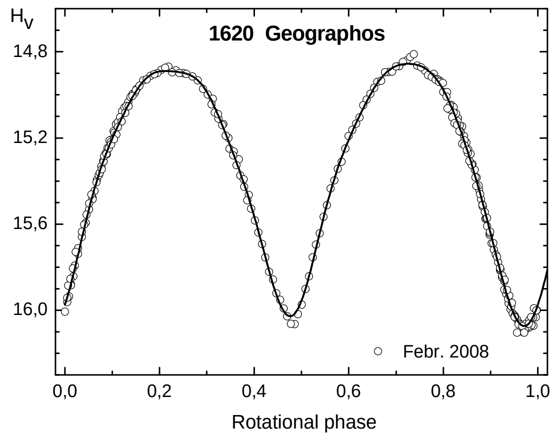

Fig.2. Composite lightcurve of Geographos in February 2008.

14627 Emilkowalski. This asteroid is the biggest member of the young cluster in the main-belt which disrupted more than 200 Kyr ago and it is one of the most recent asteroid breakups discovered in the main belt [11]. Our observations were carried out during January-March 2008. Obtained data allow us to determine the unique rotation period 11.131 hrs. Fig. 3 shows the composite lightcurve of Emilkowalski. Magnitudes are best fitted with phase-relation parameter G = 0.05 and reduced to zero phase angle. The absolute magnitude have been obtained in R-band H_R = 13.38. The amplitude is 0.85 mag, which implies an elongated shape. Future observations are needed at different aspects to determine rotation pole and shape of the asteroid.

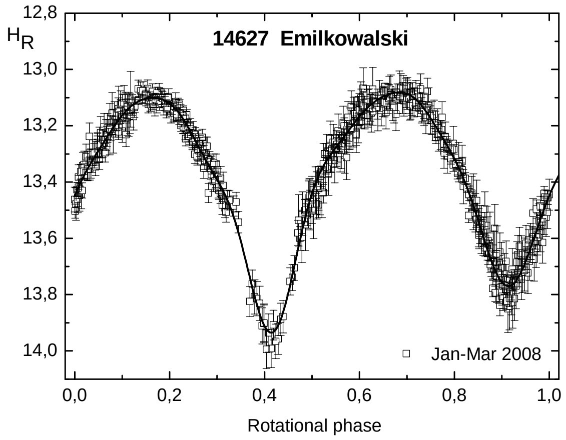

Fig.3. Composite lightcurve of Emilkowalski in January-March 2008.

Conclusions and prospects of future observations: Our work is directed to detection and study of the YORP effect by means of photometric observations of different groups of asteroids: near-Earth and small main-belt asteroids. Observed NEAs 1862 Apollo and 1620 Geographos have been found to show the YORP acceleration of their rotation periods. We expect to detect YORP for other NEAs with unusual lighcurves. The first results of YORP influencing coorbital NEAs are expected in several years of observations. We have started and will continue photometry of young cluster members to study distributions of their rotation periods and poles.

Acknowledgements: The observations at Maidanak Observatory were carried out under the Pulkovo cooperation of optical observers (PULCOO).

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