CCD photometry of selected outer-belt asteroids: Similarity of magnitude-phase dependencies among the Jupiter Trojan, Hilda, and Cybele asteroids

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A majority of asteroids between the main belt and Jupiter distance belong to three large populations: the Jupiter Trojans, and the Hilda and Cybele groups. The first two populations are resonant, moving in the 1:1 and 5:3 mean-motion resonances with Jupiter. The asteroids from the Cybele group include objects with semimajor axes in the range of 3.27 au $< a <$ 3.70 au, i.e., between the 2:1 and 5:3 mean-motion resonances with Jupiter; their inclinations are smaller than 25 deg, and eccentricities $e < 0.3$ (Zellner et al. 1985). We present results from a long-term observational program devoted to the investigation of optical properties of outer-belt asteroids. The CCD photometric observations were carried out in 2007-2013 using the 70-cm reflector of the Chuguevskaya Observational Station of the Astronomical Institute of the Kharkiv National University. The observations were aimed to measure lightcurves of selected objects of these groups as well as their magnitude phase-angle dependencies in a wide range of phase angles, including extremely low phase angles. Up to date, we obtained photometric data for 12 Jupiter Trojans, 12 objects from the Hilda group, and one asteroid from the Cybele group. Some of these objects were observed in several apparitions to obtain phase-angle coverage as detailed as possible. The observed asteroids mainly belong to the P types (5 objects) and the D types (14 objects). One object, (334) Chicago from the Hilda group, is classified as a C-type asteroid (Dahlgren et al. 1997). The obtained data allowed us to determine rotation periods, lightcurve amplitudes, V-R color indexes, magnitude phase slopes, and absolute magnitudes of the observed objects. We found that all measured P- and D-type asteroids show very similar magnitude - phase-angle behaviour. It is characterized by an absence of noticeable nonlinear opposition surge at small phase angles, previously reported for three D-type Trojans (Shevchenko et al. 2012). Only the C-type (334) Chicago has shown a non-linear opposition effect typical for the main-belt C-type asteroids. Magnitude-phase dependencies of the P-type asteroids belonging to the main belt (Harris et al. 1992; Piironen et al. 1994; Shevchenko et al. 1996), Hilda and Cybele groups, and Trojans are found to be indistinguishable within the errors of measurements, typically 0.02 mag. A similarity of magnitude-phase dependencies of objects from different dynamical groups may indicate that they underwent similar surface-evolution processes.

References: Dahlgren M., et al., 1997 Astron. Astrophys. 323. 606–619. Harris A., et al., 1992. Icarus. 95. 115-147. Piironen J., et al., 1994. Astron. Astrophys. Supl. Ser. 106. 587-595. Shevchenko V. G., et al., 1996. Astron. Astrophys. Supl. Ser. 115. 475-479. Shevchenko V. G., et al., 2012. Icarus. 217. 202–208. Zellner B., et al., 1985. Icarus. 62. 505-511.