MAGNITUDE PHASE ANGLE DEPENDENCES OF JUPITER TROJANS AND HILDA ASTEROIDS

I. G. Slyusarev[1], V. G. Shevchenko[1], I. N. Belskaya[1,2], Yu. N. Krugly[1], V. G. Chiorny[1],
[1] Astronomical Institute of Kharkiv Karazin National University, Sumska Str. 35, Kharkiv 61022, Ukraine (i_slyusarev@mail.ru), [2] LESIA, Observatoire de Paris, 5 Place Jules Janssen, 92195 Meudon, France

Introduction: CCD photometry of selected Jupiter Trojans and Hilda asteroids were carried out to investigate their magnitude phase angle dependences in wide range of the phase angles, including extremely low angles. The main goals of our study are (1) to search for differences/similarities in opposition effect behaviour of Jupiter Trojans and Hilda group asteroids; (2) to define more precisely absolute magnitude of these objects and estimate uncertanties in their albedo determinations due to using of the HG-function; (3) to study variability in opposition effect behaviour for objects of various physical and dynamical properties.

Observations: We present preliminary results of photometric observations of 6 Jupiter Trojans and 11 Hilda asteroids carried out in 2007-2011. CCD photometry was made at the 70-cm reflector of the Chuguevskaya Station of the Astronomical Institute of Kharkiv National University. The method of CCD observations and reduction is described in [1,2].

Object	Year	α (deg)	ΔR (mag)
Hillda group			
334 Chicago	2011	0.1 – 13.6	0.35
1038 Tuckia	2010	0.4 – 0.9	0.05
1180 Rita	2007	4.1	0.05
1269 Rollandia	2008	5.3 – 6.3	0.02
1578 Kirkwood	2011	0.4 – 7.3	0.22
1746 Brouwer	2010	0.1–10.4	0.21
1748 Mauderli	2011	3.2 – 13.8	0.10
1754 Cunningham	2001	3.6	0.08
3134 Kostinsky	2008	8.2 – 8.5	0.40
3990 Heimdal	2011	1.5–12.7	0.05
9829 Murillo	2009	0.4	0.30
Trojans			
2207 Antenor	2011	0.2 – 10.1	0.22
2357 Phereclos	2011	0.3 – 8.2	0.12
3451 Mentor	2010	8.3 – 9.8	0.55
4063 Euforbo	2011	12.1 – 12.3	0.21
5511 Cloanhus	2010	2.3 – 2.9	0.07
12929 1999 TZ1	2010	8.7– 11.6	0.08

The observations were carried out mainly in the V and R photometric bands of the standard Johnson-Cousins photometric system. Several observations of each object were also performed in the B band to define B-V colors. We present in Table 1 the list of observed objects, the year of our observations, the range of observed phase angles, and the maximal lightcurve amplitude measured during our observing run.

Discussion: New magnitude phase dependences of the Hilda asteroid (1748) Mauderli and the Trojans (2207) Antenor and (2357) Phereclos are shown in Fig.1. We present the magnitude phase dependences of these objects in comparison with previously published data for 3 Trojans and one Hilda asteroid (see [2,3] for details). The data of each object were shifted in the magnitude scale for the best match (Fig.1). The linear phase slope is varied between individual objects from 0.034 to 0.044 mag/deg. We have not found systematic difference in the linear phase slope between the P type and D type asteroids.

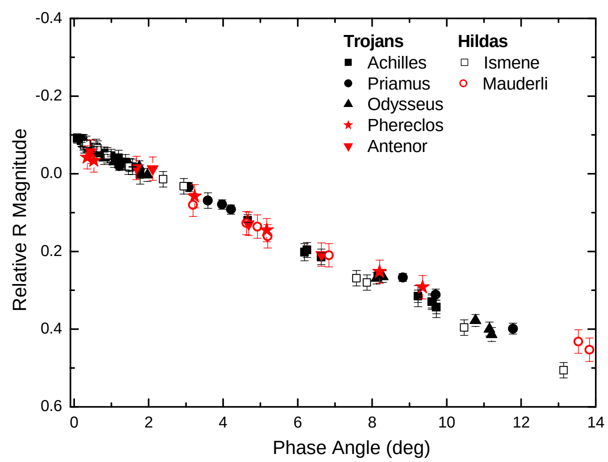

Figure 1: Phase functions of Trojans and Hilda group asteroids. Black symbols indicate previously published data from [2,3]. Our new measurements are shown by red symbols.

All objects, both Trojans and Hildas, show rather similar magnitude phase angle behaviour with an absence of noticeable nonlinear opposition surge at small phase angles. Such magnitude phase angle behaviour is different from majority small Solar system bodies showing non-linear phase curve behaviour close to opposition. An absence of opposition surge can be explained by very dark surfaces of these objects for which only single light scattering is important [2].

A linear magnitude phase angle behaviour at small phase angle was found for all measured so far Trojans and Hilda asteroids. This result should be taken into account in calculation of absolute magnitude of these objects.

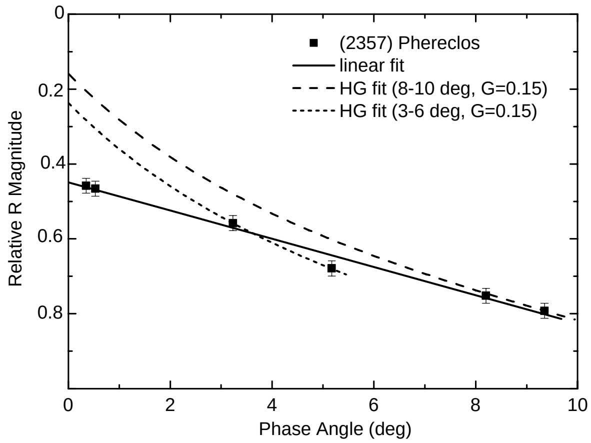

Figure 2: Example of the HG fit with the fixed G=0.15 to the observations of (2357) Phereclos. The absolute magnitude H is estimated using the observations at 8-10 deg (dashed line) and at 3-6 deg (dotted line).

Using the HG function to determine absolute magnitude of Trojans and Hildas results in systematic overestimates of H values. It can influence albedo determination of these objects. Albedos of Trojans [4] and Hildas [5] in the NEOWISE survey were calculated using absolute magnitudes from the MPC catalogue. These magnitudes are typically determined by the HG function fit to few magnitude measurements assuming G=0.15. An example of such fit to the observations of (2357) Phereclos is shown in Fig.2. We used two magnitude measurements at smaller (3-6 deg) and larger (8-10 deg) phase angles to calculate absolute magnitude H in the assumption of G=0.15. The calculated H values are at least 0.2 mag brighter as compared to the real magnitude very close to opposition. Such overestimates of absolute magnitudes of Trojans and Hildas can result in systematically higher albedo estimations of these objects.

Conclusions: Preliminary results of photometric observations of 6 Jupiter Trojans and 11 Hilda asteroids are presented. The detailed magnitude phase dependences in the wide range of phase angles were obtained for the Hilda asteroid (1748) Mauderli and the Trojans (2207) Antenor and (2357) Phereclos. All three objects show linear magnitude phase angle dependences with an absence of noticeable nonlinear opposition surge at small phase angles. These data increased the number of Trojans and Hildas with well-measured phase curves to 5 and 2, respectively. A linear magnitude phase angle behaviour at small phase angle was found for all measured so far Trojans and Hilda asteroids. This result should be taken into account in calculation of absolute magnitude of these objects. Using the HG function to determine absolute magnitude of Trojans and Hildas results in systematic overestimates of H values.

References: [1] Krugly Yu.N. et al. (2002) *Icarus* 158, 294-304. [2] Shevchenko V.G. et al. (2012) *Icarus* 217, 202–208. [3] Shevchenko V.G. et al. (2008) *Icarus* 196, 601–611. [4] Grav T. et al, (2011) *Astroph. J.* 742, 1, 40-50. [5] Grav T. et al. (2011) *Astroph. J.* 744, 2, 197.