PHASE FUNCTION OF BRIGHTNESS OF NEA 1627 IVAR. A. Rikhtehgar, and F. P. Velichko, Institute of Astronomy of Kharkiv National University, 35 Sums'ka Str., 61022, Kharkiv, Ukraine (a.emailbox@yahoo.com).

Introduction: Asteroid 1627 Ivar belongs to NEAs of Amor group, and is classified as S taxonomic type with albedo 0.15 [1], and has equivalent diameter about of 9 km [2]. According to results of photometric observations during its previous approches to Earth, it was found that asteroid has the rotation period about of $4^h.795$ [3], lightcurve amplitude range $0^m.27–1^m.55$ [4,5] and pole coordinates $\lambda_\circ$=333º and $\beta_\circ$=43º [3].

Observations: Our observations were carried out with the 0.7-m reflector of Institute of Astronomy of Kharkiv Karazin National University. We had used CCD cameras ST-6UV and FLI 47-10 equiped by standard BVRI filters. The measurements of the asteroid brightness were obtained during January-February, 1997; May, 2005; and November, 2008 [5].

The photometric observations of Ivar were made at the phase angle ranging from 0º.57 to 31º.26. This has given us a possibility to obtain magnitude-phase dependence of the asteroid in the part of opposition effect of brightness (heretofore there are three NEAs observed at α<1º, only [6]).

Phase curve: The employment of a fact that the observations on 1997 and on 2005 were obtained at very close aspect angles ζ≈130º, and adding the published data at the same aspect on 2000 [3], we have obtained the composite magnitude-phase dependence of NEA 1627 Ivar in V-band (see Fig. and [5]).

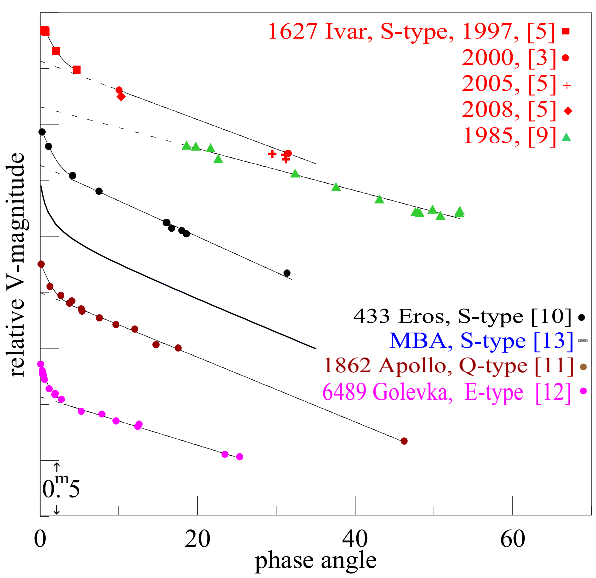

Fig. Magnitude-phase dependences of 1627 Ivar, NEAs and S-type MBAs in standard V-band.

The parameters of magnitude-phase dependences of the asteroid 1627 Ivar at two different geometries of view are presented in Figure and in Table. At the aspect angle of about 130º (red symbols in Figure) the linear part of the dependence is characterized by phase coefficient β_V=0.026±0.003, and $V_\circ(1,0)=12^m.94$. The derivied phase coefficient is close to β_V=0.024±0.002 obtained for near equatorial geometry of asteroid view on 1990 opposition [7], and a bit larger than β_V=0.022±0.001 obtained on 1985 one (green symbols and [8,9]). The mentioned discrepancy is possibly connected with the following: magnitude-phase dependence on 1985 apparition is based on a mean brightness of asteroid, while significant changes of lightcurve amplitude observed ($0^m.30–0^m.65$), and a geometry of view changed too (ζ≈20º–75º); phase angle observed was a far from zero α>18º; for the apparitions on 1997, 2000 and 2005 were observed a more south hemisphere of the asteroid's surface, and for 1985 apparition – a more north one. As a result the phase dependences of these areas of asteroid surface are different and, probably, optical properties of the areas are different, too. This amazing image calls with suggestions voiced in [4].

Table

Parameters of magnitude-phase dependences.

Asteroid	Type	β_V	a	b	V(1,0)	Ref.
1627 Ivar	S	0.026	0.57	0.02	12.99	5
1627 Ivar	S	0.022	-	-	13.29	9
433 Eros	S	0.031	0.51	0.03	10.76	10
1862 Apollo	Q	0.028	0.36	0.02	16.51	11
6489Golevka	E	0.022	0.40	0.01	19.17	12
MBA	S	0.030	0.50	0.03	-	13

The parameters of HG-function [14] of the magnitude-phase dependence are $H=12^m.61$ and G=0.25 for a more south aspect. The obtained parameters considerably deviate from ones, which were calculated on 1985 opposition H=13.24, G=0.65 [9].

For more precise approximation of the phase dependence of brightness at small phase angles we use a simple three-parameterical empirical function of Shevchenko [13]. The approximation gives the following values: $V(1,0)=12^m.99$, parameter characterizing the opposition effect amplitude a=0.57 and parameter describing the linear part of the dependence b=0.025 (see Table). The values of a and b correspond with average ones of the S-type asteroids.

In Figure we have collected the phase dependence of three NEAs, which became known until the present [10-12], and the average phase function of S-type main belt asteroids (MBA) [13]. As one can see, there isn't difference in values of parameters between phase dependence of S-type NEA 433 Eros and MBAs. They are very close to values of S-type NEA 1627 Ivar. In the same time, phase dependence of Q-type NEA 1862 Apollo is close to S-type one at linear part (slope β_v=0.028), and noticeably differs in the range of opposition effect of brightness (see parameter **a** in Table). Comparison with high-albedo E-type NEA 6489 Golevka shows that its phase function differs from asteroid with moderate albedo (S and Q types) both in the linear part, and in the range of opposition effect (see parameter a and b in Table).

Conclusions: The magnitude-phase dependence of NEA 1627 Ivar obtained from observations of a more south hemisphere of the asteroid's surface in the range of phase angle from about of 0º.6 to 31º.6 shows a well-pronounced opposition effect of brightness. Slope of phase dependence is represented by the phase coefficient β_v=0.026±0.003. The parameters of opposition surge of brightness and the value of linear phase coefficient are typical for S-type asteroids. The slope of the phase function a little differs from β_v obtained on a more north geometry of view of asteroid's surface. It is possibly connected with different optical properties of north and south hemispheres of asteroid 1627 Ivar.

Acknowledgment: This work was partially supported by Poland Grant KBN 2P03 D 002 22.

References: [1] Binzel R. et.al. (2004) *Icarus* 170, 259-294. [2] Ostro et.al (1990) *Astron.J.*99, 2012-2018. [3] Kaasalaine M. et. al. (2004) *Icarus* 17, 178-196. [4] Hoffmann M. et. al. (1990) *Acta Astronimica* 40, 389-396. [5] Velichko F. et. al. (2009) Book of Abstract of Intern. Conf. 'Astroid and Comet Hazad-2009', Russia, St. Petersburg, Sep. 21-25, 2009. P. 47-51. [6] Belskaya I. et. al. (2000) *Icarus* 147, 94-105. [7] Chernova V. et. al. (1995) *Astron. .J.* 110, 1875-1878. [8] Lupishko D. et. al. (1986) *Kinem. Fiz. Neb. Tel.* 2, 39-43. [9] Hahn G. et. al. (1989) *Icarus* 78, 363-381. [10] Krugly N. et. al. (1999) *LPSC XXX*, N1595. [11] Harris A. et. al. (1987). [12] Mottola S. et. al. (1997) AJ, 114, N3, 1234-1245. [13] Shevchenko V. (1997) *Solar System Res.* 31, 219-224. [14] Bowell E. et. al. (1989) In *Asteroids II* (R. Binzel, T. Gehrels and M. Matthews, Eds.), pp.524-556. Univ. of Arizona Press, Tucson, USA.