**THE DIVERSITY OF THE OPPOSITION EFFECT OF DARK ASTEROIDS.** V. G. Shevchenko[1], I. N. Belskaya[1], I. A. Tereschenko[1], [1]Astronomical Institute of Kharkiv Karazin National University, Sumska Str. 35, Kharkiv 61022, Ukraine, shevchenko@astron.kharkov.ua, irina@astron.kharkov.ua

**Introduction:** The brightness behavior in the range of the opposition effect (OE) is found to be different for low, moderate and high albedo asteroids [1]. Maximal amplitude of the OE occurs for moderate albedo S and M-type asteroids. It can be explained by the combined influence of main physical mechanisms such as shadow hiding and coherent backscattering. Low albedo asteroids display the smallest amplitudes of opposition effect and the largest dispersion of them as compared to moderate and high albedo asteroids (Fig. 1).

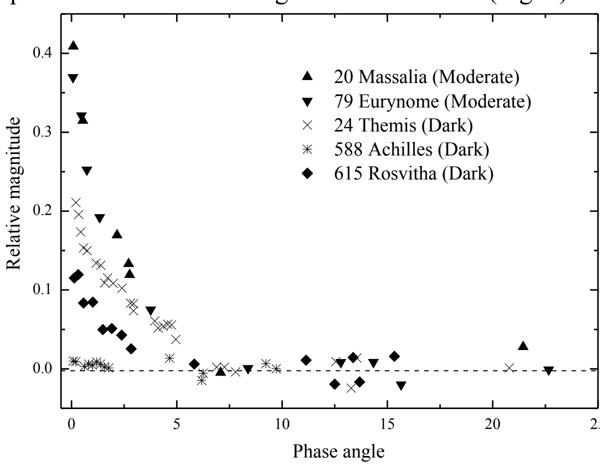


Fig. 1. Opposition effect of dark asteroids in comparison to moderate albedo ones

Some dark asteroids display a broad opposition effect with rather large amplitude (for example, 24 Themis, [2]), others appear a sharp increasing of brightness at phase angles <1 deg (419 Aurelia, [3]), and in some cases the behavior of brightness is practically linear down to subdegree phase angles (for example, 588 Achilles, [4]). What is the reason of observed differences? To investigate this question we carried out the special program devoted to detailed observations of the magnitude phase dependence of low albedo asteroids both in the linear part at phase angles up to 20-25 deg and in a region of the opposition effect including very small phase angles <1 deg [3-6]. Together with our observations and available observations of other authors, the sample of low albedo asteroids with well-measured phase curves increased to 33 asteroids. The albedos of the data set are in the range of 0.036-0.11. Here we present the preliminary results of analysis of the opposition effect behavior for low albedo main belt asteroids.

**Results and discussion:** We have determined the amplitude of OE according to [1] for 33 low albedo asteroids and performed the search of its possible correlations with different physical (albedo, diameter, color indexes, spectral slope and others) and dynamical (semiaxis, inclination, eccentricity and others) characteristics. The histogram of distribution of the OE amplitudes are shown in Fig. 2. The distribution has more complicated form than Gaussian one thouth a center of the distribution close to 0.13 mag. A simple average value for all data set is 0.13 mag. It can be considered as the mean value of the OE amplitude for low albedo asteroids.

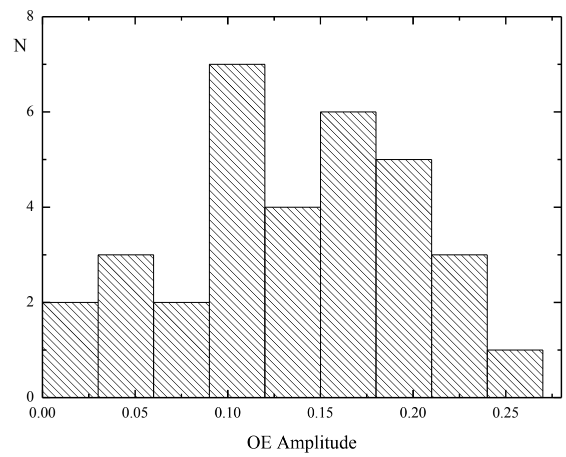


Fig. 2. Distribution of the OE amplitude for dark asteroids

About 15% asteroids in the considered sample show very small (less than 0.04 mag) values of the OE amplitude. It seems that the shadow hiding mechanism is the only one responsible for the opposition of these objects.

We found correlation of the OE amplitude of low albedo asteroids and their color index s-b [7] (Fig. 3). The OE amplitude tends to increase with an increasing of the color index, or in other words, with the increasing of the spectral slope in the UV part of spectrum. The existing of such a correlation can be explained by assuming an increase of a portion of light substance in the surface layer of asteroids, which can cause both the increasing of the opposition brightening and the spectral slope.

We found also correlation of OE amplitude and albedo [8,9] (fig. 4). Amplitude of the OE tends to increase with albedo which is opposite to trend expected for shadow hiding mechanism. It gives an evidence that another mechanism is responsible for nonlinear increase in magnitude for dark asteroids. We assume that an increase of a portion of light substance in the surface layer of dark asteroids causes increasing contribution of the coherent backscattering mechanism in the forming of OE.

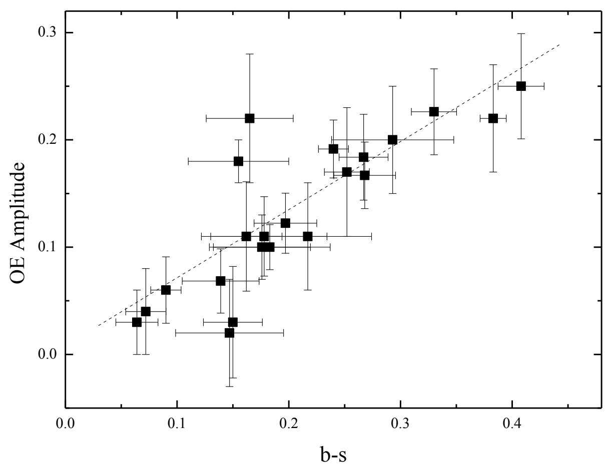


Fig. 3. Dependence of the OE amplitude on the color index s-b

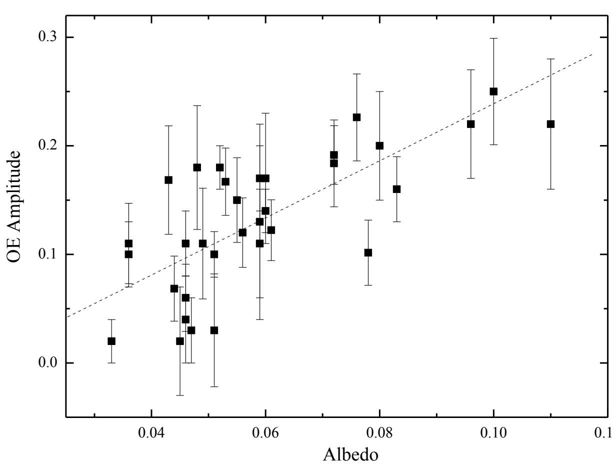


Fig.4. Dependence of the OE amplitude on the albedo

For nine asteroids from our dataset magnitude-phase relations were measured in four or five standard spectral bands (UBVRI) to check possible wavelength dependence of the OE [4-6, 10-12]. The OE amplitudes determined at different wavelengths relatively to the V band amplitude are shown in Fig.5. Although variations of the OE amplitude with wavelength were found to be rather small there is a slight trend to their decrease with increasing wavelength. We fitted by the linear function the wavelength dependence of the OE amplitude and found the coefficient to be -0.051 mag/µm.

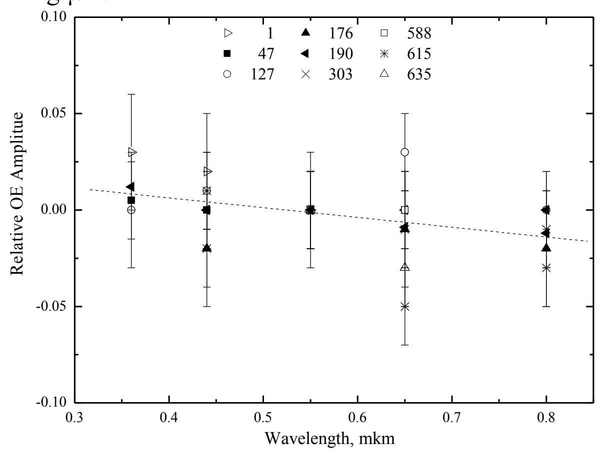


Fig. 5. Dependence of the OE amplitude of selected asteroids on wavelength

**Conclusion:** Analisys of the OE of dark asteroids has shown that the observed differences in their OE amplitudes are connected first of all with differences in their albedo even though they are small. Asteroids with albedo of ~0.05 and ~0.08 show definitely different amplitudes of the opposition brighthening. It seems that other factors play secondary role. We assume that an increase of a light substance in the surface layer leads to increasing contribution of the coherent backscattering mechanism. For the darkest objects with albedo less than 0.05 opposition surge do not observed assuming an absence of contribution of any additional mechanism excepd shadow hiding. Mean amplitude of the OE for dark asteroids is foundto be 0.13 mag and the mean linear phase coefficient is 0.044 mag/deg. These values can be used for prediction of the absolute magnitudes of low albedo asteroids.

**References:** [1] Belskaya I. N., Shevchenko V. G. (2000) *Icarus 146*, 490-499. [2] Harris A. W., et al. (1989) *Icarus 77*, 171-186. [3] Belskaya I. N., et al. (2002). *In Proceedings of ACM 2002*, 489-491. [4] Shevchenko V. G., et al. (2009) *LPSC XL*, Abstract #1391. [5] Shevchenko V. G., et al. (2008) *Icarus 196*, 601-611. [6] Tereschenko et al., (2008). *In Abstracts of The Solar System bodies: from optics to geology.* 117-118. [7] Zellner B., et al. (1985) *Icarus 61,* 355-416. [8] Tedesco E. F., et al. (2002) *Astron. J. 123,* 1056-1085. [9] Shevchenko V. G., Tedesco E. F. (2006) *Icarus 184*, 211-220. [10] Chernova G. P., et al. (1991) *Kinem. Fiz. Nebesn. Tel. 7, No. 5*, 20-26. [11] Tedesco E. F., et al. (1983). *Icarus 54,* 23-29. [12] Toth I. (1997). *Planet. Space Sci. 45*, 1525-1637.