ANALISYS 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).

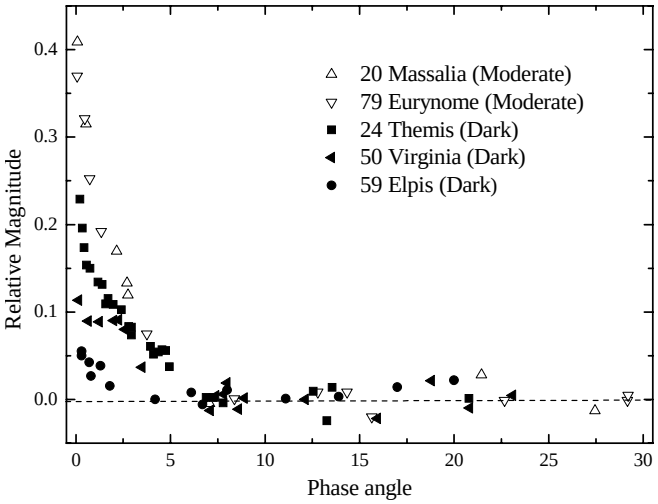

Fig. 1. Opposition effect of dark asteroids in comparison to moderate albedo ones

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, 59 Elpis, [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. As a result of this program, we have obtained the magnitude- phase relations for ten asteroids [3, 5]. Together with our previous observations [3, 4, 5, 6] and available observations of other authors, the sample of low albedo asteroids with well-measured phase curves increased to 31 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 31 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 and its Gaussian fit are shown in Fig. 2. The maximum of distribution is 0.13 mag characterizing a simple average value for all data set. It can be considered as the mean value of the OE amplitude for low albedo asteroids.

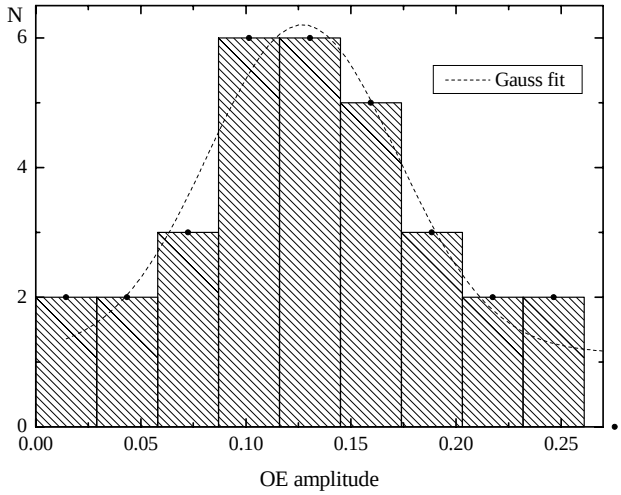

Fig. 2. Distribution of the OE amplitude for dark asteroids

About 25% asteroids in the considered sample show extreme values of the OE amplitude both very small (less than 0.05 mag) and considerably large (more than 0.2 mag). It is possible that the opposition effect can be formed only by the shadow hiding mechanism alone for the objects with very small OE amplitude.

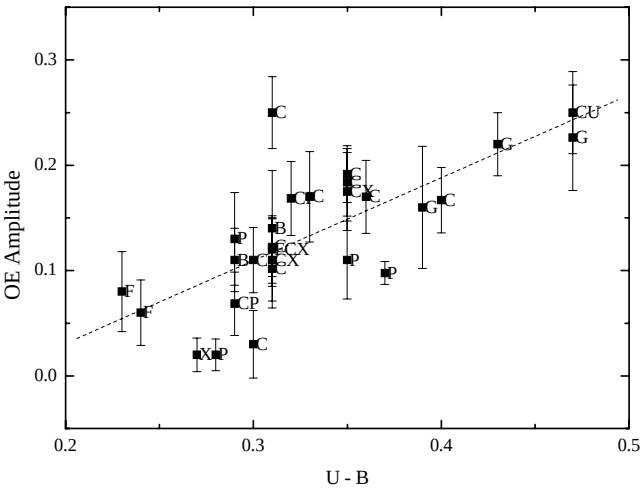

Fig. 3. Dependence of the OE amplitude on the color index U-B

We found correlation of the OE amplitude of low

albedo asteroids with their color index U-B (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 OE effect and the spectral slope. An albedo of such surfaces changes slightly to be measurable within the available accuracy that is why the correlation of the OE amplitude and albedo is not seen.

For five asteroids [5, 7, 8] from our dataset magnitude- phase relations were measured in four or five standard spectral bands (UBVRI). We determined the OE amplitudes for these asteroids at different wavelengths. Although single asteroids show the different OE amplitudes, as a whole the OE amplitude shows a small tendency to decrease with wavelength (Fig. 4). This fact needs to be studied in more detail.

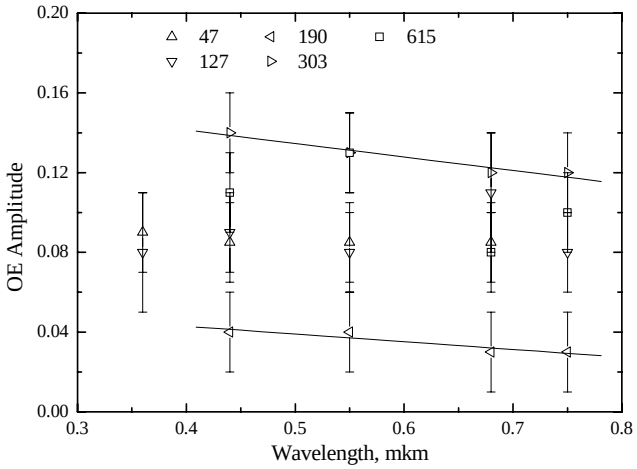

Fig. 4. Dependence of the OE amplitude of selected asteroids on wavelength

Conclusion: As a result of our investigation of the brightness behavior of dark albedo asteroids, we have shown that the mean amplitude of OE is 0.13 mag. About 25% of the measured asteroids are characterized both by very small (<0.05 mag) and by rather large (>0.2 mag) opposition effect amplitudes. The opposition effect can be formed only by shadow hiding mechanism for the objects with very small OE amplitude. An increase of the OE amplitude with increasing of the U-B color index is found. It can be explained by a presence of a small portion of light substance in the surface layer led to an increasing contribution of the coherent backscattering mechanism in the forming of OE. The OE amplitude of dark asteroids has a tendency to decrease with wavelength.

References: [1] Belskaya I. N., and 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 Asteroids, Comets, Meteors 2002*, 489-491. [4] Shevchenko V. G., et al. (1996) *Astron. Astrophys. Suppl. Ser. 115*, 1-6. [5] Shevchenko V. G., et al. (2008) *Icarus*, accepted. [6] Shevchenko V. G., et al. (1997) *Planet. Space Sci. 45*, 1615-1623. [7] Chernova G. P., et al. (1991) *Kinem. Fiz. Nebesn. Tel. 7, No. 5*, 20-26. [8] Toth, I. (1997). *Planet. Space Sci. 45*, 1525-1637.