# UNSOLVED QUESTIONS IN OPPOSITION EFFECTS OF ASSBs: FUTURE COOPERATIVE PROGRAM "64 ANGELINA 2010".

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**Introduction:** The spectacular effect of coherent backscattering (or weak localization) of electromagnetic waves by discrete random media was predicted in [1] and has been the subject of active theoretical and laboratory researches for the past two decades. Among the most salient manifestations of coherent backscattering are the brightness opposition effect (BOE) and the so-called polarization opposition effect (POE) [2]. Long-term astronomical observations do allow one to identify, for the first time, a representative class of high-albedo ASSBs with unique opposition properties [3]. This class includes E-type asteroids 44 Nysa and 64 Angelina, the planetary satellites Io, Europa, Ganymede, and Iapetus, and the A and B rings of Saturn. Nevertheless, photometric and polarimetric observations of different ASSBs at the smallest phase angles remain sparse and therefore the detailed behavior of brightness and polarization is still poorly known. A unique small phase angle of asteroid 64 Angelina are expected in January 2010. The aim of this work to pay attention of astronomers to the unsolved problems in opposition effects of ASSBs and to organize the cooperative photometric and polarimetric program for observations of asteroid 64 Angelina in January–February 2010.

**Main results of previous observations of ASSBs:** It was found that the phase curve of brightness of high-albedo ASSBs exhibit a strong and unusually narrow opposition spike at small phase angles (see [3] and references therein). For these objects, the negative polarization branch has a bimodal shape, namely a narrow minimum of negative polarization located near opposition which is superimposed on a broad regular negative polarization branch. For some of these objects it was shown that parameters of the polarization opposition effect as well as the regular negative polarization branch depend on the wavelength of scattered light [4, 5, 6].

**Unsolved questions and demands to planned observations:** There are a number of unsolved questions which are extremely important for the development of light scattering theory on regolith surfaces. The most important of their are:

1. What are exact profiles for the brightness and polarization opposition effects?
2. What are exact parameters for the brightness and polarization opposition effects?
3. What are the color dependences for the brightness and polarization opposition effects?
4. Simultaneous existence of the POE and BOE and comparability of their angular semi-widths are in agreement with the predictions of the coherent backscattering theory. Nevertheless, it should be found are any differences between the observational and theoretical characteristics of the brightness and polarization opposition effects.
5. Of fundamental importance is an investigation of the spectral dependences of the parameters of the BOE, POE, and regular negative polarization branch. The main results of previous photometric and polarimetric observations at small phase angles were obtained in the visible spectral region. Therefore it is desirable to carry out observations of ASSBs in wide spectral domain from 0.3 to 2.2 μm.
6. Accuracy of photometric and polarimetric observations should be not worse than $0.01^m$ and 0.03% respectively.

The last demand raises a question on selection of the photometric and polarimetric standards.

Such observations are virtually absent up to now. In order to clarify the above-mentioned scientific questions we have to study the most suitable ASSBs. Asteroid 64 Angelina provides an excellent opportunity. Its ephemeris (JPL's HORIZONS SYSTEM) is given in Table 1. On January 29.6, 2010 the asteroid reaches its minimum phase angle of 0.04°. The asteroid will be observable in the northern and southern sky.

Table: Ephemeris of 64 Angelina in opposition 2010

| Date | | RA | | Decl. | | r | Δ | Phase | m |
|---|---|---|---|---|---|---|---|---|---|
| M | D | h | m | ° | ′ | AU | AU | ° | mag |
| 1 | 20.0 | 08 | 56.9 | 17 | 21.7 | 2.34 | 1.37 | -4.98 | 10.2 |
| 1 | 22.0 | 08 | 55.1 | 17 | 27.7 | 2.34 | 1.37 | -3.96 | 10.1 |
| 1 | 24.0 | 08 | 53.3 | 17 | 33.9 | 2.34 | 1.36 | -2.93 | 10.1 |
| 1 | 26.0 | 08 | 51.4 | 17 | 40.0 | 2.34 | 1.36 | -1.88 | 10.0 |
| 1 | 28.0 | 08 | 49.5 | 17 | 46.2 | 2.34 | 1.36 | -0.84 | 10.0 |
| 1 | 29.6 | 08 | 47.6 | 17 | 52.6 | 2.34 | 1.36 | 0.04 | 9.9 |
| 1 | 30.0 | 08 | 47.6 | 17 | 52.6 | 2.34 | 1.36 | 0.21 | 9.9 |
| 2 | 01.0 | 08 | 45.7 | 17 | 58.4 | 2.34 | 1.36 | 1.26 | 10.0 |
| 2 | 03.0 | 08 | 43.8 | 18 | 04.2 | 2.34 | 1.36 | 2.30 | 10.1 |
| 2 | 05.0 | 08 | 41.9 | 18 | 10.2 | 2.34 | 1.36 | 3.35 | 10.1 |
| 2 | 07.0 | 08 | 40.0 | 18 | 15.7 | 2.34 | 1.37 | 4.38 | 10.2 |
| 2 | 09.0 | 08 | 38.2 | 18 | 21.1 | 2.34 | 1.37 | 5.40 | 10.2 |

**Instead of conclusion:** We propose a coordinated program for investigations of asteroid 64 Angelina in opposition 2010. Observational as well as theoretical aspects of investigation of the asteroid in the frame of this program will be discussed.

**References:** [1] Watson K. (1969) *J. Math. Phys. 10,* 688. [2] Mishchenko M. (1993) *ApJ 411,* 351-361. [3] Mishchenko M. et al. (2006) *Applied Optics 45, № 18*, 4459-4463. [4] Rosenbush V., and Kiselev N. (2005) *Icarus 179*, 490-496. [5] Rosenbush V. et al. (2006) *JQSRT 100*, 325-339. [6] Rosenbush V. et al. (2008) *Abst. Conference "200 years of Kharkov astronomy".*