

Asteroid photometry: Phase-angle effects

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We review available observational data on magnitude phase-angle dependencies of asteroids. The number of asteroids, for which good quality phase curves were measured, increases very slowly. At present, the data-set on magnitude-phase dependencies with a good phase-angle coverage and small scatter includes less than one hundred asteroids. Most part of these data is related to the ground-based observations of main-belt asteroids and covered the phase-angle range from 0.3–0.5 deg to 20–25 deg. The phase curves in the wider phase-angle range up to 120–140 deg were measured for ten asteroids observed by space missions and for several near-Earth asteroids. Ground-based and space-based observations are generally mutually consistent. For most of the observed phase-angle ranges, asteroid magnitude phase curves are found to be linear with a noticeable deviation at phase angles smaller than 5–7 deg due to the opposition effect and at phase angles larger than 70–80 deg due to the influence of large-scale surface features. The differences in the phase curves at large phase angles and their influence on the phase integral have not yet been thoroughly investigated. The measured linear phase coefficients of asteroids are in the range of 0.02–0.05 mag/deg. The opposition-effect amplitudes determined relatively to the extrapolation of the linear part of the phase curve do not exceeds 0.4 mag. Relatively small variations of asteroid phase curve parameters require accurate photometric observations and thorough account for lightcurve amplitude to distinguish phase-angle effects. The measured magnitude phase dependencies revealed essential differences in magnitude phase-angle behavior for asteroids of different surface composition both in the linear part and in the opposition effect range (Harris et al. 1989, Belskaya and Shevchenko 2000, Shevchenko et al. 2012). Maximal amplitude of the opposition effect occurs for moderate-albedo S- and M-type asteroids. Low-albedo asteroids display a greater diversity in the magnitude phase-angle behaviors from broad opposition effect to an absence of non-linear opposition brightening. About 20 % of all studied low-albedo asteroids revealed practically linear phase-angle dependencies down to subdegree phase angles. The parameters characterizing magnitude phase curves, such as the phase coefficient, amplitude, and width of the opposition effect, are generally very similar for asteroids belonging to the same composition type. We will discuss the main features of magnitude phase curves for each composition type and the relationships between phase-curve parameters and physical properties of asteroids.

References: Belskaya, I. N., Shevchenko, V. G. 2000. *Icarus* 146, 490–499; Harris, A. W., et al. 1989. *Icarus* 81, 365–374; Shevchenko, V. G., et al. 2012. *Icarus* 217, 202–208.