

POLARIZED LIGHT SCATTERED FROM ASTEROID SURFACES. IX. CONCLUSION: PHOTOPOLARIMETRIC SYSTEM OF ASTEROIDS. L. F. Golubeva and D. I. Shestopalov, Shemakha Astrophysical Observatory, Shemakha AZ-5626 Azerbaijan, (shestopalov_d@mail.ru), (lara_golubeva@mail.ru).

There is a group of interdependent optical characteristics of asteroidal regolith, which we propose to call a photopolarimetric system of asteroids.

This story began in 1917 when Louis Bell concluded that a phase coefficient, b , derived from asteroid photometric function, could be applied to evaluate a geometric albedo of asteroids [1]. The logic of his reasoning was as follows. A body having a smooth surface, each element of which scatters the incident light equally in all directions, will have a phase coefficient independent on a surface albedo. On the contrary, rough, heavily textured surface, like that of the atmosphereless bodies of the Solar System, would have a smaller geometric albedo because the surface irregularities cast multiple shadows. This effect in modern terms is called darkening at the limb of the visible disk of planet. He also assumed that if the normal albedo of local areas on the planetary surface is sufficiently high, then the effect of the shadows on the geometric albedo of the body will be smaller, as the shaded areas of the surface will be illuminated by scattered radiation from neighboring illuminated areas. Since the phase coefficient can be regarded as some measure of "a level of shadowing" then, *ceteris paribus*, the lesser shadowing of the surface, the higher geometric albedo, and the lesser the phase coefficient. Using the known data on the geometric albedo and phase coefficients in the visible spectral region for the first four asteroids, Mercury and the Moon, as well as the results of his own photometric experiments with an artificial planet, L. Bell found an empirical relationship between the phase coefficient and the geometric albedo. Thus in historical retrospect, L. Bell was the first to substantiate an indirect method for determining the geometric albedo of asteroids.

For a long time, Bell's ideas were not in demand, so far as the photographic method of asteroid observations did not provide sufficient accuracy for determining the phase coefficient. Only in 1996, V. G. Shevchenko established a sufficiently accurate correlation between the characteristics under discussion, attracting the radiometric albedo of asteroids p_V from the IRAS satellite and the modern data of the high-precision photometric observations of asteroids to calculate b [2]. It is noteworthy that the correlations found by the investigators show a very nice resemblance (Fig. 1).

Subsequently, we confirmed the correlation between b and the maximum degree of negative polarization $|P_{min}|$ that was previously found for asteroids [3, 4].

We also established new relationships between b and other parameters of negative polarization curve, that is

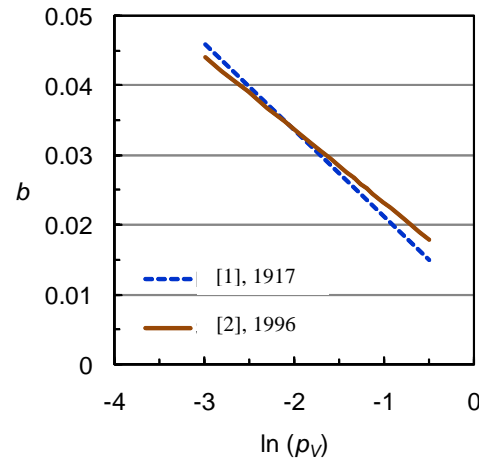


Fig. 1. Regression lines on the plot "the phase coefficient – geometric albedo", derived for asteroids by L. Bell and V.G. Shevchenko in 1917 and 1996 yrs, respectively.

the inversion phase angle α_i (where polarization degree changes sign from negative to positive), the phase angle α_{min} at which P_{min} arises, and the slope h of the polarimetric curve at the inversion angle [4]. It is easy to verify that there is a correlation between b and the parameter G of the Bowell-Lumme photometric function [5]. Since the parameter G is associated with the phase integral, we can estimate the spheric albedo A_V of the asteroid if its phase coefficient is known (Fig. 2).

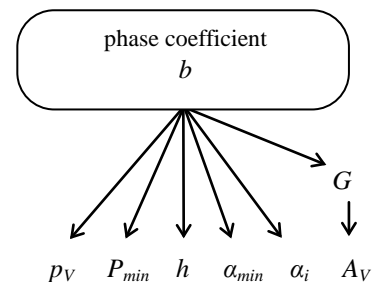


Fig. 2. Interlink between the phase coefficient and various optical characteristics of asteroids.

Thus, knowledge of only the phase coefficient of an asteroid allows us to estimate with reasonable accuracy its geometric and spheric albedo, as well as all the parameters of the phase branch of negative polarization

and, as a pleasant bonus, the diameter of the asteroid. In addition, there is a non-linear interrelation between the amplitude of opposition surge in brightness, a_{BOE} , and the geometric albedo of asteroids [2] as well as the linear correlation between a_{BOE} and the inversion angle of asteroid phase-dependent polarization curves [6].

This set of relationships between the optical characteristics of minor planets we called the photopolarimetric system of asteroids. The interrelations between b and the aforesaid optical parameters help to relate the asteroid to one of the most common optical types E, S, M or C. It is interesting that such a traditional method of astronomical observations as photometric one allows not only to determine the shape and dynamic properties of asteroids, but to perform their preliminary optical classification and estimate the diameter. In this sense, good opportunities are opening up for the faint main belt asteroids and NEAs, since the optical types and diameters remain unknown for most of them.

References: [1] Bell L. (1917) *Ap. J.* 45, 1–29. [2] Shevchenko V.G. (1996) *LPS XXVII*, Abstract # 1086. [3] Golubeva L.F. and Shestopalov D. I. (1983) *Sov. Astron.* 27, 351–357. [4] Shestopalov D. I. and Golubeva L.F. (2015) *Adv. Space Res.* 56, 2254–2274. [5] Bowell E. G. et al. (1989) in *Asteroid II*, Univ. of Arizona Press, pp. 524–555. [6] Golubeva L.F. and Shestopalov D. I. (2019) *This volume*.