POLARIZED LIGHT SCATTERED FROM ASTEROID SURFACES. III. POLARIZATION – ALBEDO RULES. D. I. Shestopalov, L. F. Golubeva, P. N. Shustarev, Shemakha Astrophysical Observatory, Shemakha AZ-3243 Azerbaijan, (shestopalov_d@mail.ru), (lara_golubeva@mail.ru), (petersh50@mail.ru).

According to Umov's law the lower an albedo of a particulate surface the higher a polarization of light scattered from the surface. This principle allows to estimate the geometric and Bond albedo of asteroids [1, 2, 3] using such polarimetric characteristics as the maximum depth of the negative branch of polarization (P_{min}) and the slope parameter (h) measured at inversion angle. Despite the fact that there are statistically significant empirical relations between albedo and the (P_{min} , h) parameters, a spread of values with respect to regression lines on log-log plot is larger than observation errors. Moreover, the scatter of data depends neither on sample volumes nor on differences in source data. We examine here this remarkable property of the polarization – albedo rules by the example of the albedo – h relation.

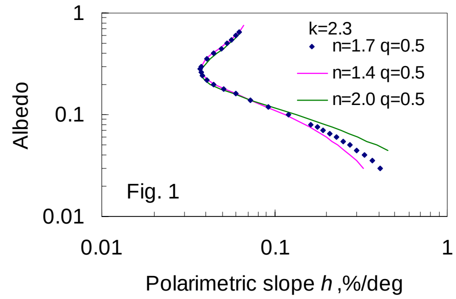
As has been shown in Part II (this volume), for asteroids belonging to E, S, M, and C types there is an empiric relation with correlation coefficient ~0.99 between the average values of the slope parameter h and photometric roughness c, namely: $h = 0.15c^2 - 0.18c + 0.10$.

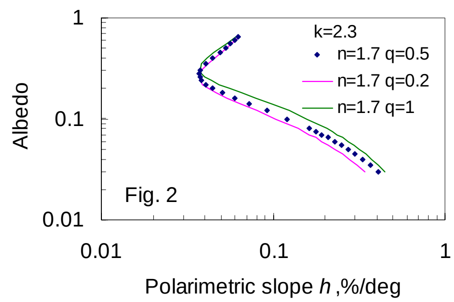
In turn the photometric roughness depends on the scaling parameter k (i.e. a ratio of the mean height of surface microtopography to the mean distance between random surface features) and the optical density, τ, of surface material and, consequently, surface albedo [4]. Other characteristics of surface material as refraction index n, soil porosity q, and average grain size l also affect albedo of particulate surface (see [4] in detail). Then we can compactly write:

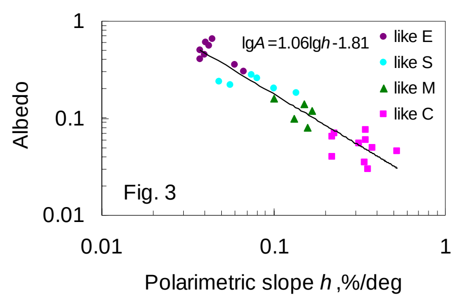
$c = k[1 - \exp(-2\tau)] = k[1 - F(A_{n,q,l})]$.

So, for each value of albedo we can calculate the surface photometric roughness c and the polarimetric slope h. Suppose that all the specimens of our synthetic collection differ in albedo whereas the scaling factor is constant, say, $k = 2.3$. The albedo – slope relation under these conditions is denoted as diamonds in Figs. 1, 2. These Figures also indicate that variations in the refraction index n and porosity q slightly affect the form of curve although the parameters themselves vary within the wide ranges.

Let now the scaling factor k be an operated variable; other surface characteristics (except for albedo) are constants. Symbols in Fig. 3 denote asteroid optical types in accordance with their albedo. If k is randomly jumping parameter within the ranges typical for the asteroid optical taxons (see Fig. 8 in Part II, this volume) then the albedo – h relation can be approximated by a linear equation (Fig. 3) with the slope and intercept close to those that have been derived from the observations of real asteroids [1, 2].







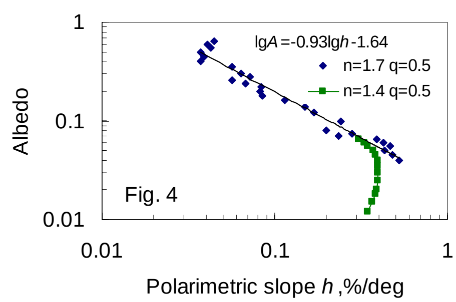


Fig. 4 represents the modeling of the albedo – h relation derived from the laboratory polarimetric and photometric measurements of meteorite specimens and candle soot [5]. In this Figure, the linear trend is determined by only random fluctuations of k, all other things being equal. The constants of linear regression are practically identical with those obtained from the experiment [5]. The nonlinear branch arises owing to the lower value of refraction index *n* that is needed to provide a very low albedo. The *k* parameter also varies, decreasing from ~ 2.8 (the tangency point of both branches) to ~ 2 (towards the lowest albedo).

For the sake of simplicity we varied only the scaling factor *k* to model the linear relation (in log-log space) between albedo and the polarimetric slope. In reality, of course, other surface characteristics of asteroids and laboratory specimens (such as a grain size, porosity, refraction index) also make a contribution to the unbalance of the correlation between the optical parameters in question.

It should be noted in conclusion that the analogous analysis is completely valid for the albedo – P_{min} relation.

Since the surface properties of asteroids belonging to various optical types change most likely stochastically the rise of observational data on asteroid albedo and polarization will scarcely lead to an "improvement" of the albedo - (P_{min} , h) relations.

References:

[1] Lupishko D. F. and Mohamed R. A. (1996) *Icarus 119*, 209–213. [2] Cellino A. et al. (1999) *Icarus 138,* 129–140. [3] Shestopalov D. I. and Golubeva L.F. (2011) *LPS XIVII*, Abstract #1028. [4] Shkuratov Yu. G. et al. (1999) *Icarus 137*, 235–246. [5] Zellner B. et al. (1977) *Proc. Lunar Sci. Conf. 8th* , 1091–1110.