Laboratory measurements of light-scattering response in chemically heterogeneous regolith.

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Interpretation of astronomical observations of small bodies of the Solar system often is a complicated problem. We present results of laboratory optical measurements of particulate surfaces (structural analog of regolith) with various brightness, which are obtained by mixing of two high-contrast materials: dark volcanic sand and bright salt. This study provides clues necessary for interpretation of observations of asteroids, bare nuclei of comets, and dwarf planets. For instance, recent *in situ* study of dwarf planet Pluto by *New Horizons* space probe [1] revealed broad surface markings with bright and dark areas; whereas, our laboratory measurements can help to estimate the volume ratio of dark and bright materials in boundary regions.

We present photometric and polarimetric measurements, obtained with the FGI field goniospectropolariphotometer, FIGIFIGO [2] at phase angle spanning the range from –20˚ to 120˚. Reflectance at phase angle of 6˚ varies from 4% (in pure volcanic sand) up to 86% (in pure salt) as compared to an equivalent Lambertian surface. We found that changing the volume ratio of salt and volcanic sand monotonically affects light-scattering by particulate surface. While samples are getting brighter, their phase function gets more flattened. Relative amount of dark and bright components unambiguously affects angular profile of the degree of linear polarization. This effect is the most apparent at side scattering, where degree of linear polarization acquires maximum value P_{max}, which takes on ~55% in the pure volcanic sand and only ~1% in the pure salt; whereas, in the mixtures it spans intermediate values. Moreover, our samples reveal an inverse correlation between albedo and P_{max} that, in the literature, is referred to as the *Umov effect* [3]. We compare the Umov effect in our samples with what is found in the lunar surface.

References: [1] http://www.nasa.gov/feature/nasa-s-new-horizons-sees-more-detail-as-it-draws-closer-to-pluto, [2] J.I. Peltoniemi et al. 2004. *Journal of Quantum Spectroscopy Radiative Transfer* 146:376–390. [3] Yu.G. Shkuratov and N.V. Opanasenko 1992. *Icarus* 99:468–484.