GLOBAL SEARCH FOR PHOTOMETRIC ANOMALIES OF LUNAR NEARSIDE. S. Gerasimenko, V. Kaydash, Yu. Shkuratov, N. Opanasenko, Yu. Velikodsky, V. Korokhin, Astronomical Institute of Kharkov National University, Sumskaya 35, Kharkov, 61022 Ukraine. gerasimenko@astron.kharkov.ua

Introduction: Images of the lunar nearside obtained by telescopes equipped with Canon cameras are used for a study of photometric properties of the lunar surface. We used the method of phase ratios to access the steepness of phase function. We found several sites with photometric peculiarities and discuss them in terms of regolith maturity and geology.

Lunar photometric survey data: The two-months imaging campaign was carried out in 2006 with the 50-cm reflector and 20-cm refractor at the Maidanak Observatory (Middle Asia) [1]. We used Canon 300D and 350D cameras as photo detectors for both the whole-disk and regional survey by raw format imaging in three wide spectral bands (λ_{eff} = 0.48, 0.52, 0.63 μm). To apply a phase-ratio method [2, 3] for description of the photometric function we converted image counts to values proportional to brightness. For this aim we performed dark signal, weak nonlinearity, and flat field normalizations for every frame and transformed frames into a common projection with accounting for small-scale image distortions due to atmospheric turbulence [3].

The photometric function itself describes the dependence of lunar surface brightness on the photometric coordinates. We used the analytical expression of photometric function by Akimov [4]. This approximation allows the brightness normalization to the equigonal geometry. The remaining term after such normalization is the phase function dependent solely on the phase angle α. Then we produced brightness phase ratios $I(\alpha_1)/I(\alpha_2)$ to estimate the dependence of brightness on α.

Imaging the phase ratio distribution: The global view of the brightness ratio (23°/44°) in green filter (λ=0.52 μm) is presented in Fig. 1. This synthetic image was produced from two almost the same phase ratios for western and eastern parts of the lunar nearside at opposite illumination angles. The bright shades here correspond to higher values of the ratio, i.e. steeper phase function. We note that local surface tilts disturb the phase ratio; it looks like illuminated topography in Fig. 1. Thus true variations of phase function can be reliably detected for flat areas (maria, crater floors, smooth plains etc).

Fig. 1 shows a substantial suppression of the mare / highland border, but the general anticorrelation of the albedo with the steepness of the phase function still can be observed. The darkest surface of Mare Tranquilitatis shows up in the phase ratio as a region with highest phase function steepness. Bright ejecta halos of mare craters appear as less steep phase function features. The detailed study of phase ratio distribution reveals several objects which do not obey the above described anticorrelation. Fig. 2 a,b presents a diffuse photometric detail centered at 17.7°W, 21.6°S (~40 km in size) in Mare Nubium with unusually high steepness of phase function. We note that features with the same albedo as this detail have substantially lower steepness (cf. Fig 2a and 2b). The phase ratio distribution over a southern Procellarum also shows anomalous details (outlined in Fig. 3). The largest photometric anomaly in Fig. 3 is ~70 km in size. Anomalies in Fig. 3 is of similar albedo as crater Euclides ejecta (shown with arrow), but has the substantially high steepness. Low Sun angle Lunar Orbiter data reveal no apparent topography associated with the photometric anomalies.

Discussion: The general anticorrelation of phase function steepness with albedo can be explained by the influence of the shadow-hiding effect and albedo on the steepness. For bright surfaces the shadow hiding effect is partially suppressed due to multiple light scattering on the surface topography. As a result the steepness decreases. The steepness also is sensitive to the surface structure at scales larger than the characteristic light diffusion length (~1 mm for the lunar regolith). Previously the high steepness anomalies for proximal crater ejecta zones were interpreted as an increase of mesoscale roughness in the ejecta, making the phase function steeper [2]. To check the possible effect of chemical content and maturity degree on the roughness we present in Fig. 2 c,d and 3 c,d the distributions of color-indexes C_{RB} (750/415 nm) and C_{IR} (950/750 nm) from Clementine data. The parameter C_{IR} as an indicator of the 1 μm pyroxene band depth shows areas of immature regolith as those with low values of the C_{IR}. The index C_{RB} is widely used as a marker for chemical differences over the lunar surface (e.g., C_{RB} decreases for high TiO_2 content soils). The anomaly in Fig. 2 c,d shows some decrease of C_{IR} but strong high C_{RB} feature that may be interpreted as a presence of chemically different material. Other anomalies in Fig 3 d stand out as immature low C_{IR} features. Also we note the increase of C_{RB} index for one anomaly in Fig. 3c. The immature regolith in photometric anomalies can be associated with the presence of an anomalously large number of boulders and blocks, i.e. large mesoscale roughness.

Conclusions: We mapped the phase ratio (23°/44°) for the lunar nearside to search for the local anomalies of the phase function. Photometric anomalies found can be interpreted as areas with increasing the surface roughness.

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References:[1] Shkuratov Yu., et al. (2007), *Proc. 10th Int. Conf. on Light Scatt. by Non-spherical Particles*, Bodrum, p. 205. [2] Kreslavsky M., Shkuratov Yu. (2003) *JGR 108*, 5015. [3]

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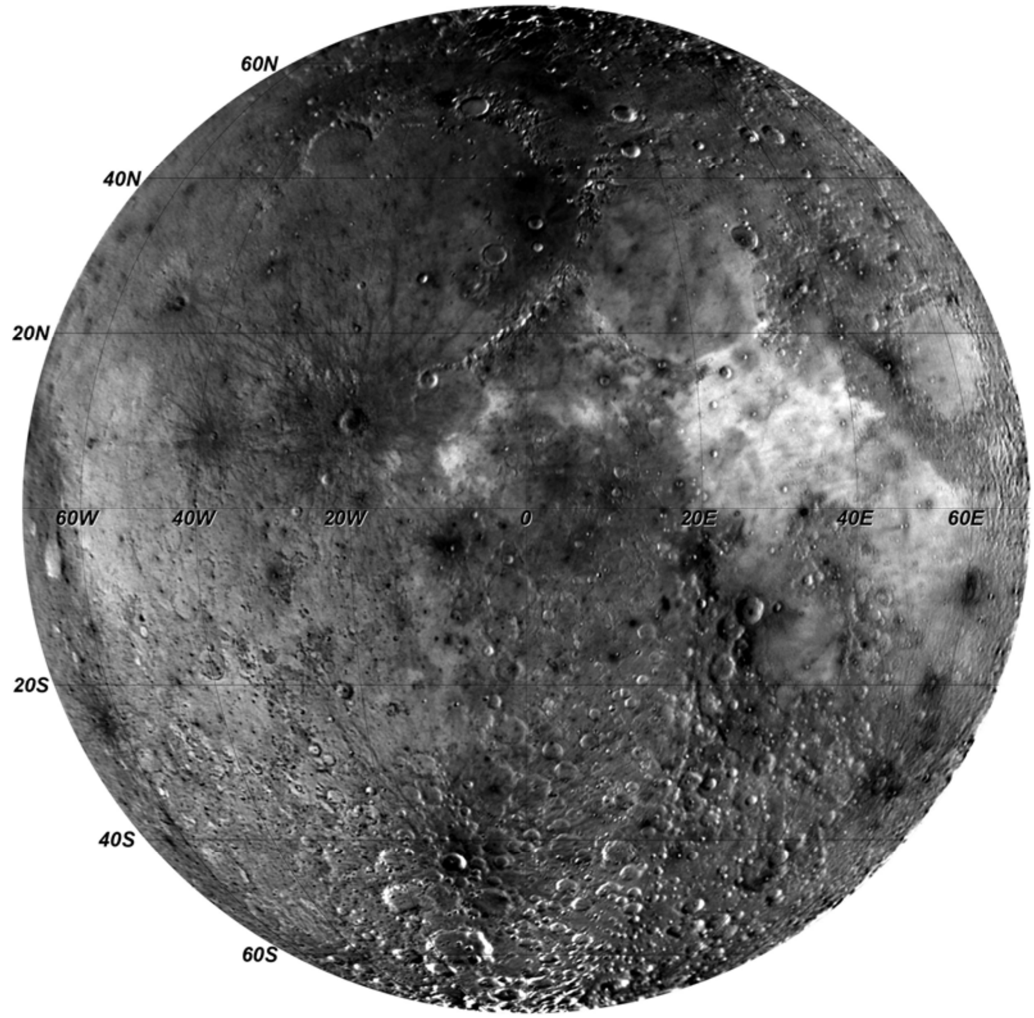

Fig. 1. Phase ratio distribution (23°/44°) for the lunar nearside. Brighter tones correspond to steeper phase function.

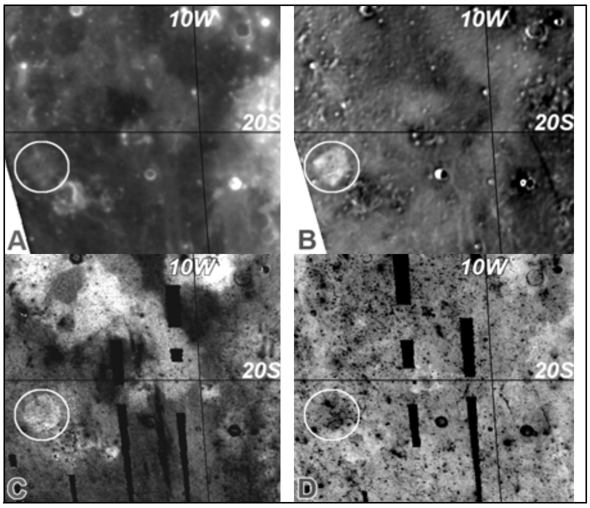

Fig. 2. Photometric anomaly outlined in Mare Nubium: (a) Brightness at α=23°, (b) Phase ratio 23°/44°, (c) Color-index 750/415 nm, (d) Color-index 950/750 nm.

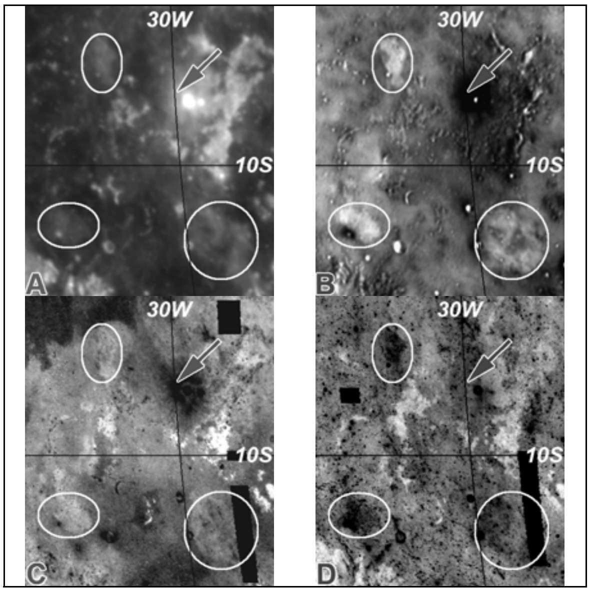

Fig. 3. Photometric anomalies outlined in southern Procellarum. Images (a)-(d) are the same as in Fig. 2.