THE LATITUDE DEPENDANCE OF BRIGHTNESS OF THE LUNAR SURFACE. Yu. I. Velikodsky, L. A. Akimov, and V. V. Korokhin. Astronomical Observatory of Kharkov National University. Sumskaya Ul., 35, Kharkov, 61022, Ukraine. E-mail: velikodsky@astron.kharkov.ua.

Abstract: It was obtained values of parameter of empirical Akimov's formula for different types of the lunar surface. Spectral dependance of this parameter was studied.

Introduction: To obtain an information about physical conditions on the planetary surfaces, one must khow the law of light reflection by such surfaces. One of the interesting classes of them is a rough surfaces of atmosphereless bodies, like the lunar one. To study the reflection law we perform a regular CCD-photometric observations of the Moon in the wide range of photometric conditions. We have obtained some results in earlier works [1,2,3]. Particularly, it was be showed that the best function of brightness distribution along the lunar surface is the empirical Akimov's formula [4]:

$$\Psi(\alpha,\varphi,\lambda) = \frac{\cos(\alpha/2)}{\left(1-(\sin(\alpha/2))^{1+q(\alpha)}\right)\cos\lambda} \cdot (\cos\varphi)^{q(\alpha)} \times \times\left(\left(\cos(\lambda-\alpha/2)\right)^{1+q(\alpha)} - \left(\sin(\alpha/2)\right)^{1+q(\alpha)}\right) \quad (1)$$

where φ and λ are photometric latitude and longitude correspondingly, α - phase angle, $\Psi(\alpha,\varphi,\lambda)$ - brightness distribution with photometric coordinates relative to the "mirror" point (were φ=0, $\lambda=\alpha/2$) for given phase angle, q - smoothness factor. The dependance $q(\alpha)$ is following:

$$q(\alpha) = v\alpha/(\pi-\alpha)\,, \quad (2)$$

where v – some coefficient. It was obtained that for highlands v=0.51 (in red light).

At 2000 year we performed observations with new CCD-camera [5]. It has higher light-sensitivity, and we obtained 10 images of the Moon at α=5°…149° in two spectral bands (λ_R=0.71±0.10 μm, λ_B=0.45±0.10 μm). In result we obtained more precise value of parameter v and studied a wavelength dependance of this parameter.

The latitude dependance of brightness of the lunar surface: The procedure of smoothness factor obtaining is described in detail in papers [1,3]. It consists in approximation of observed brightness distribution along photometric latitude with expression:

$$\Psi_{lat}(\alpha,\varphi) = (\cos\varphi)^{q(\alpha)}\,, \quad (3)$$

which is the latitude component of formula (1). To get rid of albedo variation (as much as possible), the brightness was divided by brightness near the full moon. The approximation was performed for 3 albedo clusters of the lunar surface: a) *highlands* (A>0.12), b) *bright mares* (0.082<A<0.105) and c) *dark mares* (A<0.105). Obtained values of q are presented on fig.1 (*squares* correspond to highlands, *points* – to bright mares, *circles* – to dark mares). In the same figure there are presented data, obtained with old CCD-photometer [1,3] for highlands (*crosses*). The precision of this values is 0.03-0.1. The new highlands data are in accord with old ones, and the approximation of common phase dependance of smoothness factor with formula (2) gives the value v=0.52. The point at α=149° was not taked into account here, because it has very big deviation.

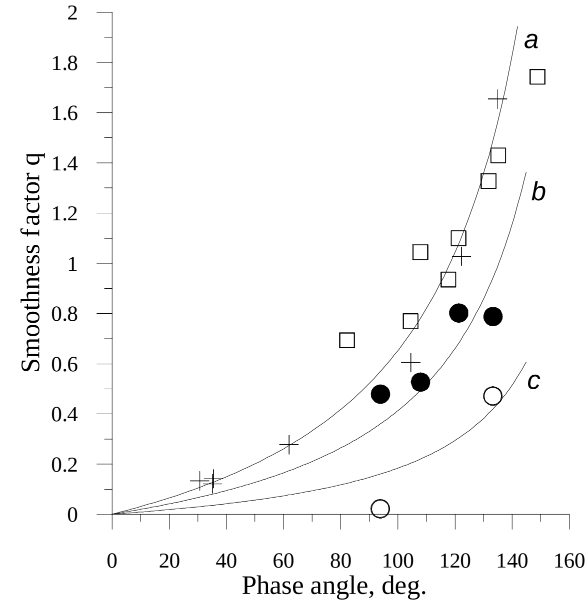

Fig. 1

For the bright mares there was obtained a value v=0.33, for the dark mares – v=0.15. Note that the last value has very low reliability, because it was obtained with only two points.

Curves of phase dependances of smoothness factor with obtained values of v are showed on the fig.1.

Spectral dependance of smoothness factor: Using a procedure similar to the described one, it was obtained the parameter of latitude dependance of the color-index C(0.45/0.71 μm). For approximation it was used formula (3), but the exponent in it here is a difference Δq of smoothness factor in blue and red bands. Values of Δq were obtained only for highlands. They are presented on fig.2. The precision of this values is about 0.03. At α>120° Δq differs from zero noticeably more, than on error. Therefore, spectral dependance of smoothness factor does exist, but it is quite opposite, than one, which could be caused by influence of multiscattered light [2]: with albedo increasing smoothness factor (and brightness fall to poles) does not increase, but, on the contrary, decreases.

We conclude that smoothness factor of lunar surface does not have an influence of albedo as such (by contribution of multiscattering). The observed decrease of smoothness factor with the wavelength is explained, obviously, by fact that with changing wavelength, a range of relief scales, that takes part in light scattering, also changes. This allows to hope that studying this effect will give some information about relation of parameter *ν*, which characterize surface relief, with concrete properties of this relief. While, on the base of available data, it is possible only to note that this parameter depends on wavelength: on the fig.2 is seen that function $\Delta q(\alpha)$ is fairly well aproximated by expression

$$\Delta q(\alpha) = \Delta\nu \cdot \alpha/(\pi - \alpha)\,, \qquad (4)$$

which is based on formula (2) and contains the difference of values of parameter *ν* in blue and red spectral bands – $\Delta\nu$. This difference amounts to 0.045 (the curve on fig.2 corresponds to this value). An existing of this approximating says that formulae (1) and (2) are applicable in the whole visible range of spectrum.

References: [1] Akimov L. A. et al. (1999) Kinematika i fisika nebesnykh tel, 15, No 4, 304-309. [2] Akimov L. A. et al. (2000) Kinematika i fisika nebesnykh tel, 16, No 2, 181-187. [3] Velikodsky Yu. I. et al. (2000) LPSC XXXI, Abstract #1391. [4] Akimov L. A. (1988) Kinematika i fisika nebesnykh tel, 4, No 1, 3-10. [5] Korokhin V.V. et al. (2000) Kinematika i fisika nebesnykh tel, 16, No 1, 80-86.

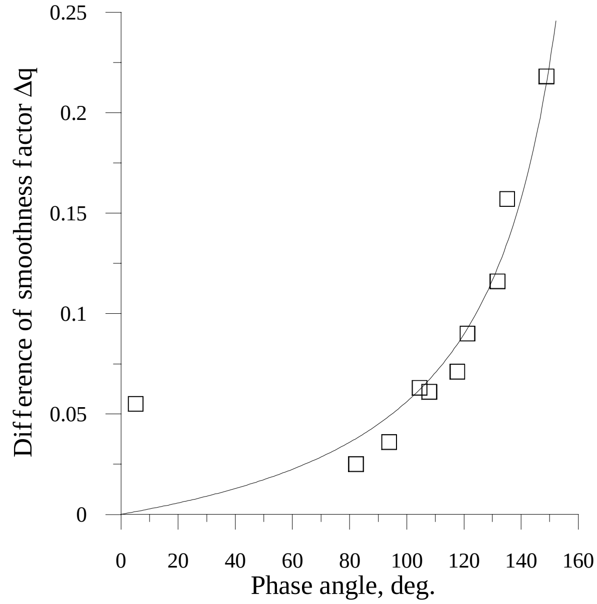

Fig. 2