MAPS OF PARAMETERS OF THE POSITIVE POLARIZATION MAXIMUM FOR THE LUNAR DISK.

V. V. Korokhin, and Yu. I. Velikodsky. Astronomical Institute of Kharkov National University. Sumskaya Ul., 35, Kharkov, 61022, Ukraine. E-mail: dslpp@astron.kharkov.ua.

Maps of parameters of the maximum of positive polarization: The surface of the Moon is an example of athmosphereless celestial bodies' surface. Due to the facts that albedo of the Moon varies in wide range and the lunar surface is available for observations from the Earth in practically full range of phase angles, it is possible to study different dependences of optical parameters. For example, the dependence of degree of positive polarization (and maximum of positive polarization P_{max} in particular) on albedo is studied well enough. However the distribution of α_{max} over the lunar disk and correlation with other optical parameters are not practically investigated.

Therefore the maps of maximum of positive linear polarization degree P_{max} and of its phase angle α_{max} have been constructed for the eastern hemisphere of the Moon, which are based on a set of polarimetric observations of the lunar surface. The observations were carried out at Kharkov Observatory in 2 wavelengths λ_{eff}=461 nm ($\Delta\lambda$=106.4 nm) and λ_{eff}=669 nm ($\Delta\lambda$=125.0 nm) with an imaging CCD–polarimeter [1] and a camera lens of 3 cm diameter, and 30 cm focal length. For approximation of phase dependence of polarization the modified Rayleigh function has been used:

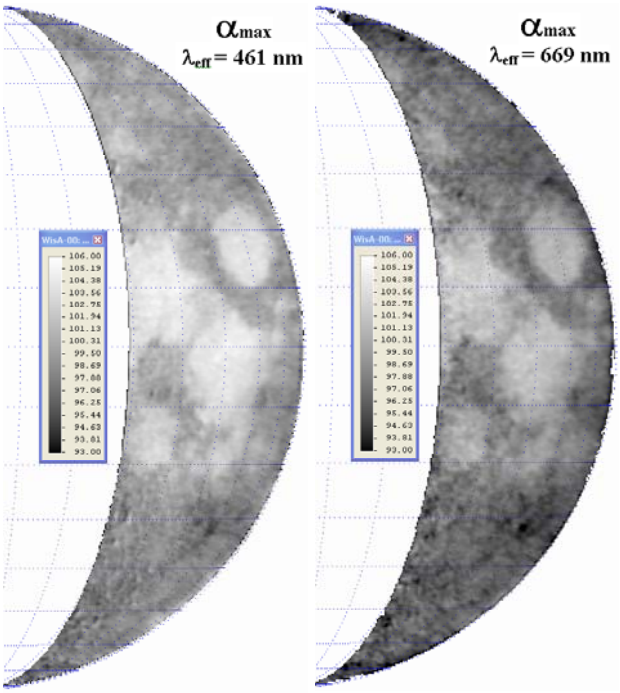
$$P(\alpha) = \frac{(\sin^2(\alpha - \Delta\alpha))^W}{1 + \cos^2(\alpha - \Delta\alpha) + dePol},$$

where $\Delta\alpha$ is a maximum shift parameter, W is a maximum width parameter, $dePol$ is a depolarization parameter.

The solutions for P_{max} and α_{max} (Fig.1) are obtained using observations at 10 different phase angles from 45° to 123° with fixed values of the parameter W (W=0.75 for λ_{eff} = 461 nm and W=0.88 λ_{eff} = 669 nm). Those values of W have been calculated as averaged from previous solution with W variation, because of obtained maps of W parameter are very noisy.

Now we have data of polarimetrical observations at phase angles 143° and 155°. Hopefully it allows us to construct the reliable maps of the parameter W. The maps of spectral indices Cp_{max}= P_{max}(669nm)/P_{max}(461nm) (Fig.2a) and $C\alpha_{max}$= α_{max}(669nm)/α_{max}(461nm) (Fig.2b) have been constructed too. All the maps are represented in the external perspective projection (distance=221.1739 of R_{Moon}, image radius=225 pix) and are accessible at http://www.univer.kharkov.ua/astron/dslpp/moon/polar/ as FITS-files. A pixel size is equal to about 8 km on lunar surface.

Data processing was fully carried out using our "IRIS" software complex (http://www.cyteg.com).

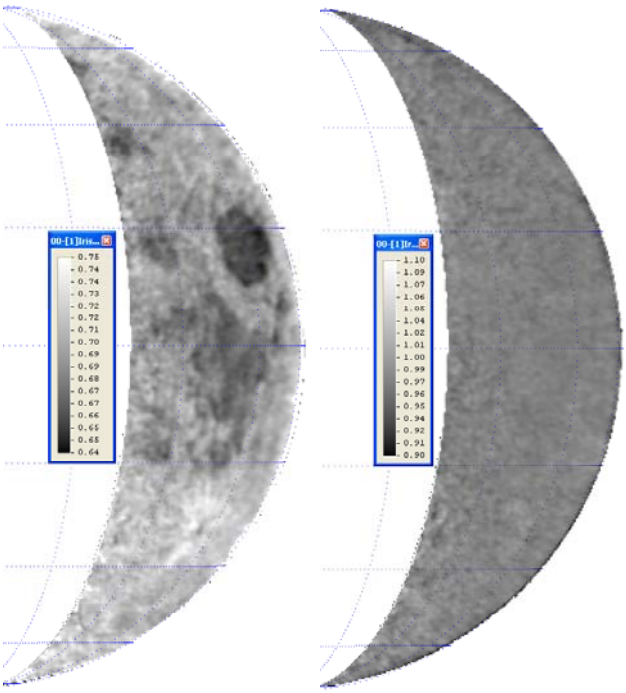


a) *b)*

Fig. 1. Maps of phase angle of maximum of positive polarization of the Moon

Distribution of P_{max} and α_{max} over lunar disk: A histogram of P_{max} distribution over the lunar disk has distinct maximum, P_{max}=7.3% for λ_{eff}=461 nm and P_{max}=5.25% for λ_{eff}=669 nm, corresponding to highlands. Distribution of P_{max} for mares is more diffuse. The range of P_{max} variations is 4.0..21.0% for λ_{eff}=461 nm and 3.0..15.0% for λ_{eff}=669 nm.

A histogram of α_{max} distribution is distinctly bimodal, with the first peak at α=99.7° (highlands), and the second one at α=104.1° (mares) for λ_{eff}=461 nm. For λ_{eff}=669 nm we have α=96.8° and α=101.2°, respectively. The histogram is narrower in blue light, 94.0° ... 106.0°, as compared to red light (90.0° ... 105.0°). The maximum of polarization occurs at larger phase angles in the blue band.



a) ***b)***

Fig. 2. a) map of spectralpolarimetric index $Cp_{max}=P_{max}(669nm)/P_{max}(461nm)$ b) map of $C\alpha_{max}=\alpha_{max}(669nm)/\alpha_{max}(461nm)$

Distribution of spectral indices Cp_{max} and $C\alpha_{max}$ over lunar disk: A histogram of Cp_{max} distribution over the lunar disk has distinct maximum, Cp_{max} = 0.70. The range of Cp_{max} variations is 0.65 ... 0.77. The map of Cp_{max} shows significant correlation with lunar details. $C\alpha_{max}$ has practically constant value over the lunar disk, $C\alpha_{max}$=0.976 (σ=0.006). There are no any lunar details on this map.

Analysis of data: The analysis of relationships between various optical parameters of the lunar surface was carried out. It was established that: 1) dependence α_{max} on logarithm of albedo and on logarithm of P_{max} shows significant linear correlation; 2) the parameters α_{max} and P_{max} depend on wavelength via albedo changes only; 3) correlation diagram "spectropolarimetric index CP_{max} – albedo" has two branches: there is anticorrelation for mares and correlation for highlands.

Conclusions: Obtained maps may be useful for progress of methods of remote sensing of surfaces of the Moon and other athmosphereless bodies and for verification of models of positive polarization of light scattered by regolith-like surfaces.

References: [1] Korokhin V. V. et al. (2000*) Kinematika i fisika nebesnykh tel*, 16, No 1, 80-86.