PARAMETERS OF THE MAXIMUM OF POSITIVE POLARIZATION OF THE MOON. 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.

Abstract: The maps of positive polarization degree maximum and its phase angle for λ_{eff}=461nm and λ_{eff}=669nm for the east semisphere of the Moon have been constructed. The maps of spectral indices $Cp_{max}=P_{max}(669nm)/P_{max}(461nm)$ and $C\alpha_{max}=\alpha_{max}(669nm)/\alpha_{max}(461nm)$ have been constructed also.

The analysis of relationships between various optical parameters of lunar surface was carried out. It was established that "α_{max} – albedo" dependence shows significant linear anticorrelation. "α_{max} – P_{max}" dependence has nonlinear character. Correlation diagram "specropolarimetric index Cp_{max} – albedo" has typical fork-like shape: there is anticorrelation for mares and correlation for highlands.

Introduction: The surface of the Moon is a good sample of athmosphereless cosmic 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, degree of positive polarization (and maximum of positive polarization P_{max} in particular) – albedo dependence is studied well. But the distribution of α_{max} over the lunar disk and correlation with other optical parameters are not practically investigated.

Mapping the parameters of maximum of positive polarization: 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, based on a set of polarimetric observations of 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's 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} are obtained using observations at 10 different phase angles from 45° to 123° with fixed values of W parameter (W=0.75 for λ_{eff} = 461 nm and W=0.88 λ_{eff} = 669 nm). Those values of W have been calculated as means from previous solution with W variation.

The maps of spectral indices $Cp_{max}=P_{max}(669nm)/P_{max}(461nm)$ and $C\alpha_{max}=\alpha_{max}(669nm)/\alpha_{max}(461nm)$ have been constructed also.

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).

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 in a whole more narrow in blue light, – 94.0°..106.0°, - as compared to red (90.0°..105.0°). As a rule, the maximum of polarization occurs at larger phase angles in the blue band.

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 lunar disk, - $C\alpha_{max}$=0.976 (σ=0.006). There are no any lunar details on this map.

Correlation diagram "α_{max} – diffuse albedo [2]": This diagram (fig.1) shows a linear dependence between the parameters: α_{max}=(-114.32±0.02)·m+109.74±0.28 for λ_{eff} =461 nm (blue points), and α_{max}=(-81.49±0.02)·m+106.98±0.19 for λ_{eff} =669 nm (red points). Correlation coefficient is equal -0.905 for λ_{eff} =461 nm and -0.911 for λ_{eff} =669 nm, i.e., a significant linear anticorrelation is observed.

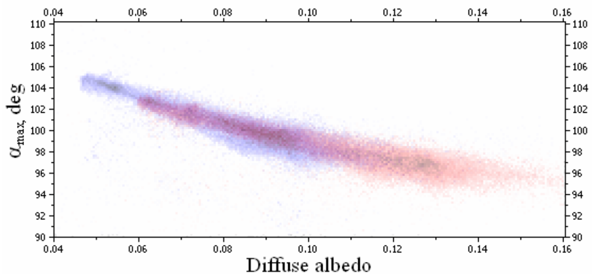

Fig. 1

Correlation diagram "α_{max} - P_{max}" (fig.2, blue - λ_{eff} =461 nm, red - λ_{eff} =669 nm): Dolfus and Bowell [3] and Kvaratzkhelia [4] have constructed "α_{max} - P_{max}" diagram before us using data of discrete observations. They supposed linear relationship between these parameters. But our data shows sharply nonlinear dependence. It is necessary to note that diagrams for different wavelenths continue one by other very well.

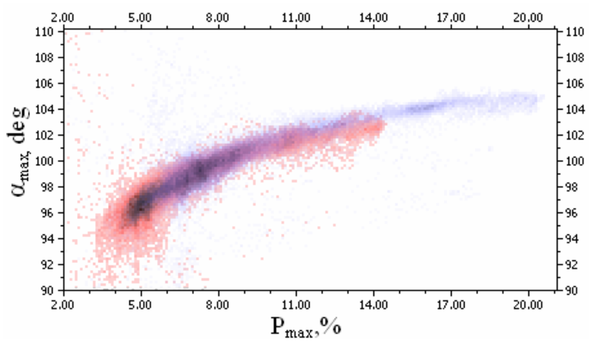

Fig. 2

Correlation diagram "specropolarimetric index Cp_{max} – albedo": Dependence between these patameteres was studied before using the data of discrete measurements only [5] and did not show any correlation Cp_{max} from albedo. Our diagram has typical fork-like shape: there is anticorrelation for mares and correlation for highlands (fig.3).

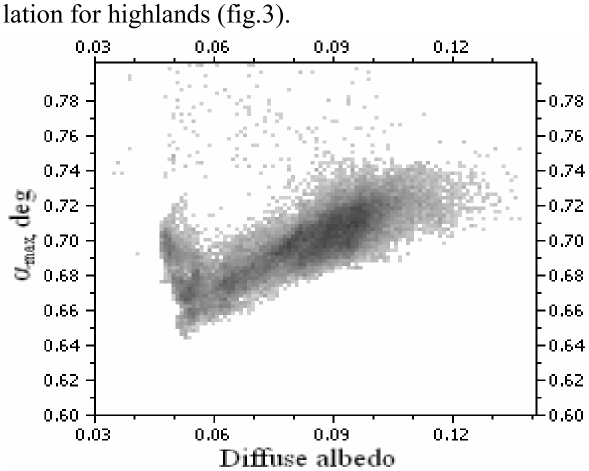

Fig. 3

Correlation diagram "specropolarimetric index Cp_{max} – color index": Shevchenko et al. [6] using data of Kvaratzkhelia [4] for spacecraft landing sites found correlation of specropolarimetric index with maturity index of lunar regolith. But Shkuratov [7] asserts that specropolarimetric index depends on maturity indirect via Umov's law and must correlate with albedo color index. We have constructed such diagram (fig.4). It really shows that correlation, but dependence has very complicated shape.

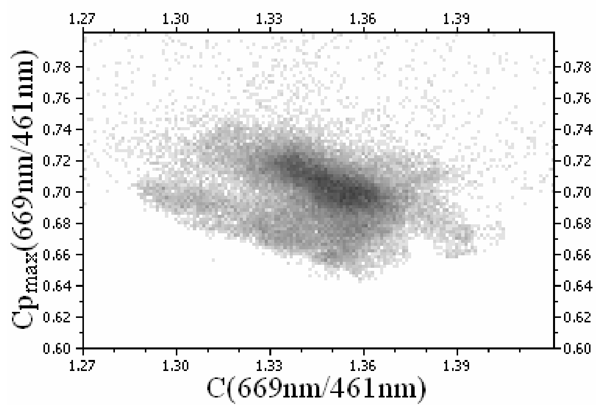

Fig. 4

Conclusions: The analysis of these new observation data, especially combined with other optical parameters, will be helpful in obtaining more information about the properties of the lunar regolith and will serve to development of methods of remote sensing of other athmosphereless cosmic bodies.

References: [1] Korokhin V. V. et al. (2000*) Kinematika i fisika nebesnykh tel*, 16, No 1, 80-86. [2] Akimov L. A. (1988) *Kinematika i fisika nebesnykh tel*, 4, No 1, 3-10. [3] Dollfus A., and Bowell E. (1971) *Astron. Astrophys.*, 10, 29-52. [4] Kvaratzkhelia O. I. (1988) *Bull. Abastumani Astrophys. Obs.*, B4, 312. [5] Opanasenko N. V. et al (1988) *Astron. tsirkular*, No 1525, 25-27. [6] Shevchenko V. V. et al. (1993) *Astron. vestnik*, 27, No 4, 16-30. [7] Shkuratov Yu. G. (2000) *Astron. vestnik*, 34, No 3, 216-232.