MERCURY: SURFACE LAYER STRUCTURE FROM OPTICAL PROPERTIES. V.V.Shevchenko, Sternberg State Astronomical Institute, Moscow University, Universitetsky 13, Moscow 119899, Russia, shev@sai.msu.ru

Introduction: Experience of lunar studies shows that space weathering processes on the Mercury (such as micrometeorite bombardment and solar wind ion bombardment etc.) are forming upper layer of regolith. This process is event of maturity and it is main block to develop a reliable model of Mercurian regolith. The physical-mechanical processes affect the optical properties of an exposed lunar soil. Concerning the Moon the main spectral-optical effects of space weathering are a reduction of reflectance, attenuation of the 1-μm ferrous absorption band, and a red-sloped continuum creation. The example of remote determination of the maturity of lunar soil from Clementine spectral data was very effective. The amount of fused glassy particles and others agglutinates in the lunar upper layer is the direct index of the soil reworking caused be the micrometeorite bombardment. Besides, this micrometeorite bombardment is also responsible for the mechanical process through which the large particles are broken down into smaller ones. For lunar regolith was showed that increasingly mature soils become progressively finer-grained, better-sorted, and composed of a greater proportion of agglutinates.

Disk-integrated photometry of Mercury: Results of observations of Mercury and the Moon confirm the close similarity of photometric properties of the bodies. In Table I some of determinations of the basic photometric quantities are summarized. The data demonstrates that average photometric characteristics of the surface layer on Mercury are nearly identical to those of the Moon.

Other argument of identical structure of the regolith surface layers of the bodies is similarity of the lunar and Mercurian photometric functions.

Table I. Lunar and Mercurian basic photometric parameters

	p_v	q_v	A_v
MOON			
Lumme & Irvin (1982)	0.152	0.476	0.072
Shevchenko (1982)	0.147	0.509	0.075
Veverka et al. (1988)	0.136	0.451	0.061
MERCURY			
Dollfus & Auriere(1974)	0.130	0.56	0.073
Veverka et al. (1988) - I	0.140	0.473	0.066
Veverka et al. (1988) - II	0.138	0.486	0.067

Fig.1 shows comparison of disk-integrated phase function for Mercury and the Moon. The lunar photometric curve was obtained from analysis of 26 lunar phases of the Earth-based observations

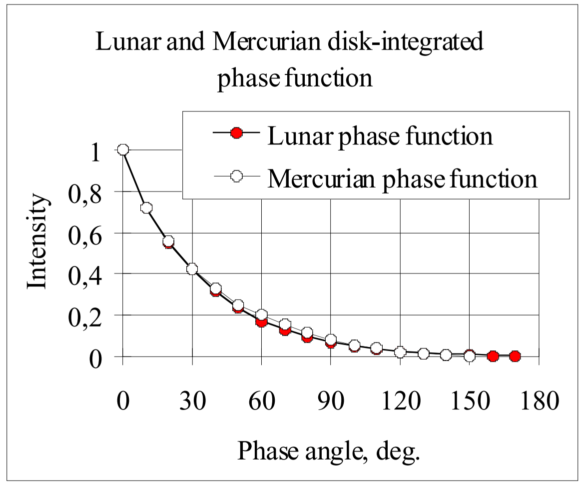

Fig. 1

and space survey from the spacecraft Zond-3, Zond-6, Zond-8 and Apollo-13 (full disks) [2, 5]. The effect of opposition was investigated and the true albedo values have been found. For interval of phase angles from 0^{o} to 2.3^{o} the effect of opposition is about 11% and from 0^{o} to 5^{o} it is 18%. Mercurian phase function was constructed on the base of Danjon s data modified by Vaucouleurs [6].

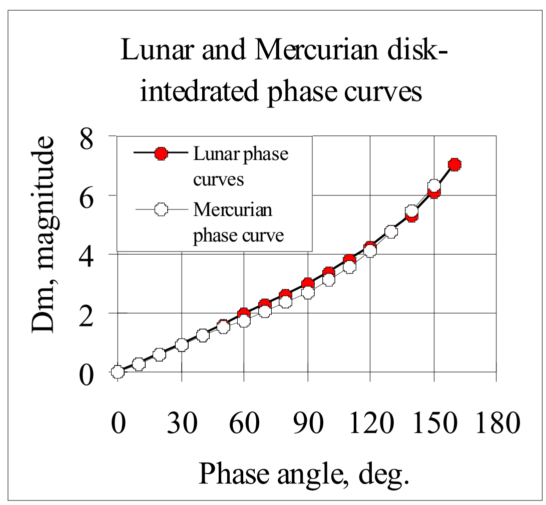

Fig. 2

Fig. 2 represents the comparison of the lunar and Mercurian disk-integrated phase curves derived on base of a cubic equations for each body [7]. It s clear that both curves are similar. Some difference in the phase range from 40^o to 100^o can be affected by surface roughness. Since inclination of the phase curve and magnitude of the opposition effect are also correlated with the shadow function being dependent on the surface roughness it s may be concluded that Mercurian relief in scale of meter details is more smooth than lunar one.

Spectropolarimetry of Mercury: The increasing rate of the fused glassy fragments, of agglutinates, and of fine size fraction in the regolith during its space weathering affects the polarization of the light reflected by an exposed lunar or Mercurian soil. Therefore, polarimetric properties of the regolith may be modified by the soil reworking process in the course of time. Dollfus showed that the maximum of polarization for irradiated by protons flux (simulation of the solar wind radiation on the Moon), is reduced in the red part of the spectrum [8]. So, the determination of the maturity level of a lunar soil could be based on upper layer. Later on the example of summary powders, laboratory taken as lunar soil analogues existence of the wavelength dependence of the known relation between albedo and maximum polarization. From systematic observation of the Moon the authors obtained a common relation:

$$\log P_{max} = k_1 \log \lambda + k_2,$$

where k_1 and k_2 are constants dependent on the type of surface terrain and from properties of regolith.

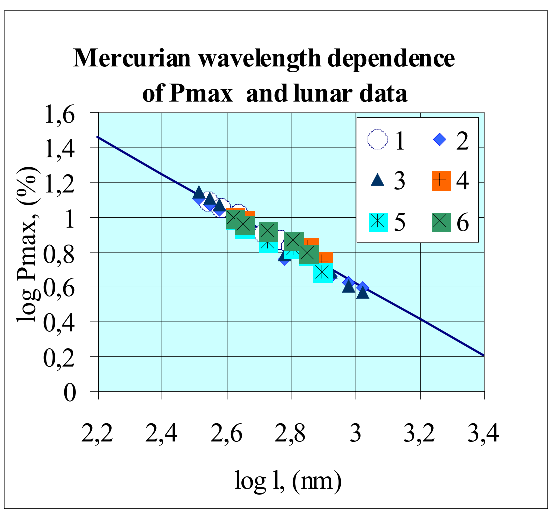

Fig. 3

This relation can be used for Mercury. In Fig. 3 shows results of summary of polarization measurements of whole disk of Mercury from [4] (circles 1). Straight line shows linear regression explained by individual shadow function in each case because of the integral phase brightness is

which corresponds to relation mentioned above (k_1 = -1.0448, k_2 = 3.7541, coefficient of correlation is — 0.9946). Positions of the points (2 — 6) corresponded to some lunar highland objects confirms the remarkable similarity of the polarimetric properties of Mercury and the Moon. Designation of points is following: 2 — Palus Somnii [9], 3 —Schiller [9], 4 —Ptolemaeus [10], 5-Bullialdus [10], 6 —Gassendi [10].

Maturity of the Mercurian soil (whole disk): In previous our works (see, for example, [11]) we developed the method to determine the maturity of lunar soil by using spectropolarimetric ratio $P_{max}(B)/P_{max}(R)$ for blue (B) and red (R) spectral regions. On the basis of known laboratory results and telescopic data, it was found that spectropolarization ratio:

$$I_m = P_{max}(419nm)/P_{max}(641nm)$$

could be used as a remote sensing parameter of lunar soil maturity. Data represented in Fig. 3 confirms that this method can be used for estimation of the Mercurian soil maturity (in scale of whole disk). Corresponding information represents in Table II.

Table II. Lunar crater maturity

Crater name	I_m	I_s/FeO
Ptolemaeus	1.452	68
Bullialdus	1.451	68
Gassendi	1.415	75

Conclusions: Maturity of the soil on the Mercurian surface in scale of whole disk is similar to space weathering of the soil in large old craters on the lunar highland.

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