IDENTIFICATION AND COMPOSITION OF THE EJECTA MERCURIAN TERRAINS WITH MARINER-10. S.G. Pugacheva, V.V. Shevchenko. Sternberg State Astronomical Institute, Moscow University, 13 Universitetsky pr., 119992 Moscow, Russia, pugach@sai.msu.ru.

Introduction. This work presents the new results of photometric studies of the surface of Mercury. The basic material for investigations is the cosmic images of the Marcurian surface from KA Mariner-10. The photometric properties and structure of the relief of the Mercury's surface were determined. The article is devoted to research of the regolith of the Mercurian surface by methods ground and space photometry. The purpose of researches is the estimation of the structure of the surface layer of the Mercurian regolith.

Photometric properties of the surface of Mercury. Mercury is the innermost planet and the least known of the terrestrial planets. The first visual observations of the planet of Mercury have been made Zollner (1865) and Muller (1893) in the 19th century. The surface brightness of Mercury was measured Danjon (1933, 1949, 1953) and Harris (1961) in phase angle 3°-123°.

The analysis of the various data of the integral photometry gives the results of determination of the main photometric constants for Mercury.

The main photometric constants were obtained by Dollfus and Auriere (1974), Veverka et al. (1988–1, 1988-II). They calculated the photometric parameters the geometrical альбедо (p_v), the phase integral (q_v), the spherical альбедо (A_v). The results of the calculations of the basic photometric parameters are tabulated in the article V.V. Shevchenko [8]. The similarity of the Mercurian photometric properties to the lunar ones permits to use the methods lunar photometry for study of the structure and characteristics of the Mercurian regolith. To study the structure of the surface of Mercury the images of the visible surface location 0027435 and 0027375 were used.

Modeling of the photometric characteristics of the reflected radiation of Mercury. The model of Hapke of the bi-directional reflectance was applied to disk-integrated observations of Mercury. The model enables to be determined the structure parameters of the relief from experimental results. The Hapke's formula is well known model for the estimation of the surface roughness [1].

The Hapke's theoretical integral phase function involves six parameters: w, B_o, h, θ, and two parameters to describe P(g): b, c. The parameter h characterizes compaction of the regolith and size of the particle. The parameter B_o defines amplitude of the opposition effect. The function P(g) includes two parameters b and c, which determines the phase function form and the nature of scattering (c<0.5 corresponds to forward scattering and c>0.5 to backward scattering). The equation S(θ) allows to calculate the effects of macroscopic roughness on light scattered by a surface having an arbitrary diffuse-reflectance function. The parameter θ is a mean topographic slope angle of the surface.

Values of the photometric parameters (w, h, B_o, b, c, θ) were definition from Mariner-10 images.

Photometric analysis of the Mercurian surface. The method calculation of the Hapke's parameters is described in the previous article [4, 5]. The morphological formations of the Mercurian relief were established on the geologic map Mercury. The different types of morphological formations of the surface are allocated on the images. Designations of the morphological types: 1 – smooth terrain, 2 – flat-floored craters, 3 – heavily cratered terrain, 4 – lineated terrain.

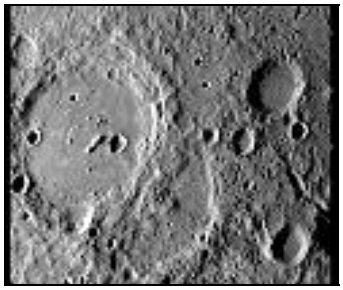

Fig.1. Image of the region of the Mercury, number 00275435. The image is resolution 274 mpp (meters per pixel). The coordinates of the image are at latitude 12.09°S to 6.20°S, at longitude 17.52°E to 24.77°E. The position of the spacecraft in the planetocentric co-ordinate system was 21.27°S and 6.71°W. The co-ordinates of the subsolar point were 0.00° latitude and 99.35° longitude. The angle parameters were the next: phase angle is 106.95°, the incidence angle is 31.51°, and the emission angle is 31.51°.

Fig.2. Image of the region of the Mercurian surface, number 0027375. The image is resolution 511 mpp. The coordinates of the image are 33.25°S to 21.84°S, 23.82°E to 41.01°E. The position of the spacecraft was 21.20°S and 4.10°W. The co-ordinates of the subsolar point were 0.00° latitude and 99.25° longitude. The angle parameters were the next: phase angle is 103.74°, the incidence angle is 70.10°, and the emission angle is 34.60°.

The images (fig.1, 2) show a several of morphological types of the relief of Mercury: hilly and lineated terrain, plains materials on the crater floors and the surrounding terrain. The most detailed study of the planet shows that the brightness across Mercury images could be fitted using a photometric method. Images have been transformed into the digital format and have been determined photometric brightness of the each pixel.

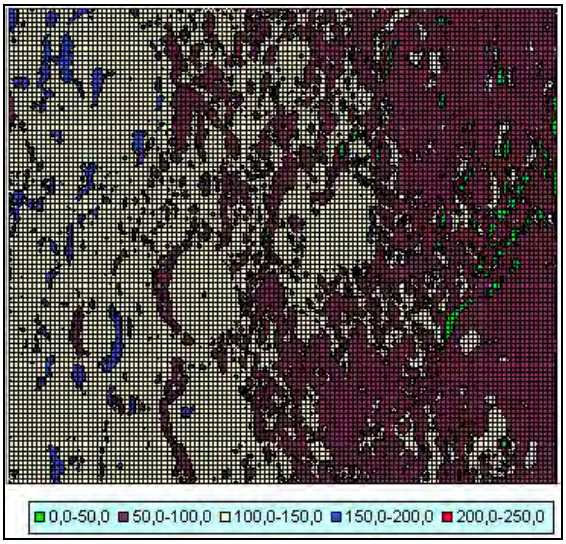

Figure 3. The image 0027375 is transformed into the digital format. Colouring indicates surface brightness (density) with resolution 50 relative units. The density of the image of the surface of Mercury may vary in the ranges 10 –200 units.

Results of the photometric estimation of the surface brightness (density) of the image 0027375 are shown on the diagram (fig. 3). For calibration of the density of the pixels images and calculation of the surface photometric brightness the average integrated lunar indicatrix was used [3, 6, 7]. The photometric function was constructed using phase curves of the lunar surface analogue. The photometric parameters of the model of Hapke of the bi-directional reflectance were calculated for 4 morphological types of the surface. The average values of the some parameters of the photometric function are given in Table.

Conclusion and Future Work.

The photometric relief and distribution of the photometric characteristics of the Mercury are indeed very similar to those of the Moon. The darkest of the terrain of the Mercury are brighter than their lunar analogue. The albedo of the heavily cratered sites is likely to be the same average albedo of the lunar highlands. The smooth plains of Mercury are significantly darker. Studying of photometric characteristics of the surface of Mercury is also an actual problem in connection with the prospective project the ESA BepiColombo (ESA, JAXA) and the project space station MESSENGER (NASA). The information about structure and composition of the Marcurian ejecta can be useful to scientific planning and realization of the future space projects.

References:

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Table. Lunar and Mercurian photometric parameters of the model Hapke.

Moon						Mercury					
w	**h**	**B_o**	**b**	**c**	**θ°**	**w**	**h**	**B_o**	**b**	**c**	**θ°**
Disk-interated**						**Disk-integrated****					
0.21	0.07	2.0	0.29	0.39	20°	0.23	0.09	2.5	0.18	0.15	20
Dark**						**Smooth terrain**					
0.13	0.05	2.6	0.27	0.20	12°	0.10*	0.07	2.8	0.25	0.18	10
Average**						**Flat-floored craters**					
0.23	0.07	2.2	0.34	0.31	19°	0.11*	0.068	2.6	0.26	0.20	11
Bright**						**Heavily cratered terrain**					
0.29	0.06	2.3	0.35	0.29	20°	0.15*	0.062	2.6	0.31	0.25	16
Foot-note: ** From Veverka J. et al (1988) [9], * From Murray B. C. et al (1974) [2]						**Lineated terrain**					
						0.22*	0.057	2.4	0.34	0.29	19