MERCURY IN THE 210-350^{O}W LONGITUDE RANGE. L. V. Ksanfomality. Space Research Institute of the Russian Academy of Sciences, Moscow, 84/32 Profsoyuznaya str., 117997, Russia. e-mail: ksanf@iki.rssi.ru

The method of short exposures appears productive in researches of Mercury [1, 2]. Telescopic observation of this planet is limited by bright sky background (because of angular closeness of the planet to the Sun). The observing period is short-term and lasts less than an hour. For production of the resolved images of the planet, during this time it is necessary to gather some thousands of electronic pictures for the further processing by modern codes. The most favourable periods of visibility of Mercury last about one week and repeat 2-3 times a year. Following are the new results of ground based observation of the longitudes of Mercury are considered that have been not covered by the MARINER-10 imaging. Earlier results [1-3] have been obtained by processing of observation made at the evening elongation, carried out on May, 1-2, 2002 at the Skinakas observatory of the Heraklion university (Crete, Greece, 35º13'E, 24º54'N). New observations of the planet were carried out in November, 2006 at the SAO observatory of the Russian Academy of Sciences (Lower Arkhiz, Karachaevo-Circassia, Russia, 41^{o}26'E, 43^{o}39'N) by the short exposures method, under good meteorology (except for November, 22). The meridian 265ºW, that on 21.11.2006 was placed on the morning (East) terminator, coincides with the position of the evening terminator during the first Mercury flyby of the MESSENGER on January, 14, 2008. This coincidence has arisen casually, but allows comparing a relief of two adjacent sectors. The advantage of the SAO observatory with respect to Mercury observation is its high altitude (2100 m) and relatively low latitude. Observations were carried out using Zeiss-1000 Ritchy-Cretien telescope (D=1.0 m, F=13 m). A red-sensitive CCD camera with a matrix pixel size 7.4x7.4 μm was used, with a cut glass filter KS 19 (short wave length border at 700 nanometers). The long-wave length border (about 1 μm) was determined by spectral properties of the CCD. So the observation was actually near-infrared.

During November, 20-24, 2006 about 20 thousand electronic photos of the planet, using the short exposure technique, were acquired. The disk of the planet on 20-24.11.2006 extended from 6 to 7 arc seconds, with the linear size of the image in a focal plane of the telescope about 0.41 mm on the average. It corresponded on the CCD to only 27 lines in the basic mode or to 54 lines in zoom mode. The phase angle of Mercury at observations was on November, 20: 103^{o}; on November, 21: 98^{o}; on November, 23: 84^{o}; on November, 24: 80^{o}. The observable planetocentric longitudes area of Mercury was 265-355^{o}W. The technique of observation of Mercury by millisecond exposures, as well as details of data processing is described in [1-3, and others].

Good meteorology during 5 days successively (with one exception) facilitated the good success of observational session of 2006, when it was possible to acquire about 20000 electronic photos for their subsequent processing. The appearance of an atmosphereless celestial body when passing quadrature (90^{o} phase) changes quickly both due to the effect of opposition and the orbital movement of the body. It was interesting to track, how the images of Mercury vary in these favourable phases in consecutive days. The phases of Mercury are more complex than lunar phases because the planet's central meridian, as compared to the Moon's, is not fixed. So for observation at any phase all sides of the planet are accessible, in principle. On the average the Mercury surface each day displaces relative to the terrestrial observer on 5^{o} eastward.

Processing initial millisecond electronic photos of the planet by methods of correlation stacking requires selection of a so-called pilot–file, the search for which usually must be done manually. The pilot-file is the most successful one, in opinion of the operator. Programs of processing analyze the contents of a sample, find in it any details, and search for recurrence of these almost imperceptible details in thousand of other stacking electronic pictures. In 2006-07 some programs of automatic processing have been created. Unfortunately, the efficiency of all automatic programs is not as good as manual selection.

Together with the selection, some other known methods are used. The point spread function (PSF) in its central part decreases smoothly from the center. Usually the width of this function is accepted at a level 0.7 or 0.5 of the maxima. If many thousands of initial electronic pictures are acquired, it is possible during their processing to take advantage of known statistics of random variables and to choose the width of the function at a level, say, 0.9 maxima. Then the resolution of the image improves appreciably.

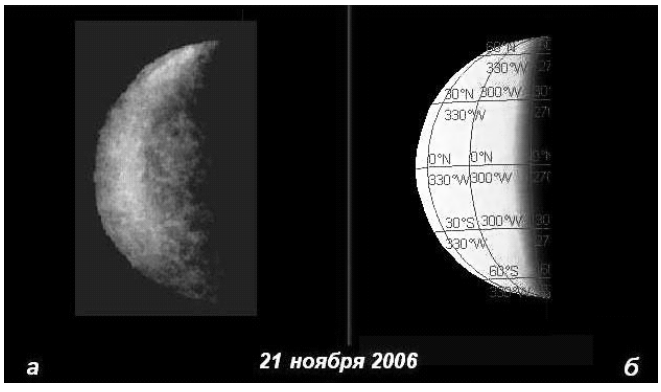

Fig. 1. (a) Stacked image resulting from observations on 21 November 2006 and (b) corresponding phase and position of the planet.

The essential element of processing is the mathematical model of "unsharp mask". However this is a two-edged instrument. The result depends on a choice of the size of the mask. If it is too small, all low spatial frequencies will be lost, and the image becomes grey uniformly; on the contrary, if the size of the unsharp mask is too great, all fine details disappear.

One of the main tasks of observation of 2006 was obtaining of a full view of Basin S, presented partly in [3]. During the time of the 2006 observation Basin S has been lit completely by the Sun (Fig. 1). For the stacking of the image (a) the processing has included about 7800 of initial electronic photos. In the grey field of Fig. 2 the coordinate grid is shown, and Basin S is indicated by a circle. In the right (b) part, image from the observation of 2002 is reproduced, allowing comparison with the eastern contours of Basin S. Presented by Fig. 2 is a full version of the unknown side of Mercury. In both panels of Fig. 2 (a, b) the terminator passes along the same meridian, approximately 270°W. Along the meridian, the extent of Basin S reaches 1300 kms. According to Fig. 2, the structure of Basin S is apparently similar to the structure of Caloris Planitia area, having, most likely, an impact origin, as suggested earlier [1]. The rim of Basin S has a more or less regular shape, as is seen in the image (a). The feature may be revealed both by shadows of the east rim and by albedo effects. The unsharp mask operation used in creating Fig. 2a, involves a compromise choice. Therefore the actual tone, either of Basin S and of dark mare on the limb, are darker, than on Fig. 2.

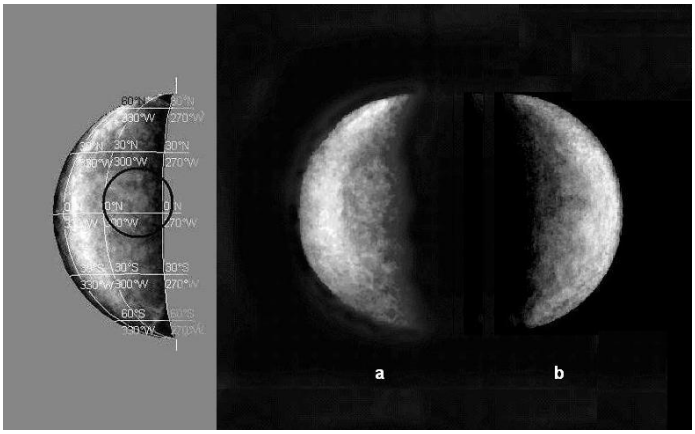

Fig. 2. Full version of the unknown side of Mercury. The position of Basin S is shown in the left panel.

The sector 265-350°W of longitudes of Mercury is enriched by contrast features in comparison with the sector 210-285°W (Fig. 2b). A few large features in Fig. 2a attract the attention. On the very limb, to the south of equator, a big dark crater mare of the genuine lunar type is seen as a dark at the left, with the center near 25°S, 330°W. Its diameter is about 700 kms. This is the first detection of such a lunar type mare on Mercury. Along the limb, from North Pole up to 20°S, a line of bright craters extends. The brightest is placed in northern part of the planet, at 65°N, 330°W, approximately. The crater is small, its diameter is 90-100 kms; to the north and south sides there are two linear structures adjoining, extending for 400-500 kms. Such opposingly directed rays of debris from an impact crater are unusual; it may be a result of a low tangent trajectory of an impactor [4].

Centered approximately at 0°, 300°W there is a huge crater with the conditional nickname "Medallion". Its northern periphery is overlapped in part with the southwest extremity of Basin S. Details of the crater "Medallion" are presented in Fig. 3, in negative versions. The visibility in this version unveils petals of the "medallion" in more detail. In the center of "medallion" there is a dark (in negative) nucleus («the central hill» in the lunar terminology), having diameter about 110 kms, surrounded with a crater bottom, diameter about 320 kms (extents are given in the meridian direction). The extensive terrace of debris has a petal-like structure and diameter of 1100-1200 kms. Thus, "medallion" is quite comparable in sizes with Basin S. However, judging by a degree of destruction, Basin S is much older than the "Medallion".

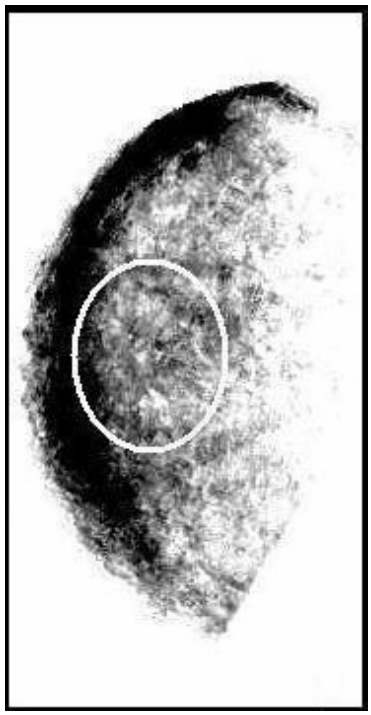

Fig. 3. The giant impact crater "Medallion" on the surface of Mercury in the longitude sector 285-350°W. Negative image. The crater "Medallion" is allocated by an ellipse.

References: [1]. Ksanfomality, L.V. (2005). *Astronomy Letters 31*, 767–785. [2]. Ksanfomality, L. et al. (2005). *Planet. Space Sci. 53*, 849-859. [3]. Ksanfomality, L.V., Sprague, A. L. (2007). *Icarus 188*, 271-287. [4]. Schultz, P.H. (1996). *J. Geophys. Res. 101*, 21, 117-21,136.