

Current and future exploration of the Moon and Mars: variations of rotation, shapes, displacements of center of mass

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Actual problems of modern selenodynamics and selenodesy, Mars rotation and inner dynamics are discussed in view of achievements by geodynamics and geodesy of last years and the possibility of re-opening prospects in modern researches of the Moon and Mars with the help of space vehicles.

Altimetry and the variation of the lunar figure and center pieces. The accuracy of satellite measurements of the Moon is now so high (Goossens S., Matsumoto K. et al., 2010; Smith et al., 2010) that it is possible to set long-term objectives for the study of temporal variations of the shape of the Moon, changing its mean radius and its mean radiuses of the northern and southern hemispheres, the eastern and western hemispheres, the displacements and oscillations of its centers of mass, the secular variations of the coefficients selenopotential etc. Altimetry method most widely used to study variations in the Earth's ocean surface, as well as some stationary geometric features of shapes and figures of celestial bodies (Mercury, Mars, Titan etc.). However, the application of this method can be significantly expanded to study the deformation of temporal variations of the solid surfaces of planets and satellites (Moon, Mars, Europa and oth.).

Tidal variations of the gravitational field of the Moon and their testing according to the lunar space missions. Due to outstanding achievements of space missions to the Moon (KAGUYA, Lunar Express etc.), there are quite real the direct determinations of cyclic (and also secular) variations of selenopotential coefficients (for low harmonics), more detailed description of tidal and non-tidal deformations of a surface, in particular researches of global planetary effects in change of opposite hemispheres of the Moon and in displacement of its centre of mass.

Eccentric positions of the shells of the Moon (and Mars) and geodynamic implications. The Moon and Mars is characterized by very significant displacements in the positions of center of the figure and the center of mass is 1.9 km from the Moon (Goossens S., Matsumoto K. et al., 2010) and the phenomenal displacement of these centers is 3.3 km for Mars (Zuber et al., 1998). These observed phenomena reflect the dynamics of shells and changes in the shells of these celestial bodies in their geoevolution. There is evidence in favor of the fact that these evolutionary changes for the Moon and Mars have place in the modern epoch. New statement of a problem about librations of the Moon with the displaced (eccentric) liquid core deserves steadfast attention and is actual. Dynamic effects caused by a eccentricity of the core can be remarkable and basically can be observed at precision laser observations with millimeter accuracy.

Mars rotation. Determination of the acceleration of axial rotation of Mars and the secular drift of the pole of its axis of rotation are the actual problems of current and future space missions to Mars. We have obtained preliminary theoretical estimates of these secular effects in the rotation of Mars, based on the assumption about existence of secular relative displacements of the core and mantle of Mars in the modern epoch and secular and directed mass redistribution of this planet (Barkin, 2009). There are some confirmations of mentioned hypothesis - secular changes in the activity of natural Martian processes, including climatic changes on Mars. Because on the Mars we observe planetary processes of a general warming, redistribution of fluids from the southern hemisphere to the northern hemisphere and secular changes in other processes, that is phenomena in nature similar to processes occurring on the Earth.

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