

[P-PS03_29AM1]Rotation, inner dynamics and natural processes on the Earth, the Moon and Mars

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10.Scope: Dynamic studies of rotational motions of celestial bodies give the important key to understanding of their internal structure, gravitational fields and dynamics of their shells. Due to space missions of last time and precision radar and laser observations from the Earth, the extremely important data on rotational motions of Mercury, the Moon, Mars, the Titan and other bodies of solar system are obtained. An increase of accuracy of observations of rotation of Mercury and the Moon in the nearest years is expected. Rotations and internal structures of solar system bodies have as the general properties so find out also the important specific features. These features of celestial bodies result in necessity of development of new approaches and methods for construction of analytical theories of their rotation. The basic purpose in work of the given session is to combine and systematize studies of rotational motions of solar system bodies in view of their multilayered structure in first for the Earth, Mars and the Moon. The reports reflecting researches on the following themes are invited. The construction of analytical and semi - analytical theories of rotation of the Moon, Mars and other bodies of Solar System. Researches of gravitational fields and an internal structure of bodies of solar system, construction of their models. Studies of tidal evolution of rotational motions etc. Tidal and non-tidal deformations of the surface of the Moon and Mars. Researches of rotational motions of the Earth and Mars as systems of interacting shells (solid core, liquid core, mantle). New methods of study of rotational motion of the Moon. Dynamics of relative oscillations of the shells of celestial and their reflections in variations of endogenous activity of planets and satellites. Studies of correlations of the rotational dynamics and natural processes of solar system bodies, their energy, space-temporal regularities of the changes of activity of processes. Their mechanisms.

10:15 AM - 10:30 AM

[PPS03-P01_PG]The free and forced librations of the Moon with liquid shell and solid core

3-min talk in an oral session

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In report we present our results of the study of lunar physical libration of the Moon on the base of its two and three layers models. On the base of analytical solution for two layers model (the Moon with liquid core) and empirical theory of the Moon's rotation (Rambaux, Williams, 2011), we have identified period, amplitude, and the initial phase of the forth mode of free libration of the Moon, caused by liquid ellipsoidal core. Preliminary results of studies of three-layers model of physical librations of the Moon

have been obtained on the base of some simplified approach for the problem of rotation of the Moon with liquid and rigid cores. The plans for future studies of the Moon rotation are discussed. The modern view of internal structure of the Moon planet takes into account a complex two- or three-layer model. In our work the analytical theory of lunar physical libration based on its two-layer model consisting of a non-spherical solid mantle and of the ellipsoidal liquid core has been developed. The Moon moves on high-accurate perturbed orbit in the gravitational field of the Earth and other celestial bodies. On the base of two layers model of the Moon we have fulfilled systematic studies of the Moon physical librations. And in first we have presented a solution of the problem in components of vector of angular velocity of the Moon. An analytical presentation of LOD of the Moon with high accuracy in form of trigonometric series has here the progressive value. In first we have determined the fourth mode of free libration of the Moon caused by the influence of the liquid core oscillations of pole axis of rotation of the Moon (its mantle), with a long period in 205.7 yr, with an amplitude of $0''0395$ and the initial phase of -134° (for the initial epoch 2000.0). This oscillation reflects the so-called phenomenon of free oscillation of the liquid core. The estimates for the dynamic (meridional) oblatenesses of the ellipsoidal liquid core of the Moon: 0.000442 and 0.000283 have been obtained. These fundamental parameters of geodynamics of the Moon could be determined only on the base of data of observations. Earlier the attempts to determine the period of free core nutation undertaken. Our results were obtained by comparing of the developed analytical theory of lunar physical libration with empirical theory libration of the Moon, constructed on the basis of laser observations in last about 40 years (Rambaux, Williams, 2011). Preliminary results of studies of three-layers model of physical librations of the Moon have been obtained on the base of some simplified approach for the problem of rotation of the Moon with liquid and rigid cores. We have analyzed the Cassini's motion of the decoupled solid core and its librations in longitude to compare with the Moon motions. On the base of Getino, Ferrandiz et al. approach we give estimations of the periods of free librations of this system. We have constructed differential equations of rotational motion of three layers Moon from positions of the Hamiltonian formalism with application of Andoyer's and Poincare's variables. Now we construct analytical theory of rotation of the Moon system consisting from the non-spherical mantle, ellipsoidal liquid core and solid core.