

Precession, nutation, pole motion and variations of LOD of the Earth and the Moon

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The theories of precession, nutation, pole motion and variations of LOD of the Earth and the Moon are developed on the base of unified approach. The Earth and the Moon are modeled as non-spherical bodies with ellipsoidal liquid core.

The base of studies is the Hamiltonian formalism with application of Andoyer's and Poincare's variables.

New analytical theory of Earth's rotation. The theory of non-spherical Earth's rotation with an elastic mantle, with variable outer shell and with ellipsoidal liquid core in the gravitational field of the Moon, the Sun and planets are developed. As the base the equations of motion have been used equations in Andoyer's variables. We take into account the second harmonic of the geopotential for high-precision orbital description of the motion of the Earth and the Moon. We take into account variations of the components of the inertia tensor of the Earth. They are based on the modern satellite data about secular, annual and semi-annual variations of geopotential. An approximate solution of the problem of the rotation of the Earth is constructed using the small parameter method in Andoyer variables, as well as projections of the angular velocity of rotation of the Earth and its core. It is assumed that the core is an ideal fluid undergoing a simple Poincare's motion. As unperturbed rotational motion of the Earth is taken no axial rotation (rotation around the polar axis of inertia of the planet), and a conical Eulerian ? Chandler motion (Barkin Yu., Barkin M., 2014). The tables of precession, nutation, polar oscillations axis of rotation of the Earth and others perturbations of the Earth rotation have been constructed. They show the good agreement between the developed theory and previously developed theories of the Earth's rotation (Kinoshita, 1977; Getino, Ferrandiz, 2001 et al.).

New analytical theory of lunar rotation. 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. 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 fourth mode of free libration of the Moon, caused by liquid ellipsoidal core. The plans for future studies of the Moon rotation are discussed. 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). The estimates for the dynamic (meridional) oblatenesses of the ellipsoidal liquid core of the Moon: 0.000442 and 0.000283 have been obtained (Barkin et al., 2014).

Keywords: Moon rotation, free libration, liquid core, solid core