

Main directions of studies in dynamics of planets and satellites

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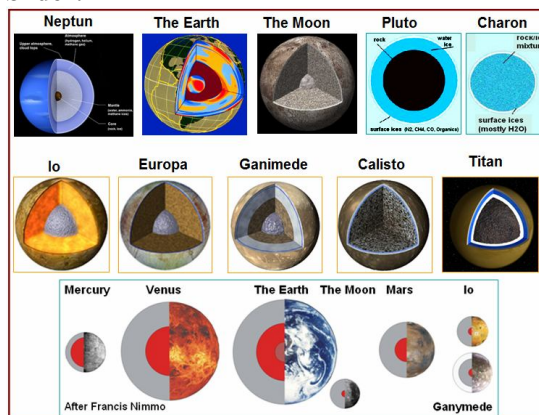
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Resume. From positions of geodynamic model of the forced gravitational relative swing, wobble and displacements of shells of a planet fundamental problems of geodynamics, geology, geophysics, planetary sciences are studied and solved and suggested new directions of studies of dynamics and evolution of solar system bodies: 1) The mechanism (non-classical) of cyclic variations of activity of natural processes in various time scales and unity of their spectrums. 2) The power of endogenous activity of planetary natural processes on planets and satellites. 3) The phenomenon of polar inversion of natural processes on planets and satellites. 4) Spasmodic and catastrophic changes of activity of natural processes. 5) The phenomenon of twisting of hemispheres (latitude zones or belts) of celestial bodies. 6) Formation of the pear-shaped form of celestial bodies and the mechanism of its change. 7) The ordered planetary structures of geological formations. 8) The phenomena of bipolarity of celestial bodies and antipodality of geology formations. These directions of studies have been mentioned and predicted by author [1] and have obtained wide list of confirmations in modern studies of solar system bodies. The mentioned phenomena in the course of time will obtain all new and new confirmations in dynamics of planets and satellites both in Solar system, and in exoplanet systems.

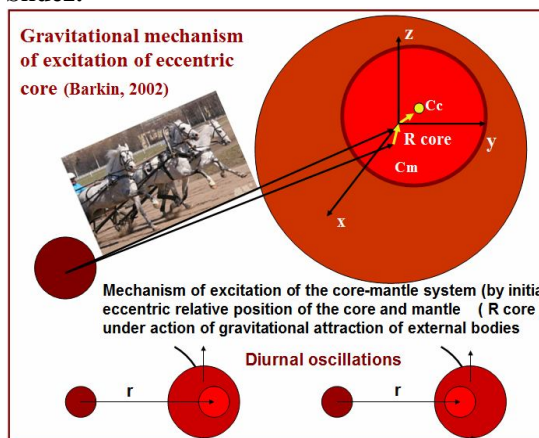
1. Mechanism. The fundamental feature of a structure of celestial bodies is their shell structure (Slide 1). The most investigated is the internal structure of the Earth. For the Moon and wide set of other bodies of solar system models of an internal structure have been constructed on the basis of the data of observations obtained at studying of their gravitational fields as a result of realization of the appropriate space missions. The basic components for the majority of celestial bodies are the core, the mantle and the crust. To other shells we concern atmospheres (for example, at Venus, Mars, the Titan etc.) and oceanic shells (the Titan, the Earth, Enceladus etc.). Shells are the complex (composite) formations. Planets and satellites are not spherical celestial bodies. The centers of mass of shells of the given planet (or the satellite) and their appropriate

principal axes of inertia do not coincide. Accordingly, all their shells are characterized by the certain dynamic oblatenesses. Differences of dynamical oblatenesses results in various forced influences of external celestial bodies on shells of the given body. Dynamical oblatenesses of shells, thus, characterize the endogenous activity of a planet by external celestial bodies. Other important factor of endogenous activity of a planet is a eccentric position of the centers of mass of the shells (for example, of the core and the mantle). The eccentricity of the shells is inherited during geological evolution of a planet as system of shells ([1], see slide 2). Parameters of eccentricity of the Earth, The Moon, Mercury, Titan, Mars, Venus are illustrated on slide 3.

Slide1.

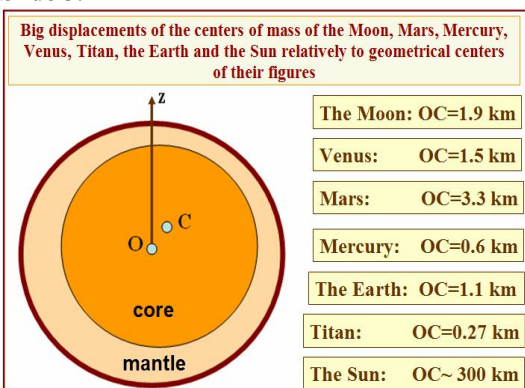


Slide2.

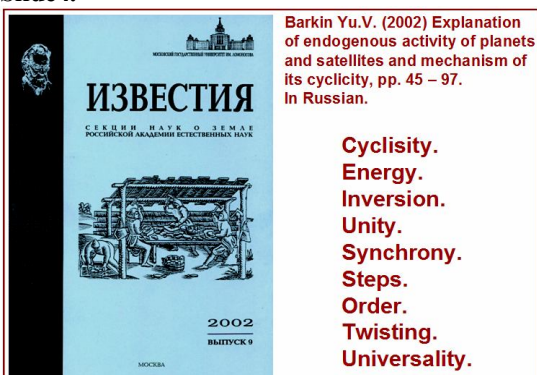


Our studies have shown that eccentricity of the shells of celestial bodies are the main reason of the more effective excitation of the shells by gravitational influence of another celestial bodies. Here it is observed clearly an influence of non-inertiality of the system of shells (for example of the Earth in Solar system) on their relative translational displacements and oscillations. Of course mentioned oscillations of the shells lead to cyclic variations of tension states of all layers of the planet, to activation or passivization of processes of generation of warm and heat flows to top layers of the Earth. And as result it leads to variations of activity all natural processes with define fundamental properties which are illustrated on slide 4. As it was shown in our papers the polar character of main oscillations of the core-mantle system leads to high activization of processes in polar regions of the planets and satellites [1, 2]. We believe that discussed mechanism is the main factor of formations of the polar fluid deposits on the Earth, Mars and another planets and satellites. The polar ice deposits are the relict results of action of mechanism of core-mantle oscillations. Simple illustrations to activity of processes and ice-water concentrations on the some planetas and satellites are given on slides 7 and 8.

Slide 3.



Slide4.



2. Consequences of excitation of the Earth system.

The new tides (Barkin, 2005) are caused by relative displacements of the core and mantle. These displacements are reflected in variations of many natural processes due to gravitational action of the core. The displacing core causes deformations of all layers of viscous-elastic mantle. In the given work from more general positions the mechanisms of excitation of a system of shells of the Earth under action of a gravitational attraction of the Sun, the Moon and planets, the phenomena of their relative swings, translational displacements and turns relatively from each other, and the wide list geodynamical consequences of the specified excitation of the Earth are studied. At once we shall emphasize, that the developed geodynamic model has allowed to carry out the important dynamic researches of displacements of shells of the Earth, their deformations and changes, and variations of its natural processes and for the first time to explain the nature of such fundamental phenomena and processes in geodynamics, geology and geophysics as: cyclicity of natural processes and its mechanism; power of processes in various time scales; unity of cyclic processes and universality of their frequency bases; synchronism of geodynamic, geophysical, biophysical and social events; inversion, contrast and opposite directed changes of activity of natural processes in opposite hemispheres of the Earth; step-by-step variations of natural processes, sawtooth course of activity of natural processes in various time scales; orderliness in an distribution of geological formations on the Earth, planets and satellites; existence of antipodal formations on planets and satellites; the phenomenon of twisting of hemispheres of bodies of solar system, twisting of layers and latitudinal zones of shells of celestial bodies including inner layers and shells, etc. All the specified phenomena from the resulted list to some extent are discussed in the given work and illustrated on the basis of modern researches in Earth's sciences and the researches executed by means of space missions. In a complex, the executed researches have shown universality of discussed mechanisms and their important role in dynamics and geoevolution of planets and satellites in other planetary systems, and also stars and pulsars with the systems of planets (Barkin, 2009).

Slide 5.

The solution of a problem about relative translational oscillations of the core and mantle of the Earth, caused by eccentricity of the core and a lunar-solar gravitational attraction (Barkin, 2001)

$$\begin{aligned}x &= \sum_{\nu} x_{\nu} \cos(\Theta_{\nu} + \lambda) + y_{\nu} \cos(-\Theta_{\nu} + \lambda) + \sum_{\tau} \sum_{\nu} X_{\nu}(\tau) \cos(\tau\Theta_{\nu} - 2S - \lambda) + Y_{\nu}(\tau) \sin(\tau\Theta_{\nu} - S), \\y &= \sum_{\nu} x_{\nu} \sin(\Theta_{\nu} + \lambda) + y_{\nu} \sin(-\Theta_{\nu} + \lambda) + \sum_{\tau} \sum_{\nu} X_{\nu}(\tau) \sin(\tau\Theta_{\nu} - 2S - \lambda) - Y_{\nu}(\tau) \cos(\tau\Theta_{\nu} - S), \\z &= \sum_{\nu} z_{\nu} \cos(\Theta_{\nu}) + \sum_{\tau} \sum_{\nu} Z_{\nu}(\tau) \sin(-\tau\Theta_{\nu} + S + \lambda),\end{aligned}$$

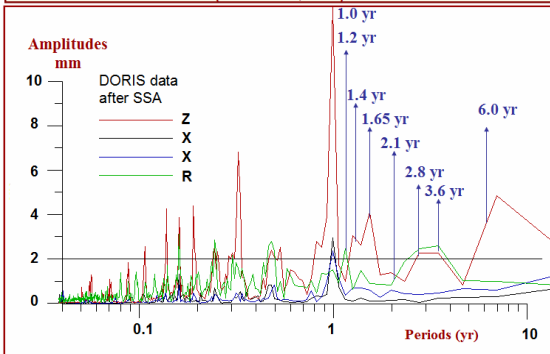
where

$$\begin{aligned}x_{\nu} &= \frac{3\rho_{\nu} B_{\nu} N^2}{2[(\Omega_{\nu} + \omega)^2 - k^2]}, & y_{\nu} &= \frac{3\rho_{\nu} B_{\nu} N^2}{2[(\Omega_{\nu} - \omega)^2 - k^2]}, & z_{\nu} &= -\frac{6z_0 B_{\nu} N^2}{\Omega_{\nu}^2 - k^2}, \\X_{\nu} &= \frac{3\rho_{\nu} D_{\nu}(\tau) N^2}{2[(\tau\Omega_{\nu} - \omega)^2 - k^2]}, & Y_{\nu} &= \frac{3z_0 C_{\nu}(\tau) N^2}{2[\Omega_{\nu}^2 - k^2]}, & Z_{\nu} &= -\frac{3\rho_{\nu} C_{\nu}(\tau) N^2}{(\tau\Omega_{\nu} - \omega)^2 - k^2}\end{aligned}$$

$$\Theta_{\nu} = \nu_1 I_M + \nu_2 I_S + \nu_3 F + \nu_4 D + \nu_5 \Omega, \quad \Omega_{\nu} = \nu_1 \Omega_M + \nu_2 \Omega_S + \nu_3 \Omega_F + \nu_4 \Omega_D + \nu_5 \Omega_{\Omega}$$

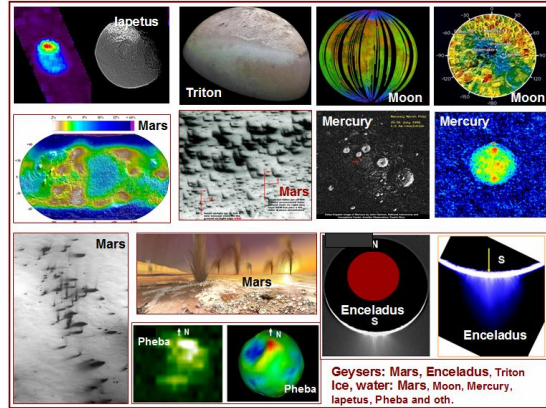
Slide 6.

Spectrum of variations of coordinates of geocenter (Zotov, Barkin, Lyubushin, 2008). Position of spectral lines of processes El Nino (Sidorenkov, 1997)

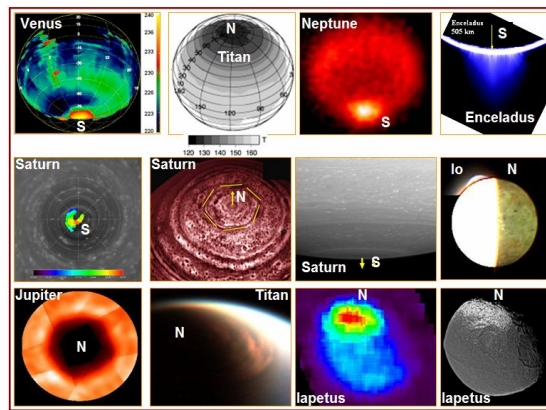


Slide 5 presents a structure of variations of the coordinates of the core of the Earth (w.r.t. mantle reference system with origin in center of mass of the mantle) due to gravitational influence of the Moon (and the Sun). Wide spectrum of frequencies Ω_{ν} are given by the combination of the known frequencies of lunar orbital theory. Θ_{ν} are combinations of basic arguments of the orbital motion. S is the angle of the Earth axial rotation with angular velocity ω . B_{ν} , C_{ν} and D_{ν} are classical functions of inclination of the axis of rotation of the Earth ρ . k^2 is a parameter of elastic interaction of the core and mantle in simple model of spherical core and mantle separated by elastic layer. If the core-mantle oscillations in reality have place it means that in position of center of mass of the full planet (the Earth) we must observed the space-temporal oscillations with identical basis of frequencies. Slide 6 illustrates this predicted phenomenon. In reality the center of

mass oscillates with frequencies which are observed in wide set of natural processes[1, 2].



Slide 7 (top), slide 8 (bottom).



Resume. Many reports on the planetary sciences, presented on GA EGU and on Europlanet in last years to some extent concern to mechanism discussed here, and corresponding results reflect the fundamental phenomena described above in a life of planets and satellites. Therefore in the future many results on planet dynamics will be reconsidered and investigated from positions of developed geodynamical model.

References

- [1] Barkin Yu.V. (2002) An explanation of endogenous activity of planets and satellites and its cyclisity. *Isv. sekcii nauk o Zemle Rossiiskoi akad. Ectestv.nauk. Vyp. 9, M., VINITI*, pp. 45-97. In Russian.
- [2] Barkin Yu.V. (2009) Moons and planets: mechanism of their life. *Proc. of Intern. Conf. "Astronomy and World Heritage: across Time and Continents"* (Kazan, 19-24 August 2009). KSU, pp. 142-161.