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Prediction of secular acceleration of axial rotation of Mars

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Secular motion of the Earth pole and non-tidal acceleration of its diurnal rotation have obtained rather precise explanation with the help of simple one-point model of the directed transport of fluid masses from a southern hemisphere in northern hemisphere with the general direction, given by geocentric axis **OP** directed to pole **P** with coordinates 70^0N, $104^03\ E$[1]. The another generalized model represents a system of two material points with masses m_2 and m_1, located on surface of the Earth at poles of geocentric axis **OP**. Masses are linearly changed in the time with velocities [2]: $\dot{m}_2 = 0.179 \cdot 10^{15}$kg/yrand $\dot{m}_1 = 0.043 \cdot 10^{15}$kg/yr.

A reduction of fluid masses of the appropriate thin spherical layer of the Earth correspond to secular increasing of masses of model points. The specified model has allowed to explain values of fundamental geodynamic parameters observably and determined during decades: a direction and velocity of drift of a pole of the Earth; value of non-tidal acceleration of axial rotation; to explain a secular variations of coefficients of the second, third, fourth, sixth and eighth zonal harmonics of a geopotential; coefficients of secular changes of a surface of ocean for the last approximately 150 years; a direction of secular drift of a geocenter and other planetary phenomena [3]. The role of the angular momentum of redistributed masses of the Earth in rotation of the Earth appeared not essential at the given stage of researches. On the essence the offered model has semi-empirical character as it bases on values of velocities of change of masses of points and the given position of axis **OP**. For their determination and estimations the part of the observant data was used, and other parameters were designed under analytical formulas. The obtained results have precisely confirmed competency and affectivity of geodynamic model [4] about existence of secular drift of a liquid core along radial direction **OP** with velocity about 2.6 cm/yr in the northern direction to Taimyr peninsula. Thus the gravitational attraction of superfluous mass of the core (19 % from the Earth mass) causes secular asymmetric inversion tide [2] of fluids which effectively manages to be modeled by two points with variable masses.

In the given work the attempt to construct a similar model of the directed secular redistribution of fluid masses of Mars from a southern hemisphere in northern is undertaken with the purpose of an explanation of observably tendencies in redistribution of masses between hemispheres and with the purpose of a prediction of the new phenomena in its rotary motion. The hypothetical assumption is made, that secular redistribution of fluid masses from a southern hemisphere in northern hemisphere of Mars mainly is determined by areocentric axis **OP** directed to the pole **P** with coordinates 57^0N, $82^0\ E$ (as is known in this direction the centre of mass of Mars relatively the centre of a figure on 2.8 km is displaced). Material points with masses m_2 and m_1 settle down at poles of geocentric axis **OP** on a surface of Mars, and their masses change linearly in the time with velocities [5]:

$\dot{m}_2 = 0.402 \cdot 10^{15}$kg/yr and $\dot{m}_1 = 0.257 \cdot 10^{15}$kg/yr.

The given modeling characteristics correspond to prospective secular variations of coefficients of the second and third zonal harmonics of gravitational potential of Mars: $\dot{J}_2 = -\ 57.0 \cdot 10^{-11}$ 1/yr and $\dot{J}_3 = -4.94 \cdot 10^{-11}$ 1/yr, more less agreed for today with the data of observations (Dehant, private communication, 2008) [6].

Let's emphasize, that the discussed phenomena of asymmetry of hemispheres, intensity of inversion processes, and bipolarity and inversion of all structures of Mars much more expressive, than at the Earth. Therefore we in the right to expect the greater efficiency in application of geodynamic model and more significant secular effects in rotation of Mars in comparison with the Earth.

The constructed model has allowed to estimate non-tidal acceleration of axial rotation which as it would be possible

to expect, essentially surpasses the similar characteristic of rotation of the Earth.

The obtained result means, that angular velocity of Mars in present period increases on the law $r = (0.708821808000 + 0.000000001038 \cdot t) \cdot 10^{-4}$ 1/s, here t - in years. It is possible assume that the estimation of acceleration can be obtained directly on the basis of the data of observations in the nearest years. Velocity of secular change of duration of day for Mars (LOD) thus can make significant value about -0.0903 ms/yr, that considerably surpasses similar value for non-tidal acceleration of the Earth (-0.006 ms/yr). The ratio of positive acceleration of the Earth rotation $\dot{r}$ to its angular velocity ω makes $\dot{r}/\omega = (6.9 \pm 1.7) \cdot 10^{-11}$ 1/yr[7]. In case of Mars the estimation of acceleration was carried out under the formula [8]: $\dot{r}/\omega = -\dot{C}\Big/C - \dot{R}\Big/G \approx -\dot{C}\Big/C = 103.8 \cdot 10^{-11}$ 1/yr.

We here have neglected by an influence of secular change of the axial angular momentum of fluid masses (atmospheric and underground) of Mars$\dot{R}$.

As shown in other my report on EGU GA 2009 in case of the Earth the total angular momentum of fluids really is small and within the limits of mistakes can be accepted equal to zero. In the case of Mars we the same as and in case of the Earth, expect of secular change of the angular momentum of Mars and change of global superrotation of its atmosphere which, at least, in part, will be compensated by the angular momentum of fluids. Thus, expected non-tidal acceleration of axial rotation of Mars can be at 10-15 times more those, but observably by astronomical methods, for the Earth. Certainly, the estimations obtained here are preliminary and the phenomena discussed here require more detailed studying with using of new data of precision observations. First of all it is important to obtain the specified values of secular variations $\dot{J}_2$ and $\dot{J}_3$.

In case of the Earth the tidal deceleration of daily rotation of the Earth essentially surpasses non-tidal acceleration (35 %) which as shown the author is caused by the directed redistribution of fluid masses of the Earth, in turn caused by polar drift of the centre of mass of the liquid core of the Earth to the north [1]. In case of Mars the opposite picture is expected. It is quite possible, as show the executed estimations, that tidal deceleration of axial rotation of Mars much less than its positive acceleration caused by global dynamics of shells (the core and mantle). And it means, that as against the Earth in axial rotation of Mars in the present epoch an acceleration, instead of deceleration of rotation should be observed.

References

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