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About possible secular drift of the pole of Mars

Yu.V. Barkin

Sternberg Astronomical Institute, celestial mechanics and gravimetry department, Moscow, Russian Federation
(barkin@inbox.ru, 07-495-9328841)

Secular drift of a pole of an axis of rotation of the Earth is studied more than 100 years. On the modern data the pole of an axis of rotation of the Earth is displaced along a meridian $72^0 9 \; W$ with angular velocity of $0"331 \pm 0"003$ 1/cy[1]. Ratios of equatorial components of angular acceleration $\dot{p}$ and $\dot{q}$ to angular velocity of the Earth ω make:

$$\dot{p}/\omega = 395 \cdot 10^{-11} \text{ 1/yr}, \quad \dot{q}/\omega = -1548 \cdot 10^{-11} \text{ 1/yr}$$

(on the appropriate axes of the Greenwich system of coordinates). A mechanical interpretation to this fundamental geodynamic phenomenon was given by author on the basis of geodynamic model of the forced interactions, oscillations and wanderings of the changeable and deformed of the core and the mantle of the Earth [2]. It was shown, that observably drift of a pole is there is not a result of postglacial rebound as sometimes it is accepted, but it is a consequence of much more fundamental phenomenon – of a secular drift of the liquid core relatively to the mantle.

The gravitational attraction of displaced (superfluous) mass of the core results in the directed planetary reorganization of fluid masses - to slow inversion redistribution of these masses from a southern hemisphere in northern. Last process supposes a simple modeling by two points with variable masses [2], [3]. It is possible to show, that the similar model of the directed reorganization of mass of a planet (and about even big basis) can be applied to the Mars [4].

On my geodynamic model [5] the observably constant displacement of the centre of mass of Mars relatively to its geometrical centre (on huge distance of 2.85 km in the direction of a geographical point $57^0 \; N$, $82^0 \; E$) there is a result of dynamic evolution of system the core – the mantle of this planet which can to proceed with the certain intensity and in present geological epoch.

I.e. by analogy to terrestrial processes we ascertain (we put forward a hypothesis), that on Mars is observed slow secular redistribution of fluid masses from a southern hemisphere in northern. As well as in the case of the Earth this process carries asymmetric, but strictly directed character. Such asymmetric slow redistribution of masses inevitably will result in secular variations of coefficients of gravitational potential of Mars, in particular in its coefficients of second and third zonal harmonics. The data available for today on variations of these coefficients basically already now allow to analyze these secular trends (more confidently for coefficient of the third harmonic J_3, and rather uncertainly for coefficient J_2). In the given work they are estimated by the following figures:

$\dot{J}_2 = -57.0 \cdot 10^{-11}$ 1/yr and $\dot{J}_3 = -4.94 \cdot 10^{-11}$ 1/yr.

On base of these values the secular variations of masses of modeling points located on a surface of Mars at poles of axis **OP** (with coordinates $57^0 N$, $82^0 \; E$ and $57^0 S$, $262^0 \; E$) have been determined:

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

It is possible, that value of velocity $\dot{J}_2 = -57.0 \cdot 10^{-11}$ 1/yr is overestimated. Longer series of observations are necessary for its specification. Therefore the estimations executed in the given work for parameters of drift of a pole and angular acceleration of axial rotation of Mars (in other my report on the given EGU GA), are especially preliminary and can be considered as numerical evaluations or examples. These estimations turn out on the basis of known formulas for a components of pole drift of a deformable planet [6]:

$$\dot{p} = (1 + \omega/\Omega) \left(\dot{C}_{21} \Big/ I - \dot{P} \Big/ G \right) \omega, \quad \dot{q} = (1 + \omega/\Omega) \left(\dot{S}_{21} \Big/ I - \dot{Q} \Big/ G \right) \omega.$$

Here $\dot{C}_{21}$ and $\dot{S}_{21}$ are velocities of secular changes of coefficients of gravitational potetial C_{21} and S_{21}. $\dot{P}$ and $\dot{Q}$ are velocities of secular changes of components of angular momentum of relative motion of the fluids of a planet. Ω is a Chandler frequency, taking into account rotational deformations of elastic planet, and ω is an angular velocity of diurnal rottaion of planet. $G = \omega C_0$ is an anperturbed value of angular momentum of rotation of Mars, C_0 is a polar moment of inertia.

Components $\dot{p}$ and $\dot{q}$ determine drift of a pole relatively to the main equatorial axes of inertia of a body in its non-deformed (or initial) state CX and CY. The appropriate components of the relative angular momentum $\dot{P}$ and also $\dot{Q}$ are referred to the specified axes. We have no any reliable data on secular variations a component of the angular momentum of all fluids of Mars. Therefore in the given work we shall be limited to estimations of influence only variations of geometry of mass:

$$\dot{p}/\omega \approx (1+\omega/\Omega)\left(\dot{C}_{21}\Big/I\right) = -0\text{"}73\ \text{1/cy}, \quad \dot{q}/\omega \approx (1+\omega/\Omega)\left(\dot{S}_{21}\Big/I\right) = -5\text{"}2\ \text{1/cy}.$$

Variations $\dot{C}_{21}$ and $\dot{S}_{21}$ were calculated for considered point-model of secular redistribution of masses of Mars under formulas:

$$\dot{C}_{21} = \dot{m}\sin 2\varphi\cos\lambda/\left(2m_P\right) = 6.5\cdot 10^{-11}\ \text{1/yr}, \quad \dot{S}_{21} = \dot{m}\sin 2\varphi\sin\lambda/\left(2m_P\right) = 46.5\cdot 10^{-11}\ \text{1/yr}.$$

Thus, within the framework of the considered model problem we come to a conclusion, that drift of a pole of Mars can occur with velocity about $v_P = 5\text{"}3$ 1/cy along meridian $98^0 0\ W$ (with angular velocity approximately in 17 times higher, than at the Earth pole drift). It is possible, that this value is overestimated because of too big value of a variation of coefficient of the second zonal harmonic has been accepted here. But even in view of this feature it is necessary to expect rather significant effects, both in acceleration of daily rotation, and in drift of a pole of Mars. And it means, that the significant effects described above can be open directly from observations in the nearest years. Grant RFBR 08-02-00367.

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