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An explanation of forms of planetary orbits and estimation of angular shift of the Mercury' perihelion using the statistical theory of gravitating spheroidal bodies

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Abstract

This work develops a statistical theory of gravitating spheroidal bodies to calculate the orbits of planets and explore forms of planetary orbits with regard to the Alfvén oscillating force [1] in the Solar system and other exoplanetary systems. The statistical theory of formation of gravitating spheroidal bodies has been proposed in [2]–[5]. Starting the conception for forming a spheroidal body inside a gas-dust protoplanetary nebula, this theory solves the problem of gravitational condensation of a gas-dust protoplanetary cloud with a view to planetary formation in its own gravitational field [3] as well as derives a new law of the Solar system planetary distances which generalizes the well-known laws [2], [3]. This work also explains an origin of the Alfvén oscillating force modifying forms of planetary orbits within the framework of the statistical theory of gravitating spheroidal bodies [5].

Due to the Alfvén oscillating force moving solid bodies in a distant zone of a rotating spheroidal body have elliptic trajectories. It means that orbits for the enough remote planets from the Sun in Solar system are described by ellipses with focus in the origin of coordinates and with small eccentricities. The nearby planet to Sun named Mercury has more complex trajectory. Namely, in case of Mercury the angular displacement of a Newtonian ellipse is observed during its one rotation on an orbit, i.e. a regular (century) shift of the perihelion of Mercury' orbit occurs.

According to the statistical theory of gravitating spheroidal bodies [2]–[5] under the usage of laws of celestial mechanics in conformity to cosmogonic bodies (especially, to stars) it is necessary to take into account an extended substance called a *stellar corona*. In this connection the stellar corona can be described by means of model of rotating and gravitating spheroidal body [5]. Moreover, the parameter of gravitational compression α of a spheroidal body (describing the Sun, in particular) has been estimated on the basis of the linear size of its kernel, i.e. *the thickness of a visible part of the solar corona.*

Really, NASA' astronomer S. Odenwald in his notice «How thick is the solar corona?» wrote: "The corona actually extends throughout the entire solar system as a "wind" of particles, however, the densist parts of the corona is usually seen not more than about 1–2 solar radii from the surface or about 690,000 to 1.5 million kilometers at the equator. Near the poles, it seems to be a bit flatter..." [6]. In the fact, as mentioned in [5], a recession of plots of dependences of relative brightness of components of spectrum of the Solar corona occurs on distance of 3–3.5 radii from the center, i.e. on 2–2.5 radii from the edge of the solar disk.

Thus, accepting thickness of a visible part of the solar corona equal to $\Delta = 2R$ (here R is radius of the solar disk) we find that $r_* = R + \Delta = 3R$, where $r_* = 1/\sqrt{\alpha}$. In other words, the parameter of gravitational compression $\alpha = 1/r_*^2$ of a spheroidal body in case of the Sun with its corona (for which the equatorial radius of disk $R = 6.955 \cdot 10^8$ m) can be estimated by the value [2]–[5]:

$$\alpha = \frac{1}{(3R)^2} \approx 2.29701177718 \cdot 10^{-19} (\mathrm{m}^{-2}). \quad (1)$$

So, the procedure of finding α is based on the known 3σ-rule in the statistical theory.

Really, as shown in the monograph [5], namely the solar corona accounting under calculation of perturbed orbit of the planet of Mercury allows to

find the estimation of a displacement of perihelion of Mercury' orbit for the one period within the framework of the statistical theory of gravitating spheroidal bodies. As it is known, on a way of specification of the law of Newton using the general relativity theory the Mercury problem solving was found [5]. Nevertheless, from a common position of the statistical theory of gravitating spheroidal bodies the points of view as Leverrier (about existence of an unknown matter) and Einstein (about insufficiency of the theory of Newton) practically differ nothing. Really, there exist plasma as well as gas-dust substance around of kernel of cosmogonic body (in particular, the solar corona in case of the Sun), i.e. the account of circumstance that forming cosmogonic bodies have not precise outlines and are represented by means of spheroidal forms demands some specification of the Newton' law in connection with a gravitating spheroidal body [2]–[5].

So, with the purpose of Mercury' trajectory finding within the framework of the statistical theory of gravitating and rotating spheroidal bodies it is necessary to estimate gravitational potential in nearby removal from the Sun, i.e. in a remote zone of a gravitational field and in immediate proximity to a kernel of a rotating spheroidal body. Taking into account that the orbit of planet Mercury entirely lays in one plane of polar angle $\theta = \theta_0 = const$ we should use the formula [5]:

$$\varphi_g(r)\Big|_{r>r_*} = -\frac{\gamma M}{r\sqrt{1-\varepsilon_0^2 \sin^2 \theta_0}}, \qquad (2)$$

where $r_* = 1/\sqrt{\alpha}$, α is a parameter of gravitational compression of a spheroidal body, M is its mass, γ is the Newtonian gravitational constant, ε_0 is a geometrical eccentricity of kernel of a rotating and gravitating spheroidal body ($\varepsilon_0^2 << 1$) [2]–[5].

This work shows that in view of greatest proximity on distance to the Sun and essential inclination of orbit of Mercury the projection of a point of perihelion of its orbit can directly get in a nearby vicinity of the Sun, namely, in the visible part of the solar corona.

In the monograph [5], using Binet' equation and formula (2) the equation of disturbed orbit of a planet (the Mercury) in a vicinity of a kernel of a rotating and gravitating spheroidal body has been derived. The obtained relation expresses the equation of the so-called "disturbed" ellipse in polar coordinates with the origin of coordinates in focus, i.e. the planet Mercury is moving on a *precessing elliptic orbit* in view of the fact that there is a modulating multiplier of a phase (or azimuth angle). So, within the framework of the statistical theory of gravitating spheroidal bodies the required angular moving of Newtonian ellipse during one turn of Mercury on the disturbed orbit (or displacement of perihelion of its orbit for the period) has been estimated [5]:

$$\delta\varepsilon = \frac{2\pi(3+e)\cdot\varepsilon_0^2}{\alpha\cdot a^2(1-e^2)^2}, \qquad (3)$$

where through a and e a major semi-axis and an eccentricity of Mercury's orbit are designated respectively, α is a parameter of gravitational compression (1) and ε_0 is a geometrical eccentricity of kernel of a rotating and gravitating spheroidal body (the Sun) [5]. Thus, according to the proposed formula (3) the turn of perihelion of Mercury' orbit is equal to 43.93" in century that well is consistent with conclusions of the general relativity theory of Einstein (whose analogous estimation is equal to 43.03") and astronomical observation data (43.11 $\pm$ 0.45") [5].

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