Gravitation, Field, and Rotation of Mercury Perihelion

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This paper considers the basic components of the problem of Mercury's perihelion rotation. It is shown that the finite speed of gravity propagation offered by Paul Gerber has no substantiation. It is established that under the influence of Newtonian gravity, the perihelion turns in a motionless reference system by 529.9" per century, whereas the data of observation shows that it turns on 582.3" per century. In early work, the effect rotation of the Sun on the movement of planets was not taken into account. The paper offers a compound model of rotation of the Sun, which allows this influence to be taken into account. In view of rotation of the Sun, Newton's law of gravity defines all sizes of perihelion rotations and defines all features of the planets' movement.

1. Introduction

Let the interaction of two bodies - to be exact, two point-masses - under Newton's law of gravitation, make the orbit of one of them relative to the other be an ellipse. If besides these two bodies - for example, the Sun and Mercury – there will be still other bodies, the orbit of Mercury relative to the Sun will change; in particular, it will rotate in the direction of orbital movement. As a result of integration of the equations of motion, the average rate of rotation is found to be 530" per century. However, as a result of the analysis given the observation in the 19th century, the rotation of the perihelion of Mercury was found to be 571" per century. For an explanation of the difference of 41", various hypotheses were invoked: influence of other bodies, ellipticity of the Sun, finite speed of gravity propagation, *etc*. Paul Gerber developed the last hypothesis mathematically in 1898 [1]. He aimed to define the speed of gravity propagation on the basis of speculative representations about the influence of one body on another. He counted the basis for this influence to be the resistance of the environment between the two bodies when one aspires to increase distance between them. Gerber considered that with a change of position of the bodies, the environment needs a certain time to make this work. Thus, he found an expression for the potential V of the influence of a body with mass m_1 on a body with mass m_2:

$$V = \frac{G(m_1 + m_2)}{r(1-\beta)}, \qquad (1)$$

where $\beta = v/c$, v is velocity of the second body relative to the first, c is the speed of light in vacuum, G is the gravitational constant, and r is the distance between the bodies.

From the potential V (1), Gerber wrote down the differential equation of motion of body m_2 relative to body m_1, and as a result of approximate analytical solution, derived an expression for the displacement of the pericenter of the orbit of body m_2 for one period T of its circuit:

$$\Delta\varphi_p = \frac{24\pi^3 a^2}{T^2 c^2 (1-e^2)}, \qquad (2)$$

where a is the orbit major semi-axis and e is its eccentricity.

Given the displacement of the perihelion of Mercury of 41" per century, Gerber determined from (2) the speed of gravity propagation of $c = 305500$ km/sec.

Clearly the idea about finite speed of gravitation follows from the assumption that two bodies cannot interact at a distance, so their interaction has to be caused by the environment that exists between them. Gereber realized the conditional character of the result (2), as confirmed by the following phrase [1]: "Certainly, nobody will deny that movement of the Mercury perihelion of angle 41" per century may depend on other, to us some more unfamiliar, circumstances, and consequently obligatory necessity for finite speed of gravity propagation of the potential is not present."

A. Einstein [2] in 1915 fixed P. Gerber's conclusion and the basic result (2) in the basis of the General Theory of Relativity (GTR). Gerber had searched for the answer to a question: what may be speed of gravity propagation. But Einstein, accepting the speed of gravity equal to c, defined the displacement of the Mercury perihelion as (2). Further, on this basis he designed GTR in four-dimensional curvilinear geometry, besides in tensorial execution. The queerness and complexity of this mathematics has caused a mass of problems, behind which the physical essence of the starting positions was lost.

Actually, except for this complexity, GTR has added nothing to Gerber's result. The result (2) received by him is caused by a kind of gravitational potential (1). And the derivation of the last is based, as it was already remarked, on speculative representations about gravitational interaction. What should be the kind of force of interaction of two bodies if gravitation is propagated with finite speed? Except for Gerber's speculative representations, other expressions for gravitational potential are also known; for example, the potential of Weber. Additionally, the force formula may be determined differently from the same expression for potential.

For definition of force we went the following way. As is known, the electromagnetic interaction is propagated at the speed of light. Based on experimental laws of electromagnetism, we have received the differential equation for force of interaction of one charged particle with a charge q_1 on another with a charge q_2, after which solution we have determined the force in such view [3]:

$$\mathbf{F}_{12} = k\frac{\mathbf{R}_{12}\left(1-\beta^2\right)}{\left[R_{12}^2 - \left|\boldsymbol{\beta}\times\mathbf{R}_{12}\right|^2\right]^{3/2}} \quad , \tag{3}$$

where $\mathbf{R}_{12}$ is the radius-vector from the first particle to the second, $k = k_e = q_1 q_2 / \varepsilon$, ε is the dielectric permittivity of the environment between the particles, $\boldsymbol{\beta} = \mathbf{v}_{12} / c_1$, $\mathbf{v}_{12}$ is the velocity vector of the second particle relative to the first; $c_1 = c/\sqrt{\mu\cdot\varepsilon}$ is speed of propagation of electromagnetic influence in the environment, and μ is the magnetic permeability of the environment.

Coulomb's Law defines the force of interaction of charged particles that are motionless relative to each other. Its difference from the law (3) for the charged particles moving relative to each other is caused by the finite speed of propagation of electromagnetic influence. If we apply this difference for the Newton law of gravity, then the expression (3) with $k = k_g = -Gm_1 m_2$, where m_1 and m_2 are masses of interacting bodies, will determine the force of the gravitational interaction that propagates with speed of light..

From force (3) we have numerically integrated the equations of interaction of two bodies for different situations, and have received the whole spectrum of possible trajectories [4-6]. For ellipse-like trajectories, the difference of force (3) from Newton gravity force consists in the change of semi-axes of orbits a, period T, and the turn of perihelion on the value $\Delta\varphi_p$ (see Table 1).

e	β_p	$\delta\varphi_p$	δa	δT
0.25	0.1	–0.003	0.0084	0.0065
	0.3	–0.032	0.076	0.055
0.43	0.1	–0.002	0.0072	0.007
	0.3	–0.025	0.066	0.060

Table 1. Normalized changes of parameters of orbits at different eccentricities e orbits and the different non-dimensional velocities β_p in the perihelion.

In Table 1, the normalized changes were determined; for example, for semi-axis a so: $\delta a = (a_N - a_\beta)/a_N$, where a_N is orbit semi-axis with interaction under Newton's law, and a_β is the same under the law (3). From the Table it is visible that change of semi-axis δa and of the period δT twice exceeds the displacement of the perihelion $\delta\varphi_p$. However, the results of observation of changes δa and δT do not agree. For the Mercury perihelion the force (3) gives $\Delta\varphi_p = 0.23''$ per century; *i.e.*, 200 times less than the value derived by Gerber and accepted in GTR. The solution of this task shows us that the approximate integration of the equation of motion for potential (1) by Gerber was very rough. Therefore, displacement of the perihelion (2) may essentially differ from the exact result that is caused by potential (1). So, probably, at the correct solution of the task, the result of Gerber and of GTR will come nearer to the the perihelion displacement $\Delta\varphi_p = 0.23''$ per century received by us.

So, the unique proved mechanism of finite speed of gravitation is the mechanism that follows from analogy of gravitation to the electromagnetic influence. At this speed of gravity propagation, the perihelion rotation makes only $0.23''$ per century. Besides, the finite speed of gravitation results in change of other characteristics of the orbit, for example, the cycle time T, semi-axis length a, *etc*. However, Newton's law of gravitation well describes all other parameters of the Mercury orbit. Therefore, finite speed of gravitation may not cause this phenomenon. Apparently, there should be another reason for the abnormal rotation of the perihelion of Mercury. This other reason should result in displacement of the perihelion of the Mercury orbit, but not change its eccentricity, the cycle time T, or inclination and position of ascending node.

2. Changes of Mercury's Orbit, According to Newton's Law, and Observation

For more than ten years we have been engaged in research on the evolution of orbital and rotary movement of the Earth and planets [7, 8]. We have developed a new method for numerical integration of the equations of interaction of n_2 bodies under Newton's law of gravity:

$$\frac{d^2\mathbf{r}_i}{dt^2} = -G\sum_{k\neq i}^{n2}\frac{m_k\mathbf{r}_{ik}}{r_{ik}^3} \quad , \quad i = 1,2,\ldots n_2, \tag{4}$$

where $\mathbf{r}_i$ is the radius-vector m_i relatively the centre of mass of the Solar system, $\mathbf{r}_{ik}$ is the radius-vector from body with mass m_k up to body with mass m_i.

The method is realized as program 'Galactica' in FORTRAN. Its accuracy greatly exceeds the accuracy of other methods, which are known from scientific publications. By this method we have integrated the equations of motion of planets, the Moon and the Sun, *i.e.* for $n_2 = 11$, for different intervals of time, including for 100 million years [9]. As a result of repeated comparisons of the received results to results of observation and results of other authors, we have found that all observed features of planets movements are described by our numerical solutions. The only exception is the velocity of movement of the Mercury perihelion: it differs by 9% from the observed result. The researched angular parameters of the Mercury orbit are displayed on Fig. 1.

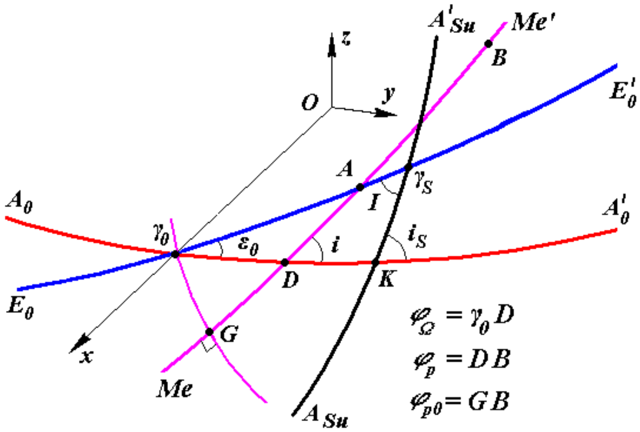

Figure 1. The parameters of Mercury's orbit in a motionless equatorial heliocentric system of coordinates x, y, z : $A_0A'_0$ is the plane of the Earth equator in initial epoch T_0, $E_0E'_0$ is a plane of the Earth orbit (a plane of motionless ecliptic) in initial epoch T_0, $M_eM'_e$ is the plane of Mercury's orbit in any epoch T, $A_{Su}A'_{Su}$ is the plane of the Sun equator in any epoch T, γ_0 is the point of a spring equinox in epoch T_0; B *is* the position of Mercury's perihelion on the celestial sphere; $\varphi_\Omega = \gamma_0 D$ is angular distance of the ascending node of the orbit; $\varphi_p = DB$ and $\varphi_{p0} = GB$ are angular distances of the perihelion; i is angle of inclination of the orbit plane to the plane of motionless equator.

The integration of Eqs. (4) is carried out in the inertial system of coordinates x, y, z, which basis is set in an initial epoch, for example J2000.0, a plane of Earth equator $A_0A'_0$. Therefore we determine the angular position of the point of perihelion B from the plane of equator $A_0A'_0$, *i.e.* $\varphi_p = DB$. However, the point D at change of position of orbit $M_eM'_e$ is displaced along it and brings the contribution to value φ_p. To reduce it, we count the position of the perihelion from point G, which is received as a result of crossing a perpendicular circle $\gamma_0 G$ with circle $M_eM'_e$ of plane of the Mercury orbit, *i.e.* $\varphi_{p0} = GB$.

On Fig. 2, the results of integration by program Galactica of the equations of motion (4) are compared to approximations of observation given by S. Newcomb [10] and by J.L. Simon *et al.* [11]. The method of integration, its errors and initial conditions are described in detail in our work [9]. The polynomial dependences of Newcomb and of Simon *et al.* are given in mobile ecliptic coordinates. Their transformation to motionless equatorial system is also given in [9]. On Fig. 2, the points *1* submit the dynamics of parameters of the Mercury orbit computed by us: an eccentricity e, longitudes of ascending node φ_Ω, the angle of inclination of the orbit plane i, the angle of the perihelion position φ_{p0} and both deviations of semi-axis Δa and cycle time ΔT_{tr} from their average values. The dash and continuous lines represent the same values received from observation. It is necessary to note that the base of observation does not exceed 2000 years. For this reason, their reliability is limited to this period of time. As we see from the graph, the approximations 2 and 3 of angle of an inclination i beyond this interval of time begin to deviate from the dependence 1 computed by us. From the graph it is visible that results of observations 2 and 3 will be well coordinated to results of solutions of the differential equations (4) for elements e, i, φ_Ω within the several thousand years in the past and in the future from initial epoch. As the rates of change of parameters of the orbit in the present period in the best degree represent distinctions they are given for epoch J2000.0 in Table 2. As we see, the greatest difference is present for rate of change of the perihelion $d\varphi_p / dT$: according to the approximations of [10-11] of observation data, it is equal 582.3" per century, against at the integration of the Eqs. (4) of gravitational interactions of bodies under Newton's law it is equal 529.9" per century. We have repeatedly checked these results; therefore, the difference between them makes 52.4" in one century instead of, as it was accepted in the beginning of 20-th century, 41" per century.

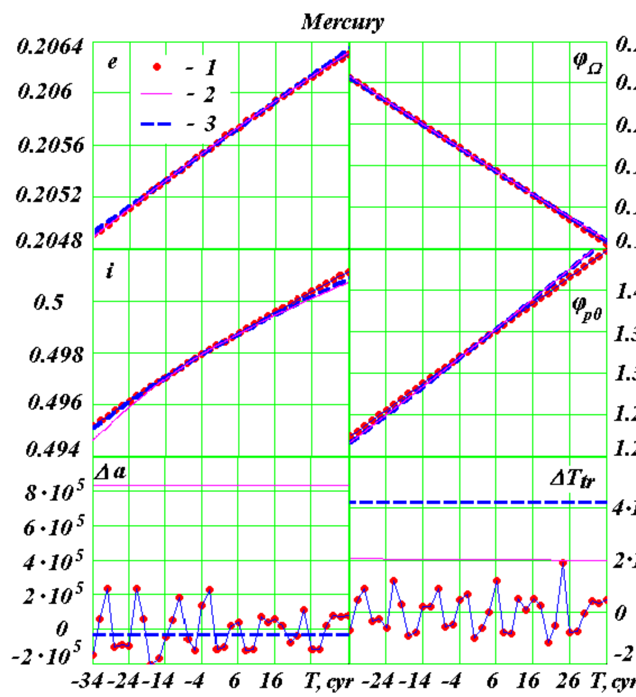

Figure 2. The change of Mercury orbit on interval -3.4 to +3.6 thousand years by results of integration of the Eqs. (4) (see point 1 on the graph) and its comparison to approximation of the observation data of S. Newcomb (line *2*) and J.L. Simon *et al.* (line *3*): e is eccentricity; angles: i, φ_Ω and φ_{p0} are given in radians, and their designation see on Fig. 1; Δa is the deviation of the major semi-axis in meters from its average value $a_m = 5.79091129 \times 10^{10}$ m and ΔT_{tr} is the deviation of the cycle time in Julian centuries from its average value $T_{trm} = 2.40842427 \times 10^{-3}$ cyr. T is time in Julian centuries from 30.12.1949; the interval between points is 200 years. The average values a_m and T_{trm} are received by integrating Eqs. (4).

On Fig. 2, the deviations of major semi-axis of orbits Δa and of durations of period ΔT_{tr} also are compared. It is visible that their values will be coordinated to the Newcomb results and the Simon *et al*. results are within the framework of distinctions between the last. The semi-axis a and period T_{tr} are functionally connected; for example, in the interaction of two bodies this connection looks like:

$$T_{tr} = 2\pi a^{3/2} \Big/ \sqrt{G(m_{Me} + M_S)}\,, \tag{5}$$

where m_{Me} and M_S are accordingly the masses of Mercury and of the Sun.

The synchrony of fluctuations Δa and ΔT_{tr} by results of our solutions confirms this connection (5). The absence of such synchrony in the results of the above mentioned authors testifies that values of errors of their results have the order of values of deviation Δa and ΔT_{tr}.

Also it is necessary to note the presence of fluctuations of the results received by us. Similar to fluctuations Δa and ΔT_{tr} there are fluctuations of other orbit parameters. Therefore at definition of rates of their change we approximated the received results for parameters e, i, φ_Ω and φ_{p0} parabolas. Such a method, and also the choice of reference system, have together allowed receiving reliable results on rates of parameters change.

Table 2. The comparison of rates of parameters change of the Mercury orbit on epoch 2000.0, *JDS* = 2451545: *Nc* and *Sim* is century changes of Newcomb, and J.L. Simon *et al*., by results of observation; $n_2 = 11$, 16, 21 - by results of integration of the Eqs. (4) with the usual Sun ($n_2 = 11$) and with Models of the Sun No. 4 and No. 5, accordingly.

Rates	The change of parameter for one century (angles i and φ_Ω in radians, φ_{p0} - in angular seconds)				
	Nc	Sim	n_2=11	4-th mod. n_2=16	5-th mod. n_2=21
de/dT	2.04E-5	2.0406E-5	2.0253E-5	2.0228E-5	2.0228E-5
Di/dT	8.1302E-5	8.1047E-5	8.5020E-5	7.4037E-5	7.4037E-5
$d\varphi_\Omega/dT$	-5.6510E-4	-5.6510E-4	-5.7229E-4	-5.9606E-4	-5.9606E-4
$d\varphi_{p0}/dT$	582.05	582.53	529.86	581.64	581.64

3. Influence of Rotating Sphere on Point-Mass

The gravitational influence of one body on another is determined by Newton's force of gravity. Unfortunately, in the 18th century a field was inserted, and the gravitational influence began to be represented so: The first body creates a field, and this field acts on the second body. The concept of a field has resulted in many mistakes in contemporary science, and has also resulted in errors in calculation of gravitational interactions. One such mistake exists in the understanding of the influence of a rotating body. For example, a homogeneous sphere, rotating or not rotating, has the same distribution of gravitational potential around itself, and creates the same gravitational field. Therefore one automatically considers that these two situations will influence equally a point-mass (PM) moving around the sphere. But actually, it is not so. Each part of the rotating body, relative to the PM, goes differently. This movement will be reflected in the interaction of this part with PM. The distinction of interactions will be precisely the same, as well as at the influence of one point-mass on another. If in the beginning the second PM is motionless relative to the first PM, the second PM will move in its direction. If the initial speed of the second PM is directed perpendicularly, their lines of connection, then depending on the size of velocity of this PM, it will move on a circle, or on ellipse, or on parabola, or on hyperbole.

So, the rotating body will influence the point-mass not as the non-rotative body. To define the influence of the rotating body on the PM, it is necessary to integrate the equation of motion of the PM with interaction according to Newton's force of gravity of all parts of the rotating body. Such a task is very difficult, and, probably, sometime it will be solved. We went on another way, and have considered compound model of rotating body. We represent its rotation as several bodies axisymmetricly located in one plane, that as a result of mutual gravitation rotate around of the central body. By varying their parameters it is possible to make some characteristics of rotation of the compound model and the considered body identical. We have created such compound model of rotation of the Earth and investigated it [12, 13]. The evolution of such model has well represented the evolution of the axis of Earth rotation.

4. The Compound Model of Sun Rotation

In the present work we represent compound model of rotation of the Sun. But as against the compound model of the Earth, here we investigated the influence of such a compound Sun on the evolution of the planets orbits. The compound model (see Fig. 3) represents n bodies with mass m_1 in regular intervals located on a circle of radius a around the central body with mass m_0. The mass of all $n+1$ bodies is equal to mass of the Sun:

$$m_1 n + m_0 = M_S\ . \tag{6}$$

The compound model of the Sun is based on the results of our exact analytical solution [3, 14] of problems of interaction of the n-bodies located axi-symmetrically on the plane around of the central body.

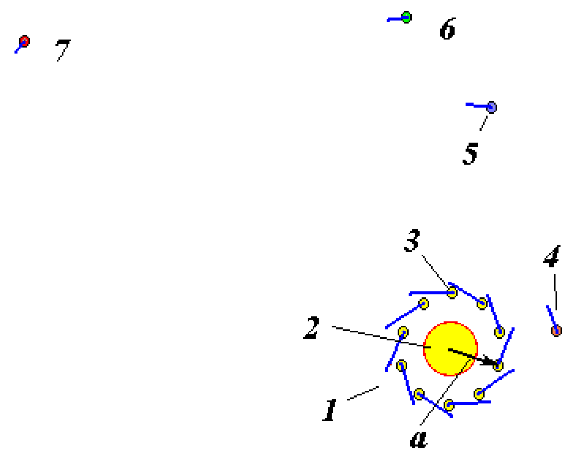

Figure 3. The compound models of the Sun rotation and their parameters for Solar mass $M_S = 1.98892 \times 10^{30}$ kg and radius $R_S = 6.97113 \times 10^{8}$ m: *1* – the compound model of the Sun; *2* - the central body; *3* – the peripheral body in Model No. 5; *4* - Mercury; *5* - Venus; *6* - the Earth and the Moon; *7* - Mars; the other planets are outside the Figure. The positions of bodies are given for 30.12.49. By lines at the bodies are given the vectors of their velocities.

Table 3. Results.

Model Number	n	$m_1 \times 10^{-23}$	$a \times 10^{-10}$
		kg	m
2	5	604.8	2.528358
3	5	1.966	2.528449
4	5	1.565	2.528449
5	10	0.782	2.528449

We have received the force of influence on each peripheral body in the following form:

$$F = G\left(m_0 + m_1 f_n\right) m_1 / r^3 \quad , \qquad (7)$$

where r is the distance from the central body m_0 up to peripheral body m_1, and the function f_n, depends on the number of bodies n:

$$f_n = 0.25 \sum_{i=2}^{n} \frac{1}{\sin\left[(i-1)\pi / n\right]} \quad . \qquad (8)$$

From physical reasons it follows that such a model will be identical to rotating Sun in influence on planets, if their angular velocities of rotation will coincide, such that the masses of parts of the rotating Sun coincide with masses of the n peripheral bodies of mass m_1, and also the distance of these bodies up to planets coincide with distance of rotating masses of the Sun up to planets. However, it is impossible to execute the last two conditions, as the compound model may exist at $a : 36R_S$, where R_S is the radius of the Sun. Therefore it is possible to vary only the quantity of peripheral bodies n and their mass m_1. Upon research into the compound model of the Earth [12, 13], it was found that the quantity of bodies $n = 5$ is optimum from the viewpoint of labor input and output adequacy. Therefore, the results submitted below were received with $n = 5$, with four variations of m_1 and one variantin of n.

At force (7) and angular velocity of the Sun ω_S, the radius of the circular orbit is defined by the expression

$$a = [G(m_0 + m_1 f_n) / \omega_S^2]^{1/3} \quad , \qquad (9)$$

where $\omega_S = 2\pi / T_S$ and $T_S = 25^d.38 \cdot 24 \cdot 3600$ is the sidereal period of rotation of the Sun in sec.

So, at given m_1 and n from (6), the mass of the central body m_0 is defined, and from (9) is defined the semi-axis a of the circular orbit of peripheral body. Bodies are located in the equatorial plane of the Sun, which in the data of R.Ch. Carrington [15,16] is inclined to the ecliptic plane J2000.0 (see Fig. 1) under angle $I = 7.^o25$, and the longitude of ascending node is $\Omega = \gamma_0 \gamma_S = 75.^o76 + 1.397 \cdot T$, where T is time in Julian centuries from epoch J2000.0. By values I and Ω the coordinates and velocities of bodies of the Sun compound model will be transformed in equatorial barycentre system of coordinates.

The equations of interaction (4) including planets, the Moon and bodies of compound model of the Sun, in all $n_2 + n$ bodies, we have integrated numerically and have carried out the researches similar submitted on Fig. 2. The orbits of four planets were investigated: from Mars up to Mercury. Five compound models of the Sun were investigated. In Model 1, the radius a of the compound model was equal to radius of the Sun R_S. However, this model appeared unstable. Parameters of other models are given in Table 3 with Fig. 3.

For Model 2 with the greatest mass m_1 of peripheral bodies *3* the dynamics of the parameters e, i, φ_Ω, φ_{p0}, which submitted on Fig. 2, has fundamentally changed. For example, the angle of inclination i began to decrease, rate of perihelion change considerably increased, and fluctuations Δa and ΔT_{tr} have increased by two orders. The similar influence of this model rendered into the orbit of Venus, but with smaller amplitudes of fluctuations; for example, values Δa and ΔT_{tr} have all increased by one order.

The values of changes of orbits of the Earth and Mars decreased, and for the Mars orbit, only the inclination angle i has essentially changed, and deviations Δa and ΔT_{tr} have practically not changed.

Let us designate the rates of perihelion change of Mercury in the Model 2 as $\varphi'_{p02} = d\varphi_{p0} / dT$ = 20704" per century, and the received by integration of the Eqs. (4) with the usual Sun designate φ'_{p00} and as the result approximations of observation designate φ'_{p0a}. Considering, that the influence of the compound model of the Sun is proportional to the mass of peripheral bodies, it is possible, having made a proportion from the above-stated values, to determine the new mass m_{1n} of a peripheral body:

$$m_{1n} = m_{12} \frac{\varphi'_{p0a} - \varphi'_{p00}}{\varphi'_{p02} - \varphi'_{p00}}, \qquad (10)$$

where m_{12} is the mass of the peripheral body in Model 2.

In the Model 3, the mass of peripheral body was taken close to the value that follows from (10). Thus the rate of change of the Mercury perihelion was received as φ'_{p03} = 594.9" per century, *i.e.* more than the observed one. The subsequent refinements of mass of peripheral body have resulted in Model 4. To check the influence of quantity of peripheral bodies, in Model 5 it was doubled to 10, and the mass m_1 was twice reduced. The results of Models 4 and 5 on the rates of parameter change for the Mercury orbit are given in Table 2. As Table 2 shows, they coincide. Thus the rate of perihelion rotation of 581.6" per century is close to the observed value 582.3" per century. With further refinement of the peripheral-body mass m_1, it is possible to make these rates equal.

From Table 2, the compound model of the Sun rotation has apparently also resulted in change of rate of the inclination angle di/dT of about 8.5×10^{-5} radian per century, up to 7.4×10^{-5}. This change is directed toward rapprochement with value 8.1×10^{-5} radian in one century received according to observation. However, the tendency is too strong; therefore, in view of the compound model the result coincides worse with observation, than without its account. The same situation, but in smaller degree, is present for $d\varphi_\Omega/dT$.

The parameters i and φ_Ω (see Fig. 1) define the orbit plane of Mercury. As the semi-axis orbits of compound model a is equal 0.437 of semi-axis of Mercury orbits the peripheral bodies of compound model render strong influence on a plane of the Mercury orbit. And the received change of rates i and φ_Ω is the evidence of that. It is obvious that rotating masses, being located on the Sun, will not cause this change.

The compound models of the Sun 4 and 5 have not changed values of deviations of semi-axis Δa and cycle time ΔT_{tr} of Mercury. These models did not render appreciable influence on the orbit parameters of Venus, and the orbits of the Earth and the Mars have practically remained without change. Thus, the influence of the rotating Sun, imitated by its compound model, results in additional displacement of the Mercury perihelion, and does not render any significant influence on other parameters of the Mercury orbit, or on the parameters of the orbits of other planets.

Conclusions

1. The mechanism of finite speed of gravitation offered in 1898 by Paul Gerber is speculative and has no a substantiation.

2. The mechanism of finite speed of gravitation based on analogy to electromagnetic influence gives displacement of the perihelion 0.23" per century, which by more than in 200 times is less than the difference between observation and calculations under the Newton law of gravity.

3. The updated rate of perihelion rotation of Mercury relative to motionless space is 582.5" per century, and by calculations under Newton's law of gravity it is 529.9" per century; *i.e.* the difference between them is equal to $\Delta\varphi_{p0}$ = 52.6" per century.

4. The finite speed of gravitation should result in not only change of displacement of perihelion $\Delta\varphi_{p0}$, but also two times larger changes of the cycle time ΔT_{tr} and length of semi-axis a. As these changes are not observed, the finite speed of gravitation may not explain displacement of the perihelion of Mercury.

5. The result received as a of Newtonian interaction rate φ'_{p0} = 529.9" per century does not take into account the influence of the rotation of the Solar mass. Accounting for the Sun rotation by a compound model allows compensating difference $\Delta\varphi_{p0}$ with observation, not changing the period ΔT_{tr} and semi-axis of Mercury's orbit a, and also parameters of orbits of other planets.

6. The concept of field inserted into mechanics complicates understanding of interactions between bodies. The influence of a rotating body on a point-mass moving relative to it differs from the influence of a non-rotating body. In view of the influence of the rotating Sun, Newton's law of gravity defines all features of movement in the Solar system.

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