ROTATION EFFECTS OF BODIES IN CELESTIAL MECHANICS

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Abstract

The gravitational equations of Heaviside are used to derive the equations of celestial mechanics. The derivation includes additional terms to the gravity potential that account for the spin (torsion) field of the sun and the galaxy which are ignored in both Newtonian theory as well as Einstein's Theory of Relativity. These *'spin'* terms account for rotation of the sun, planetary bodies, artificial satellites, and other space objects as well as the contraction of the elliptical orbits of the planets to the ecliptic plane. The consequences of the gravity theory of Heaviside are numerically verifiable and represent a modern approach to better understand Astronautics.

Introduction

One of the questions that is raised in this effort is how one could explain the possibility of a rotational torque that could be a function of a gravitational field. This could, for example, explain why satellites rotate in the same direction and require a means to compensate for this rotation. Both Newtonian mechanics and Einstein's Theory of Relativity concerning space-time curvature do not offer any explanation for such a phenomenon. The closest one comes to any possibility that this exists is in Jefimenko when he derives a gravity model somewhat along the same lines as a Lorentz force. His objective is to include the relativity factor within the gravity model. Interestingly, the model reveals a gravitational torque, which he suggests explains why the same face of the moon is always visible to the Earth.

This is powerful logic. The larger question looms and that in examining each of the planets within the solar system, they all lie within the same plane wit the exception of the first and the last. One could rationale this in that the last may have been recently captured as a free body travelling through space. With much time in the sun's gravitational field, its orbit will circularize as the other planets and it will find its own unique position without crossing the orbit of its neighbor. Moreover, the plane of the orbit will also fall within the plane of the solar system. The first planet could have been created directly from the sun and will slowly seek its stable location within its plane and also align its orbit plane with the rest of the solar system as well.

Most of the planets also rotate in the same direction as well as the moon around the Earth with very few exceptions. This behavior is widespread and implies that gravitational fields include more than a radial attractive force but that a moment also exists. This is one possibility. Another possibility is that such a rotation could be created by another, less obvious field component and could provide insights into physical vacuum theory which suggests the void consists of electric, magnetic, gravitic, and spin fields. This is in contrast to the Zero-Point field, which relies upon quantum mechanical creation and annihilation of quantum particles. Interestingly, both have there genesis in ideas brought forth by Sahkarov but somehow, possibly due to differences in translation, have taken divergent paths. These are issues of concern which may offer an explanation to this phenomenon.

Discussion and Analysis

1. The gravidynamical equations of Heaviside and a gravitational force of Lorenz

The Heaviside's equations [1] may be considered in a similar form as the Maxwell's equations:

$$\begin{aligned}
&\mathrm{div}\mathbf{D}_G = -\rho_G;\\
&\mathrm{rot}\,\mathbf{E}_G = -\frac{\partial \mathbf{B}_G}{\partial t};\\
&\mathrm{div}\,\mathbf{B}_G = 0;\\
&\mathrm{rot}\,\mathbf{H}_G = -\mathbf{J}_G + \frac{\partial \mathbf{D}_G}{\partial t};\\
&\mathbf{D}_G = \varepsilon_{0G}\,\mathbf{E}_G;\\
&\mathbf{B}_G = \mu_{0G}\,\mathbf{H}_G,
\end{aligned} \tag{1}$$

where $\mathbf{E}_G, \mathbf{D}_G$ is a gravitational field and induction correspondingly; $\mathbf{H}_G, \mathbf{B}_G$ is a spin field and induction respectively (one may also say that $\mathbf{H}_G$ is a torsion field or rotation field); ρ_G, $\mathbf{J}_G = \rho_G\,\mathbf{u}$ - a mass density and a gravitational current density respectively; $\mathbf{u}$ - is the speed of a space body;

$\varepsilon_{0G} = 1/4\pi G = 1.193 \cdot 10^{9}\,\mathrm{m}^{-3} \cdot \mathrm{кg} \cdot \mathrm{s}^{2}$ is the gravitational permeability of vacuum; G = $6.672 \cdot 10^{-11}\ \mathrm{m}^3 \cdot \mathrm{кg}^{-1} \cdot \mathrm{s}^{-2}$ is the gravitational constant; $\mu_{0G} = 0.9329 \cdot 10^{-26}\ \mathrm{m} \cdot \mathrm{kg}^{-1}$ is the spin permeability of a vacuum; $c_G = c = 1/\sqrt{\varepsilon_{0G}\mu_{0G}} = 2.998 \cdot 10^{8}\,\mathrm{m} \cdot \mathrm{s}^{-1}$ is the assumed speed of gravitational waves and the speed of light respectively.

The relativistic equations of Heaviside should be considered as covariant equations with respect to Lorenz transformations. In this connection in the non-relativistic approximation ($|\mathbf{u}|$<<c), the force acting upon the mass of a space body $\mathrm{m} = \int\limits_{V} \rho_G\, \mathrm{dV}$ (where V- volume of the space body) may be presented as:

$$\mathbf{F} = \mathrm{m}\left(\mathbf{E}_G + [\mathbf{u}\,\mathbf{B}_G]\right) = \mathrm{m}\,\mathbf{E}'_G = \mathrm{m}\frac{\mathrm{d}\,\mathbf{u}}{\mathrm{dt}}, \qquad (2)$$

where $\mathbf{E}_G, \mathbf{B}_G$ are the gravitational field and spin induction in a conditionally immobile frame of reference; and $\mathbf{E}'_G = \mathbf{E}_G + [\mathbf{u}\,\mathbf{B}_G]$ is the gravitational field in a conditionally mobile frame of reference. It is appropriate to call the field $\mathbf{E}'_G = \frac{\mathrm{d}\,\mathbf{u}}{\mathrm{dt}}$ as a field of accelerations and the force $\mathrm{m}[\mathbf{u}\,\mathbf{B}_G]$ is the gravitational force of Lorenz by the analogy to the electrical force of Lorenz $\mathrm{q}\,[\mathbf{u}\,\mathbf{B}]$, where q is an electrical charge; and **B** is a magnetic induction.

For the space body with mass M, according to the first and fifth equations (1), one may obtain the known expression for the gravitational field:

$$\mathbf{E}_G = -\frac{\mathrm{M}}{4\pi\varepsilon_{0G}\,\mathrm{r}^3}\mathbf{r}, \qquad (3)$$

where **r** is a radius unit -vector, which connects the bodies with masses m and M and starts at the center of mass M of the body.

In the case of the two-body problem of celestial mechanics, one may use an additional condition M >>m. In this case, the conditionally immobile frame of reference with a center in the place of mass M is determined. If $\mathbf{u} = \frac{\mathrm{d}\,\mathbf{r}}{\mathrm{dt}}$, and according to (2) and (3), the motion of a body with a mass m is determined by the differential equation:

$$\mathrm{m}\frac{\mathrm{d}^2\,\mathbf{r}}{\mathrm{dt}^2} + \frac{\mathrm{GMm}}{\mathrm{r}^3}\mathbf{r} - \mathrm{m}\left[\frac{\mathrm{d}\,\mathbf{r}}{\mathrm{dt}}\mathbf{B}_G\right] = 0 \qquad (4)$$

The spin field $\mathbf{B}_G$ arises due to the rotation of the mass M. In case this body doesn't rotate, then $\mathbf{B}_G = 0$ and equation (4) takes the conventional form for the two-body problem of celestial mechanics with M>>m.

2. A spin field of rotated space bodies

Bearing in mind the analogy of Heaviside's equations of gravidynamics and Maxwell's equations of electrodynamics, many formulas from Heaviside theory may be obtained from the formulas of the electrical and magnetic field theory by substituting the density of electrical charges ρ and currents $\mathbf{J}$ for the densities of gravitational masses ρ_G and currents $\mathbf{J}_G$. Obviously this rule must also be extended over all derived magnitudes of densities, charges and currents.

The spin field for a spherical body in space that rotates around some z axis at a distance that is much larger than the radius of the sphere, may be presented in spherical coordinates by:

$$\mathbf{B}_G = -\frac{\mu_{0G}\,\mathbf{K}_G}{4\pi \cdot \mathrm{r}^3}\left(2\cos\theta \cdot \mathbf{e}_r + \sin\theta \cdot \mathbf{e}_\theta\right), \qquad (5)$$

where θ is an angle, measured from the z axis; r is a distance between a center of mass and a point of observation; and both $\mathbf{e}_r, \mathbf{e}_\theta$ are the unit vectors within the spherical frame of reference.

In the theory of magnetic fields [2] $\mathrm{dK} = \mathrm{S}\,\mathrm{d}i$ is a module of an elementary magnetic moment; di is a circular current, and S is an area limited by the circular current. By analogy, the Heaviside theory uses $\mathrm{dK}_G = -\mathrm{S}\,\mathrm{d}i_G$ as a module of an elementary spin moment, where $\mathrm{d}i_G$ is a circular gravitational current that arises when a toroidal ring rotates in the plane parallel to x, y plane. Obviously, that:

$$\mathrm{dK}_G = \mathrm{S}\,\mathrm{d}i_G = \pi\,\mathrm{r}_s{}^2\rho_G \upsilon\,\mathrm{ds} = \pi\,\mathrm{r}_s{}^3\rho_G\omega\,\mathrm{ds},$$

where $\omega = \upsilon/\mathrm{r}_s$ is the angular speed of rotation of the toroidal ring with a cross section of ds; r_s is the radius of the toroidal ring,; and υ is the rotation speed of the toroidal ring.

A moment of momentum of the toroidal ring rotating around the z axis with a cross-section arc length ds is expressed by the ratio:

$$\mathrm{dK}_z = 2\pi\,\mathrm{R}^3\rho_G\omega\,\mathrm{ds},$$

therefore,

$$\mathrm{K}_G = ½\,\mathrm{K}_z \qquad (6)$$

For a body in the form of a sphere:

$$\mathrm{K}_z = \mathrm{J}_{zz}\,\omega_z, \qquad (7)$$

where $\mathrm{J}_{zz} = k\,\mathrm{mR}^2$ is the moment of inertia of a sphere relatively to the z axis; k = 2/5 = 0.4 in the case of a sphere made of a homogeneous substance; m, R are mass and radius of a sphere; and $\omega_z = \omega$ is an angular speed of rotation of a sphere. The coefficient k allows one to consider composition of planets and stars that may be inhomogeneous. Typical values are: Mercury k = 0.324, Venus – 0.332, Earth – 0.333, Mars – 0.376, Jupiter– 0.25, Saturn– 0.22, Uranus– 0.23, Neptune – 0.29, Moon – 0.396. For the Sun the moment of momentum is known to be $K_z = 1.63 \cdot 10^{41}\,\text{кg} \cdot \text{m}^2 \cdot \text{s}^{-1}$ [3].

3. The law of gravispin induction

From the second equation of Heaviside (1), the law of gravispin induction follows:

$$\oint_l \mathbf{E}_G \mathrm{d}\mathbf{l} = -\frac{\mathrm{d}\Phi_G}{\mathrm{dt}}, \qquad (8)$$

where: $\Phi_G = \int_s \mathbf{B}_G \, \mathrm{d}\mathbf{s}$ is a flux from the spin induction through some surface; l - a closed loop, enclosing the surface S.

The law of the gravispin induction is analogous to the law of electromagnetic induction. It affirms the existence of a vortex component of the gravitational field.

Let us assume that a space body has the form of sphere. Let us separate a circle with a radius r_s inside the sphere with a center on the rotational z axis of the sphere, along which an external spin induction $\mathbf{B}_{Ge}$ occurs. The reaction induction $\mathbf{B}_{Gi}$, a vector collinear to the vector $\mathbf{B}_{Ge}$, is connected by this induction. Obviously,

$$\mathbf{B}_G = \mathbf{B}_{Ge} - \mathbf{B}_{Gi} \qquad (9)$$

The external induction may be considered to be homogeneous inside the sphere. Let us assume as an approximation that the induction $\mathbf{B}_{Gi}$ is also homogeneous inside the sphere. In this case it follows from (10) that

$$\mathrm{E}_G \cdot 2\pi\, \mathrm{r}_s = -\frac{\mathrm{dB}_G}{\mathrm{dt}} \pi\, \mathrm{r}_s^{\,2}. \qquad (10)$$

In the frame of the reference of the body m, a gravitational field is $\mathrm{E}_G = \frac{\mathrm{d}\upsilon}{\mathrm{dt}}$, $\upsilon = \omega\, \mathrm{r_s}$, where υ is the rotation speed within the circle with the radius r_s that is inside the sphere; and ω is the angular rotation speed of the sphere. Substituting this expression for E_G in (10), we obtain:

$$\frac{\mathrm{d}\omega}{\mathrm{dt}} = -\frac{1}{2}\frac{\mathrm{dB}_G}{\mathrm{dt}}. \qquad (11)$$

The spin induction $\mathbf{B}_{Gi}$ arises due to the rotation of a body in space and may be determined by using a known formula in the electrodynamics that connects the current and the magnetic induction, by substituting indexes and the sign:

$$\mathbf{B}_{Gi} = -\mu_{0G} \int_V \frac{[\mathbf{J}_G \mathbf{r}]}{4\pi\, \mathrm{r}^3} \mathrm{dV}, \qquad (12)$$

where V is the volume of the sphere; $\mathbf{J}_G = \rho_G\, \boldsymbol{\upsilon}$; $\boldsymbol{\upsilon}$ is the circular rotation speed of the sphere.

According to equation (12), the spin induction inside the sphere is inhomogeneous in its value and in its direction. It has a maximum value at the center of the sphere, it is directed along axis z, and is equal to:

$$\mathbf{B}_{Gi} = -\frac{\pi \mu_{0G} \rho_G \mathrm{R}^2}{8} \omega = -\eta\omega, \qquad (13)$$

where R is the sphere's radius. If we assume in (9) and (12) the expression for $\mathbf{B}_{Gi}$ according to (13), then we allow for a response of a space body's reaction to the action of the external induction. In this case:

$$\frac{\mathrm{d}\omega}{\mathrm{dt}} = -\frac{1}{2+\eta}\frac{\mathrm{dB}_{Ge}}{\mathrm{dt}}. \qquad (14)$$

For our Solar system, the dimensionless parameter η has rather small values. Jupiter has a maximum value of this coefficient $\eta \cong 2.57 \cdot 10^{-8}$. Therefore the ratio (14) for the case when moments of mass inertia are approximately equal with respect to three orthogonal axes which traverse the center of mass of a body, may be presented in the following way:

$$\boldsymbol{\omega} = -\frac{1}{2}\mathbf{B}_{Ge} + \boldsymbol{\omega}_0 \qquad (15)$$

where $\boldsymbol{\omega}_0$ is the angular rotation speed of a space body before it enters into the spin induction field.

4. The additional gravitational force connected with the energy conversion of forward movement and angular movement

The following energy is connected with the angular speed of rotation:

$$\mathrm{W} = \frac{\mathrm{J}_{zz}}{2}\omega^2, \qquad (16)$$

where J_{zz} is a moment of inertia of a space body in the form of sphere.

One may express this energy through the spin field $\mathbf{B}_{Ge}$ subject to equation (15) in the following way:

$$\mathrm{W} = \frac{\mathrm{J}_{zz}}{2}\left(-\frac{1}{2}\mathbf{B}_{Ge} + \boldsymbol{\omega}_0\right)^2 \qquad (17)$$

Taking into account the energy W, the energy conservation law for a space body will be of the following form in the theory of Heaviside:

$$T + U + W = \text{const}, \quad (18)$$

where $T = \frac{1}{2} m(\mathbf{u})^2$ is the kinetic energy of the body; and $U = -\frac{GMm}{r}$ is the potential energy of the body with mass m in the gravitational field of the body with mass M.

Note that the energy is not connected with the gravitational force of Lorenz, since this energy always acts perpendicular to the kinematic trajectory of this body.

In the differential equation (4) a force is defined based upon the potential energy U:

$$\mathbf{F}_G = -\text{grad}\, U = -\frac{GMm}{r^3}\mathbf{r}.$$

Just as in the same way the energy W, depending only upon the coordinates, may be connected as a force with:

$$\mathbf{F}_W = -\text{grad} W \quad (19)$$

Therefore the differential equation of motion for a body m << M in the gravitation theory of Heaviside may be presented as:

$$m\frac{d^2\mathbf{r}}{dt^2} + \frac{GMm}{r^3}\mathbf{r} - m\left[\frac{d\mathbf{r}}{dt}\mathbf{B}_{Ge}\right] + \text{grad}W = 0. \quad (20)$$

The force $\mathbf{F}_W$ has an elastic character. According to (15), the body m, moving with a forward speed $\mathbf{u}$ in a field with gravitational induction $\mathbf{B}_{Ge}$, obtains an additional rotation. Conversely, the body m, coming out of the field of the gravitational induction, loses this additional rotation moment. The full energy remains constant during this process. When entering the induction field, the body experiences a deceleration, whereas at exit from the induction field it experiences an acceleration.

5. Analysis of the Heaviside's equations of celestial mechanics

All additional terms of the gravitational theory of Heaviside in the equations of celestial mechanics are proportional to the coefficient $\mu_{0G} \cong 10^{-26}$ and therefore are rather small. The spin field doesn't exceed the value of $B_G \cong 10^{-13}\ c^{-1}$ in the orbits of Earth satellites and the spin field of the Sun in the orbit of Mercury has the value of $B_G \cong 10^{-18}\ c^{-1}$. Hence, the rotation effects of bodies resulting from Heaviside's equations, are rather weak. On the other hand this means that according to Heaviside's gravitational theory, the laws of Newton celestial mechanics should be obeyed with a high accuracy in the solar system.

At the same time the direct studies of Earth satellites' motion made by NASA, show that the satellites have the proper rotation with the angular velocity of 0.1 degree/sec or approximately 0.002 radian/sec [4]. Thus, the observed rotation of Earth satellites exceeds by 10 orders the rotation that is predicted by the Heaviside's theory.

In regard to such a large difference between the calculated and observed data on rotation of space bodies in Earth orbits, we dare to put forward a hypothesis that the reason for this divergence is the so called "ether- sphere of the Earth". The existence is assumed by Azukovsky [5], Hotejev [6], and Shulgin [7].

According to the polarization model of the inhomogeneous physical vacuum [8], in the Heaviside's equations (1), the ether – sphere of the Earth may be presented by vacuum polarizations, i.e. the gravitational $\mathbf{P}_G$ and spin $\mathbf{P}_S$ polarizations:

$$\mathbf{D}_G = \varepsilon_{0G}\,\mathbf{E}_G + \mathbf{P}_G; \qquad \mathbf{B}_G = \mu_{0G}\,\mathbf{H}_G + \mathbf{P}_S, \quad (21)$$

where: $\left|\mathbf{P}_S\right| >> \left|\mathbf{H}_G\right| \neq 0$ – is inside the ether-sphere and $\mathbf{P}_S = 0$ is outside the ether-sphere of the Earth.

The polarizations $\mathbf{P}_G, \mathbf{P}_S$ are the polarizations of the physical vacuum, ether. The polarization $\mathbf{P}_S$ [m· kg·s^{-1}] has a physical meaning of the distributed angular momentum density. If, for example, a spherical body moves in the all-penetrating medium of the physical vacuum, then, according to mechanics:

$$\frac{d}{dt}\int_V \mathbf{P}_S dV = J_z \frac{d\omega}{dt}, \quad (22)$$

where: $V = 4\pi R^3/3$ is the volume of the sphere; $J_z = kmR^2$ is the moment of inertia of the sphere, and ω is the angular velocity of the sphere's rotation.

Assuming the polarization $\mathbf{P}_S$ is a constant value within the sphere and integrating (22), we obtain:

$$\mathbf{P}_s\, V = J_z(\boldsymbol{\omega} - \boldsymbol{\omega}_0), \quad (23)$$

where: $\boldsymbol{\omega}_0$ is the initial angular velocity of the sphere' s rotation.

Conclusions

Thus, we have obtained all the necessary equations and formulas to study the real parameters for the rotation and motion within orbits of Earth satellites by means of using an experimental determination of the spin polarization of the Earth's ether-sphere.

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