S E S 2 0 1 2
Eighth Scientific Conference with International Participation
SPACE, ECOLOGY, SAFETY
4 – 6 December 2012, Sofia, Bulgaria

A SOLUTION OF THE TASK OF WEIGHT LOSS OF ROTATING BALANCED MATERIAL OBJECTS IN THE GRAVITATIONAL FIELD OF THE EARTH

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Keywords: *rotation, weight loss, anti-gravity, acceleration*

Abstract: *The paper presents results of research study by means of classical mechanics to explain the reasons for "weight loss" in the rotation of material objects in conditions of action of the gravitational field and derive formulas for their quantification.*

ОДНО РЕШЕНИЕ ЗАДАЧИ О ПОТЕРИ ВЕСА ВРАЩАЮЩИХСЯ СБАЛАНСИРОВАННЫХ МАТЕРИАЛЬНЫХ ТЕЛ В ГРАВИТАЦИОННОМ ПОЛЕ ЗЕМЛИ

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Ключевые слова: вращение, потеря веса, антигравитация, ускорение.

Резюме:*В докладе представлены результаты исследования, целью которого при помощи средств классической механики дать объяснение причин “потери веса” при вращении материальных объектов в условиях действия гравитационного поля и вывести зависимости для их количественной оценки.*

Introduction

In scientific literature [1,2,4] and in scientific publications for the general public [3] facts of scientific experiments, in which there was weight loss of 2-15 % of rotating discs or gyroscopic devices, have been described, but the phenomenon has been attributed to the ones unexplained from a scientific point of view or has been improperly treated.

In the present publication we report the results of a study, aiming at an explanation through the means of classical mechanics of the reasons for “weight loss” in the rotation of material bodies under conditions of active gravitational field and also with definition of the correlation of their quantitative assessment.

For simplicity of presentation the material object is shown as a system consisting of two diametrically balanced bodies, each with mass “m” physically linked as in the figures below. The rotation system is evaluated relative to the virtual straight OO_1, which links the centre of rotation of both bodies (p.O_1) and the centre of the Earth (p.O), named “vertical axis of rotation” or “vertical” below. The straight line, which is located perpendicular to the vertical is called “horizontal axis of rotation” or “horizontal”. For the needs of theoretical study a rectangular coordinate system O_1xyz has been defined, the beginning of which coincides with the centre of rotation of both rotating bodies O_1 and its axis “z” - with the straight line OO_1.

We present three cases of disposal of the plane of rotation with respect to the vertical OO_1:

- First case: the plane of rotation is perpendicular to the vertical OO_1 (respectively the axis of rotation of the rotating system coincides with vertical OO_1);
- Second case: the plane of rotation of the rotating system and the vertical OO_1 coincide, (respectively the axis of rotation of the rotating system is perpendicular to the vertical OO_1, i.e. coincides with the horizontal);

- Third case: the plane of rotation of the rotating system enters any angle (bigger than 0° and smaller than 90^0) with the vertical OO_1.

I case - The plane of rotation of the rotating system is perpendicular to the vertical OO_1.

The behavior of the rotating system studied on the basis of a spatial pattern, depicted in Fig.1.

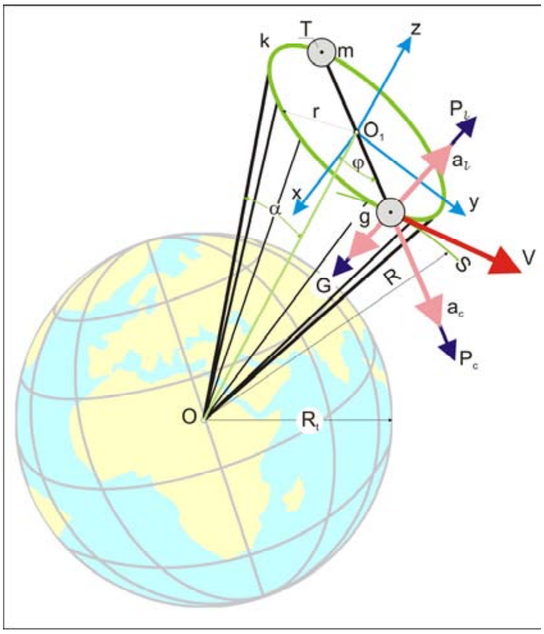

Fig. 1. Rotation of diametrically balanced material bodies around a vertical axis in the gravitational field of the Earth

Labels:

O_1xyz - reference rectangular coordinate system;
m – mass of rotating body, kg;
G – weight of rotating body, N;
P_l – force opposite to gravity, N;
P_c – centrifugal force, N;
V – peripheral speed of rotating body, m/s;
g – acceleration of gravity, m/s^2 ;
a_l – acceleration opposite the gravity, m/s^2;
a_c - centrifugal acceleration, m/s^2 ;
p.O – gravity centre of the Earth;
R_t – radius of the Earth, m;
M – mass of the Earth, kg;
R – distance between the centers of rotating bodies and the centre of the Earth, m;
r – length of the suspension arms of the rotating bodies, m;
φ – angle of rotation of the rotating body in the plane of rotation relative to the axis “x”, degrees;
– the angle between the vertical OO_1 and radius–vector $\vec{V}$, degrees;
S – the arc of trajectory of the rotating bodies in their rotation around the center of the Earth;
p. T – center of weight of the rotating body;
k – circular path of rotation of the rotating body around vertical OO_1;
- the angle between vertical OO_1 and the plane of rotation (at an inclined plane of rotation), degrees;
q – Universal (Newtonian) gravitational constant, $N.m/kg^2$;

The steady rotation of bodies with masses "m" around the axis "z" is performed with peripheral speed “V”, the vector of which is tangent to the circular trajectory of rotation "k". At the same moment the peripheral speed is also momentary speed of p. “T” at rotation of this point along the “S” arc around the center of the Earth (p. O), performed with radius “R”.

The actual existence of these two rotations results in the basic thesis:

Any rotating material body loses some of its weight in gravitational field!

As a result of first rotation the body with mass “m” will experience centrifugal acceleration "a_c", directed outwards the circle “k” along the radius-vector "$\vec{r}$". Its value is defined by the following equation:

$$(1) \qquad a_c = \frac{V^2}{r} \quad .$$

As a result of second rotation around the center of the Earth (p. O) the body will experience centrifugal acceleration "a_l", acting along the radius-vector "$\vec{R}$", with a direction opposite to the acceleration of gravity "g"and value defined by the following equation:

(2) $$a_l = \frac{V^2}{R} \quad .$$

In future this acceleration will be called **"**anti-gravitational**".**

According to the laws of mechanics that rotating body will be under the simultaneous action of both forces "G" and "P_l", where:

(3) $$G = m.g \quad ;$$

(4) $$P_l = \frac{V^2}{R}.m \quad .$$

In accordance with the initially adopted conditions of full polar symmetry of the rotating bodies the horizontal forces that arise under the impact of acceleration "a_c" will balance each other. On the system remains to act an anti-gravity force, which is a geometrical sum the elementary forces "P_l". Since their projection on the axis "z" is $\mathbf{P_l.\cos\alpha}$, where $\mathbf{\cos\alpha} \approx 1$ (r / R $\approx$0), it must be inferred that the same cumulative antigravity force can be taken as the algebraic sum of "P_l". In a system of "n" number of rotating bodies, where "n" is any even integer, the cumulative antigravity force is calculated by the equation:

(5) $$P_{l\Sigma} = \sum_2^n P_l = n.\frac{V^2}{R}.m \quad .$$

When the cumulative antigravity force is equal to or bigger than the total weight of the system (i. e. $P_{l\Sigma} \geq G$), the system remains in balance or rises along the vertical. So we may infer that:

(6) $$n.\frac{V^2}{R}.m \geq n.m.g \quad .$$.

And for the critical peripheral speed the following equation will be applied:

(7) $$V^2 = R.g \quad ,$$

which coincides with the well-known from classical mechanics $V = \sqrt{R.g}$.

This formula is also the basis for calculation of the minimal peripheral speed of the rotation, which should be rotated on the surface of the Earth a diametrically balanced system of material objects around a vertical axis, so that the system "loses" its weight:

At $R_t \approx 6{,}3.10^6$ m and g = 9.81 m/s^2

$\Rightarrow$ V $\approx$ 7,861.103 m/s - i.e. it must be equal to the first escape velocity, which is well-known with the launch of artificial satellites of the Earth.

II case – The plane of rotation of the rotating system coincides with the vertical OO_1.

The appearance of antigravity acceleration and respectively the antigravity force in the rotation of a diametrically balanced material system in this case is analyzed on the basis of the scheme, shown in Figure 2.

It is assumed that the rotation of both diametrically balanced rotating bodies is performed around an axis, which coincides with Axis "y" of the coordinate system. The rotation is sustainable r and occurs with a peripheral speed "V", the vector of which is a tangent to the circular trajectory of rotation "k", as well as in the previous case of rotation along the vertical OO_1.

The key factor here is the decomposition of the vector "$\vec{V}$" to the following components – vertical "$\vec{V}_z$" and horizontal "$\vec{V}_x$" .

From the perspective of the balance of external forces and the emerging inertia forces of rotation, the vertical components of speed "$\vec{V}_z$" of the system under consideration, in a full cycle of rotation mutually balance and the common center of weight "O_1" will not be subjected to the resultant acceleration.

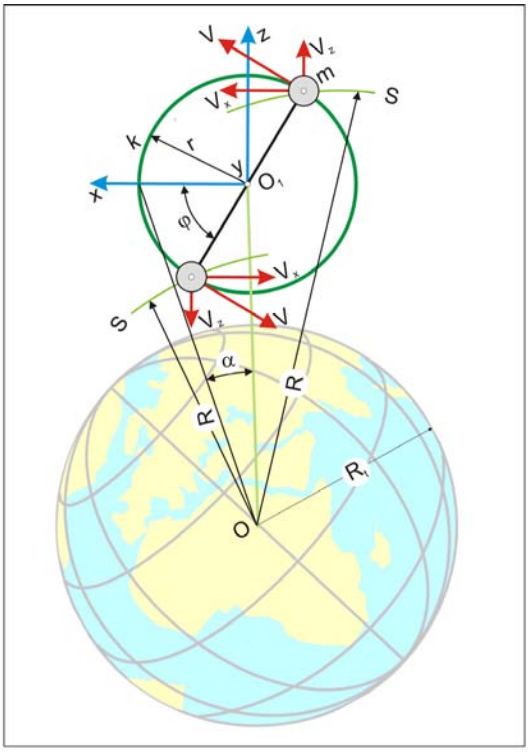

Fig. 2. Rotation of diametrically balanced material bodies around horizontal axis
in the gravity field of the Earth

However, the significance of the horizontal components "$\vec{V}_x$", is different, because they interact with the constantly existing external force of the gravity of the Earth.

As shown in case I, discussed above, any horizontal speed of a material point (regardless of its orientation in the horizontal plane), creates an anti-gravitational acceleration "a_l" in the conditions of the gravitational field of the Earth. In this specific case:

(8) $$a_l = \frac{V_x^{\;2}}{R} \quad .$$

Since then $V_x = V.\sin\varphi$, so

(9) $$a_l = \frac{V^2}{R}.\sin^2\varphi \quad .$$

The formula for calculating of the anti-gravitational force, generated by a single body of mass "m", will be:

(10) $$P_l = m.\frac{V^2}{R}.\sin^2\varphi \quad .$$

To obtain the average anti-gravitational force that the body will undergo in rotation in the case envisaged, we should find the sum of "P_l" in the limits of one rotation (from 0 to 2π), then divide it by the interval 2π. To this purpose the function "$P_l\,(\varphi)$" is integrated within the limits (from 0 to 2π) and then is divided by 2π:

(11) $$P_{l\,cp} = \frac{1}{2\pi}\sum_{2\pi}^{0} P_l = m.\frac{V^2}{R}.\frac{1}{2\pi}\int_0^{2\pi}\sin^2\varphi\, d\varphi$$

It is well-known that $\int_0^{2\pi}\sin^2\varphi\, d\varphi = \pi$, so

(12) $$P_{l\,cp} = m.\frac{1}{2}.\frac{V^2}{R} \quad .$$

For a system of "n" number of rotating bodies, where "n" is any even integer, the cumulative antigravity force is calculated by the equation:

$$(13) \qquad P_{l\Sigma} = \sum_{2}^{n} P_{l\,cp} = n.m.\frac{1}{2}.\frac{V^2}{R} \quad .$$

A comparison of equation (5) and (13) shows that *a diametrically balanced material system, rotating around horizontal axis (compared to a massive center of gravity) is subjected to an antigravity influence twice smaller than the case in which the same system with the same parameters (mass, radius and speed of rotation) rotates around a vertical axis*.

The last conclusion may serve to an experimental test of the reliability of the above theory for explanation of the phenomenon “weight loss” of rotating bodies in a gravity field. We suggest that a solid toroïd to be rotated with practically workable speed and the weight loss of the system to be measured. The measurements must take place in two experiments:

a) Upon rotation of the toroïd around a vertical axis;

b) Upon rotation of the toroïd around a horizontal axis.

Then the measured changes in the weight of the rotating system must be compared no matter how small they are. In our opinion if the results obtained are in correlation 2:1, this will sufficiently prove the reliability of this theory.

III case – the plane of rotation is inclined to the vertical OO_1.

The behavior of the rotating system has been investigated on the basis of the scheme, shown in Fig 3.

We assume that:

a) The “x” axis lies in the plane of rotation of the bodies;

b) The “z” axis makes an angle “ “ with the plane of rotation of rotating bodies and coincides with the vertical toward the center of gravity;

c) Respectively the “y” axis makes an angle (90 –)^0 with the plane of rotation of the bodies.

In the general case the speed vector “$\vec{V}$” could be decomposed to three components parallel to the axes “x”, “y” , “z”, namely : “$\vec{V}_x$”, “$\vec{V}_y$“ and “$\vec{V}_z$“.

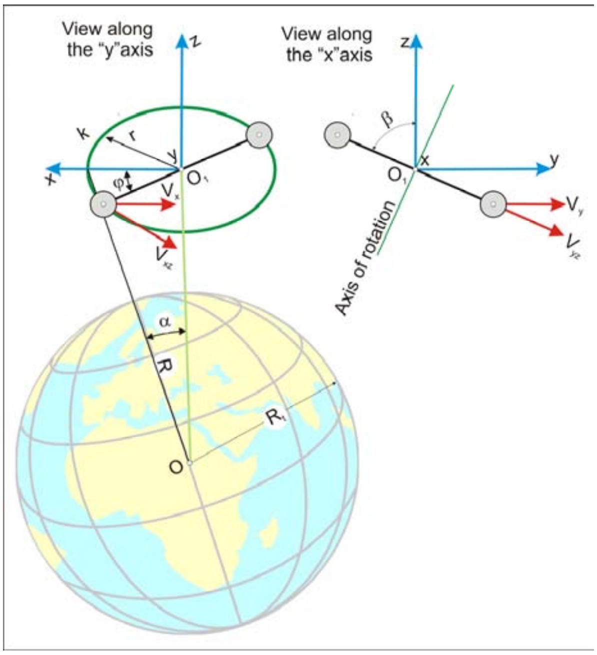

Fig. 3. Rotation of diametrically balanced material bodies around an axis randomly oriented at the vertical in the gravity field of the Earth

The two specific situations of rotation above (around the vertical axis and the horizontal axis) reveal that the vertical components of speed “V_z“ have almost no impact on the phenomenon “weight loss”. For this reason and for the simplification of the kinematic scheme (Fig. 3”) they are not taken into consideration, nor calculated.

In order to find out the general formula of the anti-gravitational acceleration it is sufficient to determine the value of the two horizontal components “V_x” и “V_y“. Each of them will generate its own antigravity acceleration. In terms of vector direction these two accelerations will coincide; therefore the total antigravity acceleration, to which the single body with mass "m" will be subjected, can be shown as an algebraic sum of two components:

(14) $a_l = a_{l\,x} + a_{l\,y}$.

$a_{l\,x} = \frac{V_x^{\,2}}{R}$, where

(15) $V_x = V.\sin\varphi$.

$a_{l\,y} = \frac{V_y^{\,2}}{R}$, where

(16) $V_y = V.\cos\varphi.\sin\beta$.

The average values of these two antigravity accelerations as function to the angle "φ" emerge from the equations:

(17) $a_{l\,x\,cp} = \frac{1}{2}\frac{V^2}{R}$.

(18) $a_{l\,y\,cp} = \frac{1}{2}\frac{V^2.\sin^2\beta}{R}$.

For the antigravity force caused by "$a_{l\ cp}$", we must apply the equations (12) or

(19) $P_{l\ cp} = m.(\frac{1}{2}.\frac{V^2}{R} + \frac{1}{2}\frac{V^2.\sin^2\beta}{R})$.

For a system of "n"-number of rotating bodies, where "n" is any even integer, the total antigravity force in the generalized case (the plane of rotation of the rotating system is tilted) is calculated as follows:

(20) $P_{l\,\Sigma} = \frac{1}{2}.n.m.\frac{V^2}{R}.(1+\sin^2\beta)$

The equation (20) at an angle β=90^0 (vertical axis of rotation) transforms into equation (5), and for β=0^0 (horizontal axis of rotation) it equals (13).

The results of the study allow us to formulate the notion of "anti-gravity" as a principle of the Newtonian mechanics:

The force with which a rotating system of material objects is repelled from the massive gravitational object (like Earth), is directly proportional to the total mass of the rotating system and the square of its peripheral speed with a radius of rotation, determined by the rule of maintaining the inertia moment of the system, and is inversely proportional to the distance between the center of the massive gravitational object and the common center of gravity of the rotating material objects. This force also depends on the angle of inclination of the plane of rotation to the straight line connecting the center of rotation of the system and the center of gravity of the massive gravitational object.

Based on the results of this study the *Law of universal gravitation* (in accordance with Newton's law) could be enriched and transformed into *Law of universal gravitation and repulsion of two material systems*. The force of interaction (attraction or repulsion) between two material systems (the Earth and rotating system) will be determined by the following equation:

(21) $P = \frac{1}{2}\, m_o\, \frac{V^2}{R}\,(1+\sin^2\beta) - q\frac{m_o.M}{R^2}$,

where m_o is the total mass of the rotating system.
When P>0, systems will repel, and if P<0 systems will attract each other.

Application of antigravity as a basic principle of Newtonian mechanics

1. It is possible to provide sufficiently precise quantitative assessment of all reported cases of weight loss of material bodies rotating in the conditions of action of gravity field.
2. Artificial satellites of the Earth can be launched and positioned on an arbitrary geostationary orbit.

3. Energy for the launch of a space object formed on the principle of antigravity could be accumulated in this object on Earth near sources of energy.
4. The force of repulsion from the Earth of a system formed on the principle of antigravity could be controlled by tilting the plane of rotation to the vertical.
5. Space device which is designed on the principle of anti-gravity can be in today's level of technologies very suitable for use on the moon.

Conclusion

The authors are far away from the idea that in such a short article they could enumerate all the possible consequences for science and technologies in case the principle of gravity is adopted. It does not contradict with the classical rules of Newtonian mechanics, it rather supplements it. In a subsequent publication we are ready to share our views of its practical implementation.

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