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Probing the Gravitational Effects of Rotating Masses in a Vacuum via the Proposed Equations

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Probing the Gravitational Effects of Rotating Masses in a Vacuum via the Proposed Equations

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Abstract: The gravitational effects of a rotating body on a nearby smaller body in a vacuum are investigated. Our findings, derived from the proposed equations, highlight the substantial gravitational forces exerted by the rotating body. These results are pertinent for developing unconventional gravity-generation methods for space and terrestrial applications. Moreover, this study enhances our understanding of angular velocity in the context of rotating and rigid mechanical systems.

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1. Background

Gravitational interactions among objects have been explored through the Cavendish experiment [1] and analogous configurations, wherein the gravitational forces between small masses were measured. Nevertheless, neither of the methodologies empirically addresses the influence of angular motion on gravitational interactions. As a result, a gap remains in our understanding of gravitational phenomena within laboratory settings.

2. Our Hypothesis

A uniform spherical object with specified mass and angular velocity in a vacuum can exert a strong gravitational force on a nearby object.

In subsequent sections, we present an experimental configuration along with a mathematical framework that underpins our hypothesis.

3. Proposed Experimental Configuration

3.1. Vacuum Chamber Specifications

The experimental setup included a vacuum chamber to minimize air resistance. Furthermore, the chamber is designed to reduce boundary effects by ensuring adequate wall separation.

3.2. Key Objects and Properties

- *Object A*: A uniform sphere with a mass of 100531 kg and a diameter of 4 meters.
- *Object B*: A smaller sphere with a mass of 523.6 kg and a diameter of 1 meter.

3.3. Key Conditions

1. *Object A* is situated at the geometric center of the chamber and is supported by a stabilizing structure. Although the object remains stationary with respect to the translational motion, it exhibits a constant angular velocity of $\omega = 6\,\mathrm{rad/s}$.
2. *Object B* maintains a separation of 1 meter from the surface of *object A*, where it remains at rest.
3. If the angular velocity ω of *object A* occurs from the north toward the south about its own axis of symmetry, *object B* should be placed on the north side of *object A*.

3.4. Predicted Outcomes

Measurable and perceptible changes in the resting state of *object B*.

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4. Insights into the Proposed Mathematical Model

4.1. Fundamental Derivation

In a vacuum, we consider a uniform sphere, known as the central object, which possesses a radius R and rotates at a constant angular velocity ω about its own axis of symmetry (due to a torque imposed on it). The tangential velocity on the surface of this central object can be expressed as follows.

$$v = \omega R \text{ [2]}$$

If we attach a long string to the surface of the central object, under the assumption that it is rigid and inextensible, it follows that any selected point on the string will have a circular path with a tangential velocity equal to that of the surface of the central object:

$$\omega R = \omega' r$$

In this context, ω' signifies the orbital angular velocity of the selected point on the string and r denotes the radial distance from the rotational axis of the central object to that point. Rearranging the equation for ω', we obtain:

$$\omega' = \omega \times \frac{R}{r}$$

4.1.1. Amendment for Gravitational Purpose

The gravitationally induced orbital angular velocity perceived by any selected point ω', located at a radial distance r from the rotational axis of a uniform sphere, can be expressed as follows:

$$\omega' = \omega \times \frac{R^2}{r^2}.$$

There is an inverse square relationship between the induced angular velocity ω' and the radial distance r. As r increases, ω' decreases, following the inverse square law ($\omega' \propto r^{-2}$). [3]

4.2. Limitations

4.2.1. Gravitational

1. The proposed equation of $\omega' = \omega \times \frac{R^2}{r^2}$ utilizes a non-relativistic methodology, rendering it unsuitable for application within the context of general relativity. [4]
2. The equation of $\omega' = \omega \times \frac{R^2}{r^2}$ anticipates an orbital trajectory for a test point; nevertheless, it overlooks other factors (e.g.,initial tangential velocity) necessary for the body positioned at that point to attain stable orbital motion.

4.2.2. Mechanical

The equation presented as $\omega' = \omega \times \frac{R}{r}$, while potentially beneficial for applications in mechanical and rigid rotating systems, such as measuring orbital angular velocity at different locations on a fan blade, assumes negligible air resistance.

5. Calculating the Gravitational influence of *Object A*

5.1. Via the Proposed Equation

$$\omega' = \omega \times \frac{R^2}{r^2}$$

The given parameters are as follows:

- ω' is the orbital angular velocity, gravitationally induced by *object A* at the location of *object B*.
- ω is the angular velocity of *object A* around its own axis (6 rad/s).

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- R is the radius of *object A* (2 m).
- r is the radial distance from the rotational axis of *object A* to the location of *object B* (3 m).

By substituting the given parameters:

$$\omega' = \frac{6 \cdot 2^2}{3^2},$$

we obtain:

$$\omega' \approx 2.67\,\mathrm{rad/s}$$

5.2. Via the Centripetal Force of Object B

The centripetal force $(\vec{F}_{\mathrm{A}})$ of *object B*, attributable to its anticipated orbital or curved motion resulting from the gravitationally induced angular velocity ω' of *object A* , can be delineated as follows:

$$F = m \cdot r \cdot (\omega')^2 \ [5]$$

The given parameters are as follows:

- m is the mass of *object B* (523.6 kg),
- r is the radial distance from the axis of rotation of *object A* (3 m),
- ω' is the orbital angular velocity gravitationally induced by *object A* at the location of *object B* (2.67 rad/s).

By substituting the given parameters:

$$F = 523.6 \cdot 3 \cdot (2.67)^2$$

we obtain:

$$F \approx 11,198.08\,\mathrm{N}$$

5.3. Via the Earth's Gravitational Force

To calculate the gravitational force exerted by the Earth $(\vec{F}_{\mathrm{Earth}})$ on *object B*, we use the following equation:

$$F = m \cdot g \ [6]$$

where:

- m is the mass of *object B* (523.6 kg),
- g is the gravitational acceleration at the Earth's surface (9.8 $\mathrm{m/s^2}$).

By substituting the given parameters into the equation, we obtain the following:

$$F = 523.6 \times 9.8 \approx 5,131.28\,\mathrm{N}$$

6. Conclusions

6.1. Implications of Calculations

According to the previous calculations, the centripetal force arises from the gravitational impact (ω') of *object A* (11,198.08 N) exceeds the gravitational force that Earth (5,131.28 N) exerts on *object B*, as illustrated below:

$$F_{\mathrm{A}} > F_{\mathrm{Earth}}$$

This inequality leads to perceptible changes in the resting state of *object B*.

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6.2. Pathways for Future Investigation

Future research could include the following:

- Analysis of the proposed experimental configuration alongside its predicted outcomes within controlled laboratory settings.
- Gravitational interaction of multiple rotating objects with different or identical masses.

6.3. Potential Applications

1. The production of strong gravitational forces in the vicinity of masses of high density and rotation, for terrestrial and space applications, in contrast to the conventional methods, e.g., using centrifugal force within extensive rotating sections to simulate gravity-like effects. [7]
2. The proposed equation of $\omega' = \omega \times \frac{R^2}{r^2}$ holds potential utility in the study of planetary system dynamics, specifically in quantifying gravitational forces resulting from planetary rotations, within the non-relativistic domain.

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