Concept Paper

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

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Article

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

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Abstract: This study examines the gravitational effects of a rotating body on a nearby smaller body in a vacuum. Our findings, derived from the proposed equations, highlight the substantial gravitational forces exerted by the rotating body. These insights are pertinent for developing unconventional gravity-generation methods for orbiting satellites and terrestrial applications. Additionally, this study enhances our understanding of the relationship between angular velocity and gravitational forces.

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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 persists in our understanding of gravitational phenomena within laboratory settings.

2. Our Hypothesis

A sphere, which rotates at a specified angular velocity ω in a vacuum can exert a strong gravitational force ($\vec{F}$) on a smaller mass nearby m'. In subsequent sections, we delineate the experimental configuration and elucidate 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, a density of $3\,\mathrm{g/cm^3}$, and a diameter of 4 meters.
- *Object B*: A smaller sphere with a mass of 523.6 kg, a density of $1\,\mathrm{g/cm^3}$, 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 translational motion, it exhibits a constant angular velocity of $\omega = 6\,\mathrm{rad/s}$, aligns with its principal axis of rotation, and is oriented from north to south.
2. *Object B* is situated at the North Pole, maintaining a separation of $r = 1\,\mathrm{m}$ from the surface of *object A*, where it may be in motion or at rest.

3.4. Predicted Outcomes

Measurable and perceptible variations or modifications in the state (rest or motion) of *object B* .

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4. Insights into the Proposed Mathematical Model

4.1. Fundamental Equation

The angular velocity at a designated point ω' located at a radial distance r from the rotational axis of a uniformly rotating sphere can be expressed as:

$$\omega' = \frac{\omega \cdot R}{r},$$

where, ω is the angular velocity of the sphere about its own axis, R is the radius of the sphere and r is the radial distance from the rotational axis of the sphere to the point of interest.

4.1.1. Extension for Gravitational Phenomenon

The gravitationally induced angular velocity ω' at a radial distance r from the rotational axis of a uniformly rotating sphere can be expressed as :

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

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

4.2. Limitations

- Within the framework of general relativity [3], angular velocity around a rotating mass is expressed as $\Omega_{LT} = \frac{2GJ}{c^2 r^3}$ [4], where G is the gravitational constant, J is the angular momentum of the central mass, c is the speed of light and r is the radial distance from the rotating mass. In contrast, the proposed equations of ω' adopt a classical approach and are not applicable in relativistic contexts.
- Both equations assume a frictionless environment and a uniform spherical structure rotating at constant angular velocity ω.

5. Calculating the Gravitational influence of *Object A*

5.1. Via the Proposed Equation

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

The given parameters are as follows:

- ω' is the 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).
- 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:

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

5.2. Via the Gravitational Force of Object A

To calculate the gravitational force of *object A* ($\vec{F}_A$) acting on *object B*, we use the following equation:

$$F = m \cdot r \cdot \omega^2 \text{ [5]}.$$

The given parameters are as follows:

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- 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 angular velocity 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 ($\vec{F}_{\text{Earth}}$) 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 Earth's surface (9.8 m/s^2).

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

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

6. Conclusion

6.1. Implications of Calculations

As calculated, the gravitational force exerted by *object A* (11,198.08 N) is greater than the gravitational force exerted by Earth (5,131.28 N) on *object B*, as follows:

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

This inequality leads to perceptible changes in the state of rest or motion of *object B* at the designated distance of 1 meter.

6.2. Pathways for Future Investigation

Future theoretical or experimental research could explore the following:

- Variations in density, dimensional scaling, and angular velocity within the system.
- Gravitational interaction of multiple rotating objects with different or identical masses.

6.3. Potential Applications

1. The creation of gravitational fields in the vicinity of rotating masses for both terrestrial and space applications.
2. The suggested equations may find utility in the dynamics of planetary systems, especially in comprehending rotational effects.

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