Journal of Space Exploration
ISSN: 2319-9822

Journal of Space Exploration

Theory Article | Vol 15 Iss 1

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

Muhammad Ahmad*

Department of Physics, Quaid-i-Azam University, Islamabad, Pakistan

***Corresponding author:** Muhammad Ahmad, Department of Physics, Quaid-i-Azam University, Islamabad, Pakistan; E-mail: mr.ahmad43278@gmail.com

Received: February 01, 2025, Manuscript No. TSSE-25-160717; **Editor assigned:** February 04, 2025, PreQC No. TSSE-25-160717 (PQ); **Reviewed:** February 18, 2025, QC No. TSSE-25-160717; **Revised:** April 01, 2026, Manuscript No. TSSE-25-160717 (R); **Published:** April 08, 2026; DOI: 10.37532/2319-9822.2026.15(1).404

Abstract

The gravitational effects of a rotating body on a nearby 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 on the role of angular velocity in the dynamics of planetary systems.

Keywords: Gravitational dynamics; Artificial gravity; Vacuum experiments; Classical mechanics

Introduction

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.

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.

Description

Proposed experimental configuration

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.

Key objects and properties:

Citation: Ahmad M. Probing the Gravitational Effects of Rotating Masses in a Vacuum *via* the Proposed Equations. J Space Explor. 2025;15(1):404.
© 2026 Trade Science Inc.

- **Object A:** A uniform sphere with a mass of 100 kg and a radius of 2.50 meters.
- **Object B:** A smaller sphere with a mass of 50 kg and radius of 0.50 meter.

Key conditions:

- Object A, at some altitude, maintained by a stabilizing framework. Although the object remains stationary with respect to the translational motion, it exhibits a constant angular velocity of ω=6 rad/s.
- Object B maintains a separation of 1 meter from the surface of object A, where it remains at rest. Thus, the total distance from the center of mass object B to the rotational axis of object A becomes 4 meters.
- 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.

Predicted outcomes: Measurable and perceptible changes in the resting state of object B.

Insights into the proposed mathematical model

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:

$v = \omega R$ [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:

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

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].

Limitations:

Gravitational:

- The proposed equation of $\omega' = \omega \times R^2/r^2$ utilizes a non-relativistic methodology, rendering it unsuitable for application within the context of general relativity [4].

- The equation of $\omega' = \omega \times R^2/r^2$ anticipates an orbital trajectory for a test point; nevertheless, it overlooks other factors (e.g. initial velocity) necessary for the body positioned at that point to attain stable orbital motion.

Mechanical: The equation presented as $\omega' = \omega \times R/r$, while potentially beneficial for applications in mechanical and rigid rotating systems, assumes negligible air resistance.

Calculating the gravitational influence of object A

***Via* the proposed equation:**

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

By substituting the given parameters into the equation:

$$\omega' = \frac{6 \cdot (2.5)^2}{(4)^2},$$

we obtain:

$\omega' \approx 2.34$ rad/s.

***Via* the centripetal force:** The centripetal force ($\vec{F}_A$) of object B, attributable to its anticipated orbital or curved motion resulting from the gravitationally induced angular velocity ω' of object A, can be described as follows [5]:

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

By substituting the given parameters into the equation:

$F=50 \cdot 4 \cdot (2.34)^2$

we obtain:

$F \approx 1095.12$ N

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

$F = m \cdot g$ [6,7]

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

$F = 50 \times 9.8 \approx 490$ N

Conclusion

Implications of calculations: According to the previous calculations, the centripetal force (1095.12 N) arises from the gravitational impact (ω') of objet A exceeds the gravitational force that Earth (490 N) exerts on object B, as demonstrated below:

$F_A > F_{Earth}$

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

Pathways for future investigation: Future research could include the following:

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

Potential applications:

- The efficient production of strong gravitational forces in the vicinity of rotating masses 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.

- The proposed equation of $\omega' = \omega \times R^2/r^2$ holds potential utility in the study of planetary dynamics, specifically in quantifying gravitational forces resulting from planetary rotations, within the non-relativistic domain.

References

1. Cavendish H. Experiments to determine the density of the Earth. By Henry Cavendish, Esq. FRS and AS. Philos Trans R Soc Lond. 1798;88:469-526.
2. Walker J, et al. Fundamentals of physics. New York: Wiley; 2008.
3. Mangut M, Gürsel H, Kanzi S, et al. Probing the Lorentz invariance violation via gravitational lensing and analytical eigenmodes of perturbed slowly rotating bumblebee black holes. Universe. 2023;9(5):225.
4. Barker BM, O'Connell RF. The gravitational interaction: Spin, rotation, and quantum effects-A review. Gen Relativ Gravit. 1979;11(2):149-175.
5. Ruggiero ML, Astesiano D. A tale of analogies: A review on gravitomagnetic effects, rotating sources, observers and all that. J Phys Commun. 2023;7(11):112001.
6. Mashhoon B, Hehl FW, Theiss DS. On the gravitational effects of rotating masses: The Thirring-Lense papers. Gen Relativ Gravit. 1984;16(8):711-750.
7. Bukley A, Paloski W, Clément G. Physics of artificial gravity. In Artificial gravity 2007 (pp. 33-58). New York, NY: Springer New York.