

Peer Review

Review of: "Rough Estimates of Solar System Gravitomagnetic Effects in Post-Newtonian Gravity"

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Certainly! Here's your improved review report with Roman numerals restarting in each major section, while keeping the tone constructive, polite, and comprehensive:



Review Report

Manuscript Title: *Rough Estimates of Solar System Gravitomagnetic Effects in Post-Newtonian Gravity*

Author: Soon-Tae Hong



Summary

This manuscript presents a theoretical study of gravitomagnetic effects—gravitational analogs of magnetic fields—within the framework of Modified Linear General Relativity (MLGR). Drawing formal analogies with classical electromagnetism, the author derives Maxwell-like gravitational field equations and applies them to several astrophysical systems, including:

- The Earth–Moon system
- The Sun and its orbiting planets
- Saturn's B-ring

Key findings include:

- Predictions of extremely small but non-zero mass magnetic fields and associated general relativistic (GR) forces.

- Demonstration that these forces are anti-parallel to Newtonian gravitational forces for most planets.
- A novel estimate of the mass magnetic dipole moment of Saturn's B-ring, potentially linked to Cassini data and the hypothesized satellite Chrysalis.

The study suggests that these subtle effects, though currently beyond direct detection, may become observable with future high-precision astrophysical instrumentation.

General Assessment

The manuscript addresses a timely and conceptually rich topic in gravitational theory and astrophysics. The use of a vectorial formalism within MLGR to model gravitomagnetic phenomena is mathematically consistent and physically motivated. The analogies drawn with electromagnetism are helpful in interpreting gravitational effects involving mass currents and rotational motion.

However, to enhance the scientific rigor and contextual relevance of the work, several important issues should be addressed prior to consideration for publication.

Major Points for Revision

I. Comparison with Prior Theoretical Work

The linearized formalism presented in the manuscript appears closely related to earlier foundational studies on gravitomagnetism. To clarify the novelty and scope of the current approach, the author is strongly encouraged to explicitly compare their formalism with the following key references:

- I. B. Mashhoon, "Gravitoelectromagnetism," in: *Reference Frames and Gravitomagnetism*, World Scientific, 2001.
- II. B. Mashhoon, "Gravitoelectromagnetism: A Brief Review," arXiv:gr-qc/0311030.
- III. S. Kopeikin, "Gravitomagnetism and the Speed of Gravity," *Int. J. Mod. Phys. D*, 15(3), 305–320 (2006).

A clear discussion of how the MLGR-based formulation differs from or extends these prior models would significantly strengthen the manuscript and help position it within the broader literature.

II. Discussion of Observational Context

The paper would benefit from a more thorough and up-to-date discussion of the experimental and observational efforts aimed at detecting gravitomagnetic effects in the solar system. Several relevant studies include:

- I. I. Ciufolini et al., “An improved test of the general relativistic effect of frame-dragging using the LARES and LAGEOS satellites,” *Eur. Phys. J. C*, 79, 872 (2019).
- II. I. Ciufolini et al., “A test of general relativity using the LARES and LAGEOS satellites and a GRACE Earth gravity model,” *Eur. Phys. J. C*, 76, 120 (2016).
- III. S. Kopeikin, “The Gravitomagnetic Influence on Earth-Orbiting Spacecrafts and on the Lunar Orbit,” in: *General Relativity and John Archibald Wheeler*, Springer, 2010.
- IV. S. Kopeikin, “Comment on ‘Gravitomagnetic Influence on Gyroscopes and on the Lunar Orbit,’” *Phys. Rev. Lett.*, 98(22), 229001 (2007).
- V. S. Kopeikin and E. Fomalont, “Gravimagnetism, causality, and aberration of gravity in the gravitational light-ray deflection experiments,” *Gen. Rel. Grav.*, 39(10), 1583–1624 (2007).
- VI. L. Iorio and B. Mashhoon, “Review of the Gravitomagnetic Clock Effect,” *Ann. Phys.*, 536(5), 2300466 (2024).

Incorporating a critical review of these works and discussing how the predictions of the current model could be tested or constrained by existing or future missions (e.g., LARES, Gravity Probe B, Gaia) would greatly improve the paper’s relevance and impact.

Recommendation

Recommendation: Major Revision Required

The manuscript presents a promising theoretical framework and offers novel predictions. However, to meet the standards of scholarly rigor and originality, the author should:

- Provide a detailed comparison with established gravitomagnetic formalisms.
- Expand the discussion of observational strategies and current experimental constraints.
- Clarify the assumptions and limitations of the MLGR approach in contrast to standard post-Newtonian treatments.

Addressing these points will significantly enhance the scientific value and clarity of the work.

Declarations

Potential competing interests: No potential competing interests to declare.