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Research Article

INNOVATIVE MIRROR GRAVITATIONAL QUANTUM FIELD THEORY: A DUAL-PHASE PARITY FRAMEWORK FOR GRAVITATIONAL-MAGNETIC COUPLING AND QUANTUM-CLASSICAL UNIFICATION

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Abstract

The prevailing description of gravitation, rooted in Newtonian mechanics and Einstein's general relativity (GR), successfully accounts for the spherical morphology of celestial bodies and their orbital dynamics through spacetime curvature. However, it leaves unresolved foundational questions regarding the microscopic origin of gravitational interactions, the reconciliation with quantum field theory (QFT), the nature of putative gravitons, and the mechanisms underlying long-term orbital stability and apparent "uplift" or anomalous forces in astrophysical systems. This research paper introduces the Mirror Gravitational Field Theory (MGFT), a novel conceptual and mathematical framework positing a dual-phase parity-symmetric gravitational field. In this model, each macroscopic gravitational source is coupled to a complementary "mirror" phase field characterized by parity (P) symmetry properties. Spontaneous symmetry breaking within this dual-phase system generates effective attractive and repulsive components that manifest as a gravito-magnetic coupling. Our innovative theory draws analogies to gravito-electromagnetism (GEM) in the weak-field limit of GR while incorporating quantum-inspired duality and phase transitions, offering a pathway toward unifying GR with the Standard Model forces. Key predictions include dynamic push-pull orbital stabilization, potential explanations for dark matter-like effects via mirror-phase contributions, and testable gravitational anomalies.

Keywords: Mirror Gravitational Field Theory, Dual-phase gravity, Parity symmetry and spontaneous symmetry breaking, Gravito-magnetic coupling, Gravitational duality, Mirror phase fields, Unified field framework, Attractive-repulsive gravitational dynamics.

INTRODUCTION

The historical progression from geocentric models to the heliocentric framework of Copernicus, Galileo, and Kepler, followed by Newton's universal gravitation and Einstein's geometric description of gravity via the Einstein field equations, has profoundly advanced our understanding of celestial mechanics. Yet, gravity remains the outlier among the fundamental interactions: it resists straightforward quantization, exhibits no clear microscopic mediator (graviton) consistent with perturbative QFT at all scales, and poses challenges for unification with the electroweak and strong forces.Persistent issues include the incompatibility of GR's smooth spacetime with quantum vacuum fluctuations, the hierarchy problem, the cosmological constant problem, and the apparent need for dark matter/energy to explain galactic dynamics and cosmic acceleration. MGFT addresses these by proposing an intrinsic dual-phase structureto the gravitational field, wherein a primary phase (observable gravity) is mirrored by a parity-linked secondary phase. This duality, governed by principles akin to CPT symmetry extensions or mirror-matter scenarios, introduces phase-dependent interactions that can produce both Newtonian-like attraction and subtle repulsive or stabilizing effects.

Theoretical Framework: Mirror Gravitational Fields

MGFT posits that the gravitational field **g** possesses an intrinsic two-phase structure: a standard (attractive) phase $\phi_+$and a mirror (complementary) phase ϕ_-, related through a parity transformation operator $\mathcal{P}$. The full mirror gravitational potential can be expressed in a unified field formalism as:

$$\Phi_{\text{MG}} = \Phi_+ + \Phi_-\text{with}\Phi_- \approx \mathcal{P}\Phi_+$$

where the mirror phase Φ_-exhibits transformed coupling under spatial inversion or chiral properties.

Dual-Phase Lagrangian and Symmetry in Solar System

Consider an effective Lagrangian density incorporating both phases and their interaction:

$$8 * 2 \mid (\mathscr{L}_{\text{M}\Gamma} \boxdot) \mid= -\frac{1}{16\pi G} R + \bar{\psi} i\gamma^\mu D_\mu \psi + \mathscr{L}_{\pi\eta\alpha\sigma\varepsilon} \boxdot + \mathscr{L}_{\iota\nu\tau}(\text{position}) \boxdot$$

Notation: 8 refer to the 8 planets in the solar system
2 refer to the mirror field that interact in between the planet

So, that the Dual-Phase Lagrangian& Symmetry is:

$$\mid (\mathscr{L}_{\text{MG}} \boxdot) \mid= -\frac{1}{\pi G} R + \bar{\psi} i\gamma^\mu D_\mu \psi + \mathscr{L}_{\text{phase}} \boxdot + \mathscr{L}_{\text{int}}(\text{position}) \boxdot$$

Here, $R$is the Ricci scalar (GR term), and the phase sector is modeled via a complex scalar-like order parameter $\phi = \phi_+ + i\phi_-$(inspired by Higgs-like mechanisms or superconducting magnet phase fields):

$$\mathscr{L}_{\text{phase}} = \mid D_\mu \phi \mid^2 - V(\phi)$$

with a symmetry-breaking potential:

$$V(\phi) = \lambda(\mid \phi \mid^2 - v^2)^2$$

Spontaneous mirror symmetry breaking (SSB) at a characteristic energy scale v(potentially Planck-suppressed or related to quantum gravity cutoff) selects a vacuum expectation value, breaking the global U(1) or parity symmetry and generating Goldstone-like modes that contribute to long-range gravitational effects. The interaction term $\mathscr{L}_{\text{int}}$introduces gravito-magnetic coupling:

$\mathscr{L}_{\text{int}} \supset \kappa\, \mathbf{J}_m \cdot \mathbf{B}_g$

where $\mathbf{J}_m$is a mass-current density, $\mathbf{B}_g$the gravitomagnetic field (analogous to GEM), and κa coupling constant linking the mirror phases.

In the weak-field, slow-motion limit, the effective gravitational field equations yield modified GEM-like equations with additional mirror contributions:

$$\nabla \cdot \mathbf{E}_g = -4\pi G(\rho_+ + \rho_-), \nabla \times \mathbf{B}_g - \frac{\partial \mathbf{E}_g}{\partial t} = -\frac{4\pi G}{c}\mathbf{J}_m + \text{mirror phase terms}$$

The mirror phase ρ_-can be partially "dark" (weakly coupled to ordinary matter), providing a natural mechanism for effective dark matter halos or anomalous accelerations.

Push-Pull Dynamics and Orbital Stability

The interplay between attractive (ϕ_+ -dominated) and repulsive/stabilizing (ϕ_- -induced) components creates a dynamic equilibrium. For a planet orbiting a star, the net force includes a classical term plus a phase-gradient contribution:

$$| \mathbf{F}_{\text{net}} |\boxdot = | -\frac{GMm}{r^2}\hat{r} + \alpha\nabla(\phi_+ \cdot \phi_-) |\boxdot$$

$\boxdot$ *refer to mirror field*

where αparametrizes the mirror coupling strength. This push-pull mechanism, arising from asymmetric phase shifts post-SSB, naturally sustains nearly circular orbits and explains subtle deviations or "uplift" forces reported in certain astrophysical contexts. The parity-violating aspects (mild breaking) align with observed cosmic asymmetries and offer a bridge to quantum gravity via discrete symmetries.

Mathematical Model: Effective Field Equations

The core dynamical equations of MGFT can be derived from varying the action $S = \int \mathscr{L}_{\text{MG}}\sqrt{-g}\, d^4x$. In the linearized regime around Minkowski spacetime, the metric perturbation $h_{\mu\nu}$ couples to the dual-phase stress-energy tensor $T_{\mu\nu}^{\text{MG}} = T_{\mu\nu}^{+} + T_{\mu\nu}^{-}$.

A simplified scalar toy model for the mirror field evolution (useful for numerical simulation or further quantization) is the coupled Klein-Gordon-like system:

$$\phi_+ - m_+^2\phi_+ = \lambda(\phi_+^2 + \phi_-^2)\phi_+ + \text{source terms}$$

$$\square\phi_- - m_-^2\phi_- = \lambda(\phi_+^2 + \phi_-^2)\phi_- + \kappa F_{\mu\nu}\tilde{F}^{\mu\nu} (\text{parity-mixed term})$$

where $m_\pm$ are effective masses post-breaking, and the topological term introduces magnetic-like gravitational effects. Quantization proceeds via canonical methods or loop quantum gravity-inspired discretizations, potentially yielding graviton-like excitations with mirror partners.

For planetary motion, the effective potential becomes:

$$V_{\text{eff}}(r) = -\frac{GM}{r} + \frac{L^2}{2\mu r^2} + \beta\frac{\sin(\Delta\theta_\phi)}{r^\gamma}$$

(with β, γfitted parameters from mirror phase difference $\Delta\theta_\phi$), which stabilizes orbits through additional minima or flattened regions.

Where,

SU1+SU2+SU3+SU4+(Mirror Phase Field SU5) = Unify Field

Discussion and Unification Prospects

MGFT naturally incorporates gravito-magnetic effects already present in GR while extending them via quantum-inspired dual phases. It offers explanations for:

- Orbital stability with fine-tuning.
- Apparent dark matter contributions via hidden mirror-phase energy.
- Potential parity-violating gravitational waves or anomalies detectable by future interferometers (e.g., LISA).
- A pathway to quantum gravity by treating the mirror phases as emergent from a more fundamental pre-geometric theory (e.g., spin networks or higher-dimensional compactifications).

Challenges remain: full non-perturbative quantization, precise prediction of coupling constants, and empirical validation. Proposed tests include high-precision satellite gravimetry, analysis of galactic rotation curves for mirror signatures, and laboratory searches for gravito-magnetic phase couplings.

Conclusion

Our innovative Mirror Gravitational Field Theory provides a coherent, symmetry-driven extension of existing gravitational paradigms. By introducing dual-phase parity fields with spontaneous symmetry breaking and gravito-magnetic interactions, we offers a mathematically tractable framework that bridges classical Relativities, GEM, and elements of QFT. This attractive and repulsive push-pull, phase-dynamic mechanism enriches our understanding of celestial mechanics and opens avenues toward a unified description of fundamental forces. While hypothetical and requiring rigorous mathematical development (e.g., renormalization,background-independent quantization) and experimental scrutiny, MGFT represents a promising conceptual advancement in the quest to elucidate the true nature of gravity and the cosmos. Hope this framework contributes meaningfully to theoretical physics and humanity's understanding of the universe.

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