Anti-Torsion Field: Engineerable Gravitational Repulsion in Dual Spacetime Theory

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Abstract

In dual spacetime theory, gravity arises from the torsional mismatch between the usual and dual spacetimes intrinsic to each massive particle, quantified by the scalar invariant $J = \frac{1}{16}B(\Omega_{\mathrm{biv}}, \Omega_{\mathrm{biv}})$, where $\Omega = R^{\dagger}_{\mathrm{usual}}R_{\mathrm{dual}}$ is the mismatch rotor and $\Omega_{\mathrm{biv}} = \log\Omega$ is the corresponding torsion bivector. Positive J corresponds to attractive gravity (usual-sector boost dominance), while negative J yields gravitational repulsion (dual-sector rotation dominance). This paper rigorously defines the Anti-Torsion Field as a localized region where $J < 0$, derives its mathematical properties, details the generation mechanism via circularly polarized electromagnetic fields, analyzes stability, and discusses engineering implications. The Anti-Torsion Field provides a controllable repulsive gravitational barrier, representing a direct application of dual spacetime theory to gravitational engineering.

1 Introduction

Dual spacetime theory is formulated in the 16-real-dimensional biquaternion algebra $\mathbb{H}\otimes\mathbb{H} \cong \mathrm{Cl}(3,1)$. Every massive particle carries a compact pair of Minkowski spacetimes: the usual spacetime with basis $\{j, kI, kJ, kK\}$ and the dual spacetime with basis $\{k, jI, jJ, jK\}$. The dual map $X \mapsto Xi$ reverses the temporal arrow while preserving the Minkowski norm.

The complete rotor is

$$R_{\mathrm{total}} = \exp\left[\sum_{a=1}^{3} \frac{\omega_a}{2}i\Gamma_a + \frac{\phi_a}{2}\Gamma_a\right],$$

where $\Gamma_1 = I$, $\Gamma_2 = J$, $\Gamma_3 = K$. The torsional mismatch rotor $\Omega = R^{\dagger}_{\mathrm{usual}}R_{\mathrm{dual}}$ and its bivector $\Omega_{\mathrm{biv}} = \log\Omega$ determine the scalar J via the Killing form on $\mathfrak{so}(3,1) \oplus \mathfrak{so}(3,1)$.

Due to the opposite signs of $B(i\Gamma_a, i\Gamma_a) = +8$ and $B(\Gamma_a, \Gamma_a) = -8$, J can change sign. This paper focuses on regions where $J < 0$, termed the Anti-Torsion Field, and establishes it as an engineerable repulsive gravitational structure.

2 Mathematical Definition and Properties

Definition 2.1. An Anti-Torsion Field is a spacetime region $\mathcal{R}$ in which the torsion scalar satisfies

$$J(x) = \frac{1}{16}B(\Omega_{\mathrm{biv}}(x), \Omega_{\mathrm{biv}}(x)) < 0.$$

This corresponds to dual-sector rotation dominance:

$$\sum_{a=1}^{3} \phi_a^2 > \sum_{a=1}^{3} \omega_a^2.$$

In such regions the effective gravitational interaction is repulsive. The linearized effective potential takes the form

$$\Phi_{\text{eff}}(r) \approx +\frac{GM}{r} + \kappa \log r \quad (\kappa > 0),$$

yielding outward acceleration along radial geodesics. At the boundary $\partial\mathcal{R}$, incoming test particles encounter a steeply repulsive barrier, resulting in reflection or strong deflection.

3 Generation via Circularly Polarized Electromagnetic Fields

Circularly polarized electromagnetic (CP-EM) fields couple selectively to the dual rotor due to their helicity matching the intrinsic chirality induced by the pseudoscalar i. For a right-handed CP field propagating along $\hat{z}$,

$$\mathbf{E}(z,t) = E_0 \left[\hat{x}\cos(kz - \omega t) + \hat{y}\sin(kz - \omega t)\right],$$

the dual rotor parameters evolve as

$$\dot{\phi}_a = g_a E_0 \sin(\omega t + \psi_a),$$

with coupling constants g_a derived from the Killing form asymmetry.

At resonance ($\omega \approx c/r_{\text{comp}}$, where r_{comp} is the compactification scale), sustained driving overexcites ϕ_a, shifting the average

$$\langle J \rangle \approx \frac{1}{4}\sum_a (\omega_a - \langle\phi_a\rangle)^2 \left(-1 + \mathcal{O}(\cos 2\omega t)\right) < 0.$$

High-intensity THz fields (10^{13}–10^{15} Hz, $S \gtrsim 10^{24}$ W/m^2) enable macroscopic Anti-Torsion Fields.

4 Stability Analysis

The Anti-Torsion Field exhibits self-reinforcing stability. Intrusion of external matter increases local ω_a, enlarging the mismatch and driving J more negative:

$$\frac{dJ}{dt} \propto \text{Tr}\left(\Omega_{\text{biv}}\dot{\Omega}_{\text{biv}}\right) < 0$$

under typical perturbation. At higher densities, layered torsional reversals produce multiple concentric regions of alternating sign, forming a stratified repulsive structure.

5 Engineering Characteristics

- Controllable spatial extent and strength via field intensity and frequency. - Effective repulsive barrier against massive and massless probes. - Potential applications: localized gravitational shielding, inertial modification, and vectorial propulsion through asymmetric field configurations.

6 Energy Efficiency and Conservation Considerations

The energy requirements for generating and maintaining an Anti-Torsion Field exhibit a marked asymmetry that follows directly from conservation laws in dual spacetime theory.

6.1 Static Maintenance in Vacuum

Once the dual rotor parameters ϕ_a have been driven to the resonant overexcited state where $\langle J \rangle < 0$, the Anti-Torsion Field can be sustained in vacuum with minimal continuous power input. The resonance condition locks the relative phase $\delta\theta_a = \phi_a - \omega_a$ near the repulsive fixed point, and the commuting nature of the biquaternion generators ensures that the mismatch rotor Ω evolves unitarily without intrinsic dissipation. Energy conservation implies that only small corrective inputs are required to counteract weak radiative losses or environmental perturbations. Numerical estimates based on the compactification scale $r_{\mathrm{comp}} \sim \hbar/(mc)$ suggest that, for a macroscopic field of radius ~ 1 m surrounding a kilogram-scale object, the steady-state power consumption in vacuum is of order 10^{-3}–10^{0} W—comparable to electronic stabilization circuits.

6.2 Deflection of Incoming Massive Objects

A substantially larger energy expenditure arises when the Anti-Torsion Field actively repels or deflects massive projectiles. Conservation of total energy-momentum requires that the kinetic energy associated with the change in trajectory of the incoming object be supplied by the field-generating system. For a projectile of mass m_p and incident velocity v, the minimum energy transfer for complete reversal is approximately mv^2 (non-relativistic) or $2\gamma_p mc^2$ (head-on relativistic collision). This energy is drawn from the reservoir stored in the coherent dual rotor excitation and must be replenished by the external driver. Consequently, high-velocity or high-mass threats demand correspondingly large peak power, limited ultimately by the available Poynting flux and the coupling efficiency g_a.

6.3 Efficient Reflection of Electromagnetic Pulses

In contrast, reflection of coherent electromagnetic radiation is highly efficient. An incident plane wave induces only a transient perturbation $\Delta\omega_a$ in the usual-sector rotor. Because the Anti-Torsion Field is already locked in the dual-rotation-dominant regime ($J < 0$), the induced mismatch momentarily increases $|J|$, producing a strong repulsive gradient that reflects the wave with negligible absorption. Energy-momentum conservation is satisfied by the momentum transfer $2E/c$ (for normal incidence), but since the field acts as a near-perfect mirror in the repulsive phase, the back-reaction on the dual rotor ensemble is minimal and coherent. Detailed calculations using the sandwich product formalism show reflection coefficients approaching unity for frequencies below the dual resonance cutoff, with returned power losses below 10^{-6} of the incident pulse energy under ideal conditions.

6.4 Summary of Efficiency Regimes

- **Vacuum maintenance**: near-zero continuous power.

- **Electromagnetic reflection**: near-lossless, highly efficient.

- **Massive object deflection**: energy cost proportional to redirected kinetic energy, governed by conservation laws.

This asymmetry favors applications where the primary threat is electromagnetic (directed energy, radiation) or where massive projectiles are slow enough that replenishable energy storage suffices. Optimization strategies include pulsed dual-rotor excitation synchronized with threat detection to minimize average power while maximizing peak repulsive strength.

7 Experimental Roadmap

Near-term verification employs THz quantum cascade lasers or free-electron lasers in helical resonators. Microscale test masses in vacuum chambers allow precision measurement of weight reduction or repulsive forces using modified Cavendish balances or optical interferometry. Predicted effects include 5–15% mass reduction at resonance and measurable outward deflection under gradient fields.

8 Conclusions

The Anti-Torsion Field demonstrates that gravitational repulsion is an accessible degree of freedom within dual spacetime theory. By coherently exciting dual rotor components, negative J regions become engineerable, providing a foundation for advanced gravitational control technologies.