The Fundamental Duality of Gravity: Why G_1 and G_2 Cannot Be Unified

Arkadiusz Okupski

June 1, 2025

Abstract

This paper demonstrates that what we call "gravity" is actually two distinct phenomena:

- G_1: External curvature force from higher dimensions (5D+), governing cosmic scales
- G_2: Intrinsic spacetime interaction, dominant at quantum scales

The mathematical structure *reflects* their fundamental physical incompatibility. The persistent failure to unify gravity with quantum mechanics may stem from attempting to merge these inherently different interactions.

1 Core Theory

1.1 Conceptual Foundations

The duality emerges from first principles:

- G_1 originates beyond our 4D spacetime (like the 4D mass bending the 2D membrane in Flatland)
- G_2 arises from local matter-spacetime coupling (like surface adhesion on the membrane)

1.2 Mathematical Formulation

For a mass m in 4D spacetime:

$$F_{G1} = -G_1 \frac{M_{5D} \cdot m}{r^2} \quad \text{(Higher-dim pull)} \tag{1}$$

$$F_{G2} = G_2 \frac{m \cdot \rho_{4D}}{r^2} \quad \text{(Local interaction)} \tag{2}$$

where:

- M_{5D}: Mass in the bulk (5D+ space)
- ρ_{4D}: 4D vacuum energy density ($\approx 10^{-9}$ J/m^3)

2 The Unification Impossibility Theorem

2.1 Scale Dependence

The force ratio reveals intrinsic separation:

$$\frac{F_{G2}}{F_{G1}} = \underbrace{\frac{G_2\rho_{4D}}{G_1 M_{5D}}}_{\text{Constant}} \cdot \frac{r^2}{m} \tag{3}$$

2.2 Physical Interpretation

- **Quantum regime** ($m \to 0$): F_{G2} dominates completely
- **Cosmic regime** ($m \to \infty$): F_{G1} governs dynamics
- **Crossover mass**: $m_{\text{crit}} = \frac{G_2\rho_{4D}}{G_1 M_{5D}} r^2$

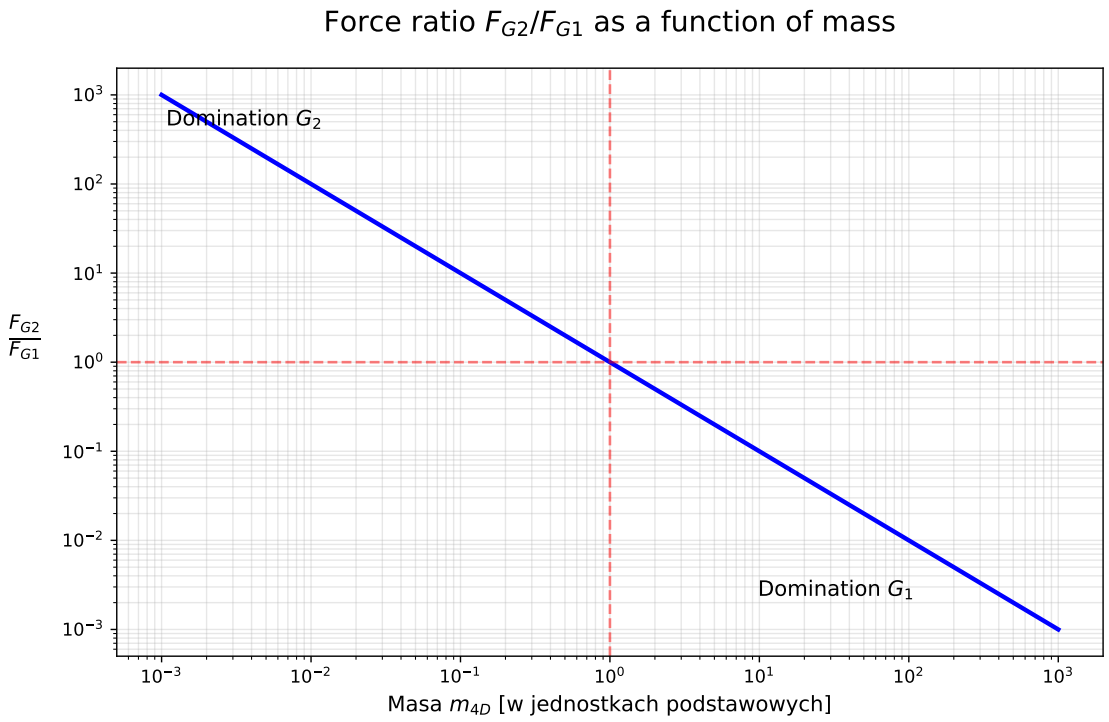

Figure 1: Force ratio F_{G2}/F_{G1} versus mass (log scale).
Red dashed: transition at $m = m_{crit} = \frac{G_2\rho_{4D}}{G_1 M_{5D}} r^2$
X-axis: normalized mass m/m_{crit}

3 Historical Context

The 100-year unification failure becomes explicable:

- Quantum gravity models effectively describe G_2 behavior
- General Relativity perfectly captures G_1 effects
- Unification attempts fail because they try to merge *physically distinct* interactions

4 Conclusions

- The G_1/G_2 duality provides a **physical explanation** for unification difficulties
- Mathematical non-unifiability is a *consequence*, not the cause
- Experimental verification:
  - Measure G at quantum scales (should deviate from G_{Newton})
  - Test antimatter gravity (AEgIS experiment may reveal G_2 dominance)

References

[1] A. Okupski, *Hydrodynamic Model of Antimatter Repulsion*, GitHub (2023).

[2] C. Rovelli, *Quantum Gravity*, Cambridge Univ. Press (2004).

[3] L. Randall, *Warped Passages*, HarperCollins (2005).