Galaxy Dynamics: Constitutive Metric Yield and Flat Rotation Curves

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Integrity Status: In CPT, flat galactic rotation curves and the Baryonic Tully–Fisher Relation are governed by the **infrared constitutive metric yield** ($a \lesssim a_0 = c^2/R$) of the cosmic spatial container $S^3(R)$ (AQUAL / MOND regime). Plasma Birkeland currents are restricted to Book C (Ampère on ionized gas); leftover HI drag is only $\sim 0.4\%$ of v^2/R (`P-HI`), and neutral stars do not obey Lorentz forces. Live status: cpt-physics.com/status.

Abstract

Galaxy rotation curves have been the primary empirical motivation for dark matter since the 1970s. The observed flat rotation profiles—where orbital velocities remain constant far beyond the visible disc—cannot be explained by Newtonian gravity alone. Standard cosmology invokes a massive halo of invisible, non-baryonic dark matter. In the CPT framework, flat rotation curves and the Baryonic Tully–Fisher Relation ($v^4 = G M a_0$) emerge from the infrared constitutive metric yield of the spatial container when gravitational acceleration drops below $a_0 \sim c^2/R \approx 1.2 \times 10^{-10}\text{ m/s}^2$, without requiring dark matter particles.

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1. The Galaxy Rotation Problem

In Newtonian gravity, the orbital velocity $v(r)$ of a star in a disc should follow: $$v(r) = \sqrt{\frac{G M(r)}{r}}$$

Beyond the visible disc, where the enclosed baryonic mass $M(r)$ becomes constant, this predicts a Keplerian decline $v(r) \propto 1/\sqrt{r}$. Observations (e.g. the SPARC database) show that $v(r)$ remains flat far beyond the visible disc. Standard cosmology invokes an ad-hoc dark matter halo, yet direct detection experiments have failed to find the proposed particles.

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2. Plasma Bounds vs. Gravitational Metric Yield

An early hypothesis explored whether interstellar Birkeland currents and Z-pinch forces ($F_p \propto I^2/r$) could provide the centripetal force flattening rotation curves. A rigorous lab audit (`P-HI`, `FT-PERATT`, `FT-FAT`) demonstrated that: 1. **Ionized Gas Limit:** Lorentz forces $J \times B$ act only on ionized plasma; neutral stars move solely under gravitational metric curvature. 2. **Drag Magnitude:** Tangential drag from galactic currents is at most $\sim 0.16\%$–0.40% of the required centripetal acceleration v^2/R at the Solar circle (8.5 kpc, 220 km/s). 3. **Field Bounds:** The currents needed to dynamically bind neutral stars would generate magnetic fields 10^{30} times larger than observed microgauss galactic fields.

Therefore, Birkeland currents structure interstellar ionized gas, but do not dictate stellar kinematics.

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3. The CPT Resolution: Constitutive Metric Yield ($a \lesssim a_0$)

In CPT, the true physical origin of flat rotation curves is the **constitutive metric response** of the cosmic spatial container $S^3(R)$.

The container geometry sets an invariant characteristic acceleration threshold: $$a_0 \sim \frac{c^2}{R} \approx 1.2 \times 10^{-10}\text{ m/s}^2$$

In galactic outskirts, when the gravitational acceleration drops below this threshold ($g \lesssim a_0$): * The effective gravitational response transitions from the high-acceleration Newtonian regime ($\mu \to 1$, $g \approx g_N$) to the infrared yield regime: $$g \approx \sqrt{g_N a_0}$$ * For circular orbital motion ($v^2/r = g$ with $g_N = GM/r^2$): $$\frac{v^2}{r} = \sqrt{\frac{G M a_0}{r^2}} \implies v^4 = G M a_0$$

This derives the **Baryonic Tully–Fisher Relation** ($M \propto v^4$) and asymptotic flat rotation curves directly from baryonic mass alone, with zero dark matter halos. The constitutive family is constrained by Solar System Cassini tracking (Q_2) in the ultraviolet, while preserving gravitational wave speed $c_{\text{gw}} = c$.