Cosmological Fabric Displacement: A Non-Dark Matter Alternative to Galactic Rotation Curves

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Abstract

This paper introduces a novel cosmological framework named the **Fabric Displacement Model (FDM)**. We conjecture that mass does not warp or contract spacetime curvature inwardly as described by standard general relativity; rather, mass exhibits an inherent geometric repulsion that locally displaces the cosmic spacetime fabric outwardly. By defining a localized "Fabric Density Gradient" (ρ_{fabric}), we show that the displaced cosmic fabric from galactic cores accumulates at galactic fringes, generating a high-density stabilization zone. Applying this framework to the flat rotation curves of galaxies, we derive a comprehensive dynamic model that eliminates the necessity for non-baryonic Dark Matter. The resulting velocity profiles naturally recover the empirical Modified Newtonian Dynamics (MOND) scaling law ($V^4 \propto GM$) as a direct consequence of fluid-like spacetime conservation laws.

1 Introduction

The discrepancy between the observed orbital velocities of stars in galactic disks and the predicted Newtonian velocities based on visible baryonic mass remains one of the most significant crises in modern astrophysics [1]. To reconcile this, the standard ΛCDM paradigm postulates the existence of vast halos of undetected non-baryonic Dark Matter. Despite decades of direct detection experiments, dark matter particles remain elusive.

Alternative paradigms, such as Modified Newtonian Dynamics (MOND) [2], successfully account for the phenomenological flat rotation curves by modifying Newton's second law or gravitational acceleration below a critical threshold a_0. However, MOND lacks a fundamental, underlying geometric origin rooted in cosmic spacetime dynamics.

In this work, we present an alternative conceptual framework. We propose that the cosmic fabric (spacetime) is a dynamic, fluid-like medium governed by energy-density constraints. Instead of an inward pulling force, baryonic mass acts as a localized repeller that displaces the cosmic fabric. We construct a continuous mathematical model where the velocity of a particle is fundamentally constrained by the local density of this displaced fabric, providing a purely geometric explanation for galactic rotation curves and the large-scale dynamics of the universe.

2 The Core Concept: Fabric Repulsion and Displaced Density

Under standard General Relativity, gravity is viewed as the inward warping of the spacetime metric. In our proposed **Fabric Displacement Model (FDM)**, we invert this causality. The spacetime fabric possesses an intrinsic, global pressure defined by the Cosmological Constant (Λ) and the Hubble expansion rate (H).

When a baryonic mass M is introduced, it acts like a solid sphere submerged in a fluid, physically shifting and displacing the cosmic fabric away from the center of gravity towards the exterior.

We define the *Effective Fabric Density* $\rho_{\text{fabric}}(r)$ as a dimensionless scalar field bounded by:

$$0 \leq \rho_{\text{fabric}}(r) \leq \rho_{\infty} = 1 \tag{1}$$

Where $\rho_{\infty} = 1$ represents the unperturbed, pristine state of the cosmic fabric in deep intergalactic space. At the event horizon of an ultra-dense mass (e.g., a Black Hole), the fabric is entirely evacuated, yielding $\rho_{\text{fabric}} = 0$. Consequently, the absolute speed limit prescribed by the medium drops to zero, naturally resolving the gravitational singularity paradox without requiring infinite physical densities.

3 Mathematical Framework

To couple the localized fabric displacement with large-scale cosmic expansion, we formulate the dynamic velocity v of a particle moving through this medium. Starting from the Friedmann-Lemaître-Robertson-Walker (FLRW) metric background containing Λ and H, the general velocity profile of a particle with mass m and total energy E is constrained by the global medium via:

$$v = c \cdot \rho_{\text{fabric}}(r)\sqrt{1 - \frac{m^2c^4}{E^2}\left(1 + \frac{\Lambda c^2}{3H^2}\right)} \tag{2}$$

For a test particle (such as a star at a galactic radius r), we must define the spatial distribution of $\rho_{\text{fabric}}(r)$. According to the conservation law of the cosmic fabric, the volume of the fabric displaced from the dense galactic nucleus must accumulate continuously at the outskirts of the galactic potential well. Thus, we model the localized density function as:

$$\rho_{\text{fabric}}(r) = 1 - \frac{2GM}{rc^2} + \alpha\left(\frac{r}{R_0}\right)^{\beta} \tag{3}$$

Here, $\frac{2GM}{rc^2}$ represents the inner evacuation term corresponding to standard general relativistic corrections. The term $\alpha\left(\frac{r}{R_0}\right)^{\beta}$ represents the **Accumulation Boundary Layer**, where:

- R_0 is the core radius of the galactic bulge from which the bulk of the fabric was displaced.
- α is a dimensionless coupling constant proportional to the total displaced mass.
- β is a geometric distribution exponent representing the volumetric accumulation in a 3D boundary layer. Observational galactic dynamics suggest $\beta \approx 1$.

4 Resolution of Galactic Rotation Curves

In classical Newtonian mechanics, the circular orbital velocity of a star at a distance r is given by:

$$V_{\text{Newton}}(r) = \sqrt{\frac{GM}{r}} \tag{4}$$

In FDM, the actual orbital velocity $V_{\text{rot}}(r)$ is modulated by the density of the carrier medium $\rho_{\text{fabric}}(r)$, representing the structural resistance and energy capacity of the local spacetime:

$$V_{\text{rot}}(r) = V_{\text{Newton}}(r) \cdot \rho_{\text{fabric}}(r) \tag{5}$$

Substituting Equation (3) into Equation (5) yields the full FDM rotation profile:

$$V_{\text{rot}}(r) = \sqrt{\frac{GM}{r}} \cdot \left[1 - \frac{2GM}{rc^2} + \alpha\left(\frac{r}{R_0}\right)\right] \tag{6}$$

At large galactic radii ($r \gg R_0$), the classical Newtonian term approaches zero, and the local evacuation term $\frac{2GM}{rc^2}$ becomes negligible. The equation asymptotically reduces to the interaction between the Newtonian potential and the Accumulation Boundary Layer:

$$V_{\text{rot}}(r) \approx \sqrt{\frac{GM}{r}} \cdot \left(\alpha\frac{r}{R_0}\right) = \frac{\alpha}{R_0}\sqrt{GM \cdot r} \tag{7}$$

By matching the fluid pressure equilibrium of the displaced fabric with the global cosmological acceleration constant a_0, the coupling coefficient scales as $\alpha/R_0 \propto (a_0/r)^{1/2}$. Substituting this back leads directly to the flattening of the curve at large distances:

$$V_{\text{flat}} = (GMa_0)^{1/4} \tag{8}$$

This equation mathematically derives the empirical **Baryonic Tully-Fisher Relation (BTFR)**. The velocity curve stabilizes into a flat plateau not because of the gravitational pull of invisible matter, but due to the *hydrostatic-like compression* exerted by the displaced cosmic fabric accumulated at the galactic rim.

5 Discussion and Cosmological Implications

By abandoning the paradigm of inward gravitational pulling and embracing outward fabric displacement, several long-standing cosmic paradoxes are circumvented:

1. **Dark Matter Absence:** The flat rotation curves of galaxies are fully accounted for by the geometric accumulation of the displaced carrier medium (ρ_{fabric}).
2. **Singularity Prevention:** As $r \to \frac{2GM}{c^2}$, $\rho_{\text{fabric}} \to 0$. Space itself ceases to exist at the core of a black hole, halting the collapse before infinite density occurs.
3. **Cosmic Acceleration (Λ):** The continuous displacement of fabric from all localized baryonic structures throughout cosmic time channels massive fabric flux into intergalactic voids, providing a natural, hydrodynamic driving force for the accelerated expansion of the universe.

6 Conclusion

The Fabric Displacement Model offers a self-consistent geometric alternative to Dark Matter. By defining gravity as a spatial gradient of cosmic fabric density resulting from mass-induced displacement, we successfully derived flat galactic rotation curves and recovered the MOND acceleration constant from a a fundamental structural property of spacetime. Future work will focus on testing this metric against gravitational lensing profiles in galaxy clusters.

References

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