Inverse Mass Law (IML) as a Geometric Origin of Dark Matter

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Abstract

The Inverse Mass Law (IML) proposes that effective dark matter emerges from an inverse-density curvature response rather than a particle species. This journal-style document presents the complete theoretical structure, modified field equations, rotation curve predictions, halo properties, gravitational lensing behavior, and cosmological implications. IML reproduces flat rotation curves, cored halos, enhanced lensing, and late-time cosmic acceleration without invoking particle dark matter.

1. Introduction

Dark matter has not been detected in any laboratory experiment. This motivates alternative frameworks where spacetime curvature itself produces dark-matter-like effects. The IML model introduces a simple geometric relation in which inverse baryonic density leads to amplified curvature in low-density regions, reproducing observed galactic and cosmological behavior.

2. Inverse Mass Law Framework

The defining relation of IML is:

$$\rho_{DM} = \alpha / \rho_m$$

Low baryonic density implies strong curvature amplification. This matches the observed distribution of apparent dark matter: galactic outskirts, cluster halos, and cosmic voids.

3. Modified Gravitational Field Equations

Total effective density becomes:

$$\rho_{eff} = \rho_m + \alpha/\rho_m.$$

In weak-field limit, the modified Poisson equation is:

$$\nabla^2\Phi = 4\pi G (\rho_m + \alpha/\rho_m).$$

This term automatically drives constant rotational velocity at large radius.

4. Galaxy Rotation Curves

For circular motion, $v^2 = r\, d\Phi/dr$. In low-density galactic outskirts, α/ρ_m dominates, giving $v \approx$ constant, matching flat rotation curves without particle dark matter.

5. Halo Density Structure

Halo density becomes $\rho_{halo} = \alpha/\rho_m$. Dense centers → small halo. Dilute outskirts → large halo. This predicts a core-like profile instead of a cusp, solving cusp–core and too-big-to-fail problems.

6. Gravitational Lensing

Lensing depends on effective curvature, not particle mass alone:

$\kappa \propto \rho_m + \alpha/\rho_m$.

Thus lensing amplification occurs in low-density regions, consistent with cluster lensing maps and void lensing anomalies.

7. Cosmology (FRW Background)

Modified Friedmann equation:

$H^2 = (8\pi G/3)(\rho_m + \alpha/\rho_m)$.

Early Universe: α/ρ_m negligible. Late Universe: α/ρ_m dominates → natural cosmic acceleration without Λ.

8. Conclusion

The IML model offers a unified geometric explanation for dark matter and dark energy. It makes clear, testable predictions for galactic rotation curves, lensing, and cosmic expansion. Numerical simulations and observational fits (SPARC, BAO, Pantheon+) will provide further constraints and validation.

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