Matter-Originated Spacetime Gradient Model (MOSGM)

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Abstract

We propose the Matter-Originated Spacetime Gradient Model (MOSGM), a phenomenological framework in which spacetime properties arise from large-scale matter distributions rather than existing as an independent background. The model predicts environment-dependent corrections to galactic rotation dynamics without invoking dark matter particles.

1 Introduction

Galaxy rotation curves exhibit systematic deviations from Newtonian expectations when interpreted within standard General Relativity without dark matter. Existing explanations typically invoke non-baryonic dark matter or modifications to gravity.

MOSGM takes a different approach: it denies the existence of matter-free spacetime and instead assumes that spacetime gradients emerge from matter distributions themselves.

2 Core Assumptions

MOSGM is based on the following assumptions:

1. Spacetime does not exist independently of matter.
2. Large-scale matter density gradients induce spacetime property gradients.
3. Local gravitational dynamics respond weakly but measurably to these gradients.

3 Phenomenological Framework

In the weak-field, non-relativistic regime relevant for disk galaxies, MOSGM modifies the effective gravitational response through an environment-dependent correction. The effective radial acceleration is written as

$$g_{\text{eff}}(r) = g_{\text{N}}(r)\,[1 + \alpha\, F(\nabla \Sigma_{\text{env}})], \tag{1}$$

where $g_{\text{N}}(r)$ is the Newtonian acceleration sourced by the baryonic mass distribution, Σ_{env} denotes the large-scale environmental matter density, α is a dimensionless coupling parameter, and F is a phenomenological response function.

The environmental density Σ_{env} characterizes the surrounding matter distribution on scales much larger than the galaxy itself. The response function F is assumed to be monotonic in the magnitude of the environmental density gradient and vanishes in homogeneous environments.

4 Observational Consequences

MOSGM predicts correlations between galaxy rotation curve residuals and large-scale matter density gradients evaluated on scales of $\sim$ 5–10 Mpc. Such correlations are absent in standard dark matter models and are not expected in acceleration-based modified gravity frameworks.

The predicted effect is weak but cumulative across large galaxy samples, enabling statistical detection or constraint using existing observational datasets.

5 Falsifiability

MOSGM is falsifiable through observational tests. If no statistically significant correlation is detected between rotation curve residuals and environmental matter density gradients across well-controlled galaxy samples, the coupling parameter α must be consistent with zero. A positive detection would instead indicate an environment-dependent gravitational correction arising from matter-originated spacetime structure.

6 Conclusion

MOSGM provides a testable and falsifiable alternative explanation for galaxy rotation anomalies without introducing new particles. It preserves the local successes of General Relativity while introducing weak, environment-dependent corrections.

References

[1] F. Lelli, S. McGaugh, J. Schombert, *SPARC: Mass Models for Disk Galaxies*, Astronomical Journal, 152, 157 (2016).