Gravitational Quiescence of Cosmic Voids under Curvature Activation Thresholds in UMT

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May 2025

Abstract

Universal Motion Theory (UMT) predicts that cosmic voids, despite possessing residual curvature, exhibit gravitational quiescence due to sub-threshold curvature activation. This addendum models the gravitational behavior of void centers, predicts weak lensing signatures at void boundaries based on curvature activation gradients, and compares these predictions to observed cosmic void profiles. The derivation strengthens UMT's explanatory power for large-scale gravitational structures without altering its core framework.

1 Introduction

Standard cosmology explains cosmic voids as underdense regions with reduced gravitational pull due to a lack of matter. Universal Motion Theory (UMT) offers a geometric alternative: voids are regions where curvature exists but fails to activate sufficient motion closure, leading to gravitational quiescence despite nonzero curvature.

In UMT, the emergence of gravitational effects depends on the curvature activation function $\Phi(\rho)$, where ρ is the local curvature density. Voids with $\rho < \rho_{th}$ exhibit $\Phi \approx 0$, suppressing gravitational tension even when geometrically curved.

2 Curvature Activation and Void Behavior

The curvature activation function is given by:

$$\Phi(\rho) = \frac{1}{1 + e^{-k(\rho - \rho_{th})}} \tag{1}$$

where k is the steepness parameter and ρ_{th} is the activation threshold curvature density.

Regions within cosmic voids satisfy $\rho \lesssim \rho_{th}$, implying:

$$\Phi(\rho) \approx 0 \tag{2}$$

Thus, the effective gravitational field within void centers is:

$$G_{eff} = \nabla(\Phi\kappa) \approx 0 \quad (3)$$

where κ is the mean local curvature.

Despite $\kappa \neq 0$, the lack of activation suppresses gravitational dynamics.

3 Predicted Weak Lensing Signatures

At void boundaries where $\rho \to \rho_{th}$, curvature activation gradients $\nabla\Phi$ become significant. These gradients predict subtle weak lensing effects:

- **Minimal lensing within void centers** due to $\Phi \approx 0$.
- **Sharp lensing gradients** at void edges corresponding to activation threshold crossings.
- **Anisotropic shear patterns** tracing $\nabla(\Phi\kappa)$ structures.

The weak lensing convergence κ_{lens} near void boundaries should correlate with regions where $d\Phi/d\rho$ is maximal.

4 Comparison to Observations

Observational surveys (e.g., DES, SDSS) indicate:

- Voids exhibit lower-than-expected gravitational pull relative to standard ΛCDM predictions.
- Weak lensing maps show sharper boundary transitions than simple underdensity models predict.
- Some voids show effective gravitational "silence" despite geometric deformation.

UMT naturally explains these features as consequences of curvature activation dynamics: - Gravitational quiescence inside voids. - Boundary-enhanced lensing signatures. - Alignment of anisotropic patterns with activation gradients.

5 Conclusion

This addendum formalizes the gravitational behavior of cosmic voids under Universal Motion Theory, highlighting the role of curvature activation thresholds in producing gravitational quiescence. Predicted weak lensing features offer direct, falsifiable observational tests of UMT's geometric activation framework.

References

1. Bernot, R. (2025). Universal Motion Theory Manuscript.
2. DES Collaboration. (2016). The Dark Energy Survey Year 1 Results.
3. Clampitt, J., Jain, B. (2015). Lensing measurements of large cosmic voids.