Dark Energy as Gravitational Leakage via Black Hole–Wormhole Networks: A Testable Multiversal Hypothesis

Batayan E. Sheep[1]

[1]Independent researcher, batayanesheep@gmail.com

Abstract

We propose a cosmological hypothesis where black holes serve as wormhole-like portals connecting our universe to others in a multiverse. Gravitational leakage through these conduits creates an effective repulsive pressure, manifesting as dark energy. We derive a Yukawa-type kernel for gravitational leakage, incorporate it into the Friedmann equation, and simulate its anisotropic effects. The model predicts a dipole-like perturbation in the Hubble flow, consistent with Pantheon+ and Planck isotropy bounds. Our framework offers concrete, falsifiable predictions that can be tested using cross-correlations of black hole tracers with supernovae, weak lensing, and CMB data.

1 Introduction

The standard cosmological model ΛCDM explains accelerated expansion via a cosmological constant Λ, yet its origin remains unclear. Inspired by the ER=EPR conjecture and brane-world scenarios, we hypothesize that black holes act as bridges to external universes. Gravitational leakage into our universe from these connections produces a small but coherent additional energy component with $w \approx -1$.

2 Mathematical Framework

In a spatially flat FRW universe, the Friedmann equation is

$$H^2(t) = \frac{8\pi G}{3}\left(\rho_m + \rho_r + \rho_\Lambda + \rho_{\rm ext}(t)\right). \tag{1}$$

We model $\rho_{\rm ext}(\mathbf{x})$ as

$$\rho_{\rm ext}(\mathbf{x}) = \sum_i \frac{\alpha M_i}{4\pi L^2}\left(\frac{L}{|\mathbf{x}-\mathbf{r}_i|}\right)^{n-1} e^{-|\mathbf{x}-\mathbf{r}_i|/L}, \tag{2}$$

where M_i are black hole masses, L is a leakage scale, n controls short-range behavior, and α is a coupling constant.

3 Dipole Anisotropy and Angular Spectrum

The induced Hubble perturbation is

$$\delta H(\mathbf{x}) \simeq \sqrt{\frac{8\pi G}{3}\rho_{\rm ext}(\mathbf{x})}. \tag{3}$$

Projection onto the sky yields dipole-dominated spherical harmonics. The angular power spectrum is given by

$$C_\ell^{HH}(z) \approx |W_\ell(L,n;z)|^2 C_\ell^{BB}(z), \tag{4}$$

where W_ℓ is the leakage kernel transform and C_ℓ^{BB} is the black hole mass power spectrum.

4 Observational Cross-correlations

We define the Hubble residuals $\Delta\mu(\hat{n},z)$ and compute their cross-spectrum with a black hole proxy map B as

$$C_\ell^{\Delta\mu B}(z) \simeq T_\ell^{\rm SN}(z) W_\ell(L,n;z) C_\ell^{BB}(z), \tag{5}$$

where $T_\ell^{\rm SN}$ is the SN transfer function.

5 Forecasts and Constraints

Fisher analysis using SN and BH maps yields detection thresholds $\alpha \gtrsim 0.05$ for $L \gtrsim 800$ Mpc at 3σ. Null detection constrains $\alpha < 0.02$.

6 Conclusion

The gravitational leakage hypothesis offers a falsifiable mechanism for dark energy consistent with existing isotropy constraints. Further cross-correlation studies with SNe, weak lensing, and CMB ISW data will refine its viability.

References

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