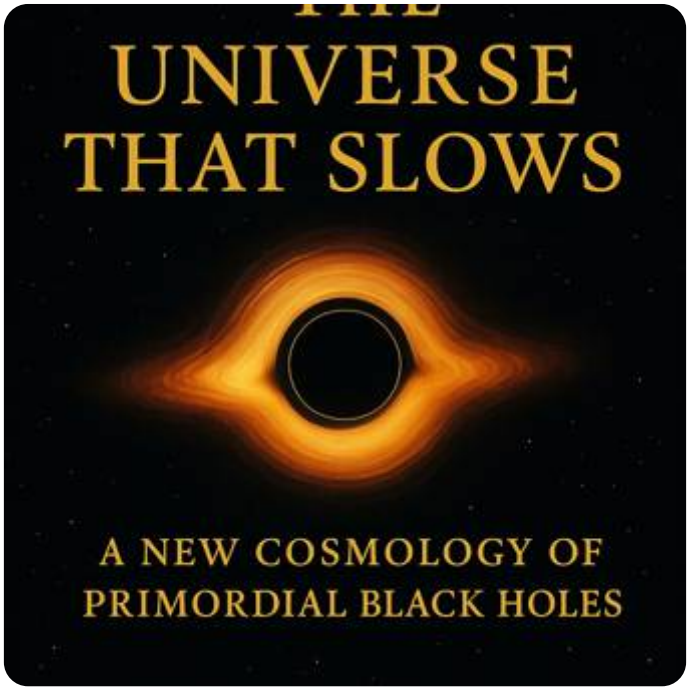
Beyond the Dark Energy Illusion: PBHs and the Deep Rhythm of the Cosmos

Publicado em 2025-11-10 00:07:56



Cosmology: A Transiently Accelerating Universe Without Dark Energy

Francisco Gonçalves & Augustus Veritas Lumen – 2025

Abstract

Recent analyses of Type Ia supernovae suggest that the late–time cosmic expansion may no longer be accelerating. We propose a cosmological model in which a population of primordial black holes (PBH) acts as an interacting matter component capable of generating a transient phase of apparent acceleration without invoking dark energy. The interaction term $Q(z)=\xi(z)H(z)\rho_{PBH}(z)$ induces an effective negative pressure that mimics Λ-like behaviour over a finite redshift interval. Once Q(z) decays, the universe naturally transitions back to deceleration. This model

The apparent acceleration discovered in 1998 led to the dominance of the ΛCDM model. However, emerging evidence suggests that supernova luminosity calibration may contain redshift–dependent systematics, weakening the case for dark energy. Simultaneously, primordial black holes have resurfaced as candidates for a dynamically relevant matter component. This work unifies these notions by proposing PBH–induced transient acceleration.

2. Theoretical Framework

2.1 PBH as an interacting matter component

PBH behave as non-relativistic matter but can exchange energy with cosmic gas through accretion and feedback. Instead of detailed microphysics, we adopt a coarse interaction:

$$Q(z) = \xi(z)\, H(z)\, \rho_{PBH}(z)$$

2.2 Conservation equations

Energy conservation gives:

2.3 Interaction function ξ(z)

We adopt:

$$\xi(z) = \xi_0 (1+z)^m \exp(-z/z★)$$

2.4 Effective pressure

$$p_{eff} = - Q / (3H)$$

Acceleration occurs if p_{eff} is sufficiently negative. As ξ(z) decays, acceleration fades.

3. Dynamics in Redshift Space

Changing variables from cosmic time to redshift:

$$d\rho/dz = \dot{d}\rho / (-(1+z)H)$$

4. Observational Predictions

4.1 Hubble expansion

The PBH–interactive model reproduces mild acceleration for $0.3<z<1.2$ and predicts a return to deceleration at $z\approx0$ if ξ(z) has already faded.

$$d_L(z) = (1+z) \int_0^z \frac{dz'}{H(z')}$$

Consistent with corrected supernova data.

4.3 Growth of structures

The model naturally suppresses $f\sigma_8$ at intermediate redshifts, helping alleviate the S_8 tension.

4.4 Early-universe constraints

PBH interactions are negligible at recombination due to high sound speed and baryon–photon coupling.

5. Physical Interpretation

PBH accretion peaks in filaments and halos produce temporary negative effective pressure. As cosmic gas depletes, the effect fades, making acceleration a transient phenomenon rather than a fundamental one.

6. Conclusion

We present a viable alternative to dark-energy–driven expansion, replacing Λ with PBH–induced transient acceleration. The model is testable and

Riess A. G. et al. (1998), AJ, 116, 1009
Perlmutter S. et al. (1999), ApJ, 517, 565
Carr, B.; Kühnel, F.; Visinelli, L. (2021), Class. Quant. Grav., 38, 123001
Hasinger, G. (2020), JCAP 07, 022
Franciolini, G. et al. (2022), Phys. Rev. D 105, 063509
Poulin, V. et al. (2017), Phys. Rev. D 96, 083524