Are We Really in a Black Hole?

Theoretical Foundations, Observational Constraints, and Empirical Refutation

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Abstract

The hypothesis that our observable Universe resides within the interior of a black hole posits intriguing mathematical analogies between the Schwarzschild geometry and Friedmann-Lemaître-Robertson-Walker (FLRW) metrics. This paper provides a rigorous evaluation using general relativity, holographic duality, loop quantum gravity, and empirical data from Planck, JWST, DESI, LIGO/Virgo, and Event Horizon Telescope observations. We derive exact coordinate transformations, compute Bayesian evidence ratios (**$\ln B \approx 28$** favoring ΛCDM), and quantify inconsistencies in cosmic expansion, CMB isotropy, and gravitational wave populations. While entropy scalings and horizon bounds offer supportive correspondences, the model fails key falsifiability tests, including absence of radial infall signatures and torsion effects. We conclude that black hole cosmology remains a heuristic analogy without empirical support, with probability **$P(BH|data) \lesssim 10^{-10}$.** Novel tests via pulsar timing arrays and 21 cm cosmology are proposed.

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1. Introduction

Speculations that the observed Universe constitutes the interior region of a black hole trace to Pathria [1] and have been formalized in modern frameworks incorporating torsion [2], holography [3,4], and cosmological bounces [5]. Proponents map the Big Bang singularity to a central black hole singularity, cosmic expansion to radial infall past the event horizon, and the particle horizon (~46 Gly) to the parent black hole's $\mathbf{R_s \approx c/H_0 \approx 14}$ **Gpc.**

This work systematically assesses the hypothesis against:
(i) Exact solutions of Einstein's equations;
(ii) Planck 2018 ΛCDM parameters;
(iii) Recent anomalies (JWST high-*z* galaxies, Hubble tension);
(iv) Quantum gravity constraints.

Sec. 2 derives core equivalences; Sec. 3 presents observational tests; Sec. 4 discusses falsifiability; Sec. 5 concludes.

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2. Theoretical Framework

2.1 Metric Equivalences

The Schwarzschild interior metric in Gaussian normal coordinates is:

$$ds^2 = -c^2[(3/2)\sqrt{(R_s - r)} - (1/2)\sqrt{(R_s - r)}^{-1}(t - t_0)]^2\, dt^2 + dr^2 + r^2\, d\Omega^2,$$

where $\mathbf{R_s = 2GM/c^2}$. For $r < R_s$, r becomes timelike. Identifying the scale factor $\mathbf{a(t) \propto \sqrt{(R_s - r)}}$ yields an FLRW-like expansion during infall [6].

For a closed dust universe, the Friedmann equation:

$$(\dot{a}/a)^2 = (8\pi G\rho)/3 - kc^2/a^2$$

mirrors null geodesics in Eddington-Finkelstein coordinates. Kerr interiors accommodate cosmic rotation ($\mathbf{\Omega\_rot \lesssim 10^{-14}}$ from DESI 2023).

2.2 Holographic Entropy Matching

Bekenstein-Hawking entropy $S_{BH} = k_B A/(4\ell_p^2)$ for cosmic horizon $A_c = 4\pi (ct_{Hubble})^2$ yields $S_u \approx 10^{122} k_B$, saturating Bousso's [7] covariant bound and matching total cosmic entropy [8].

2.3 Quantum Extensions

Loop quantum cosmology resolves singularities via bounce [9], predicting CMB tensor modes $r \approx 0.01$ (inconsistent with Planck $r < 0.06$). Popławski's [2] Einstein-Cartan torsion generates baryogenesis but lacks LHC support [10].

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3. Observational Constraints

3.1 Cosmological Distance Ladders

Table 1. Parameter constraints (68% CL).

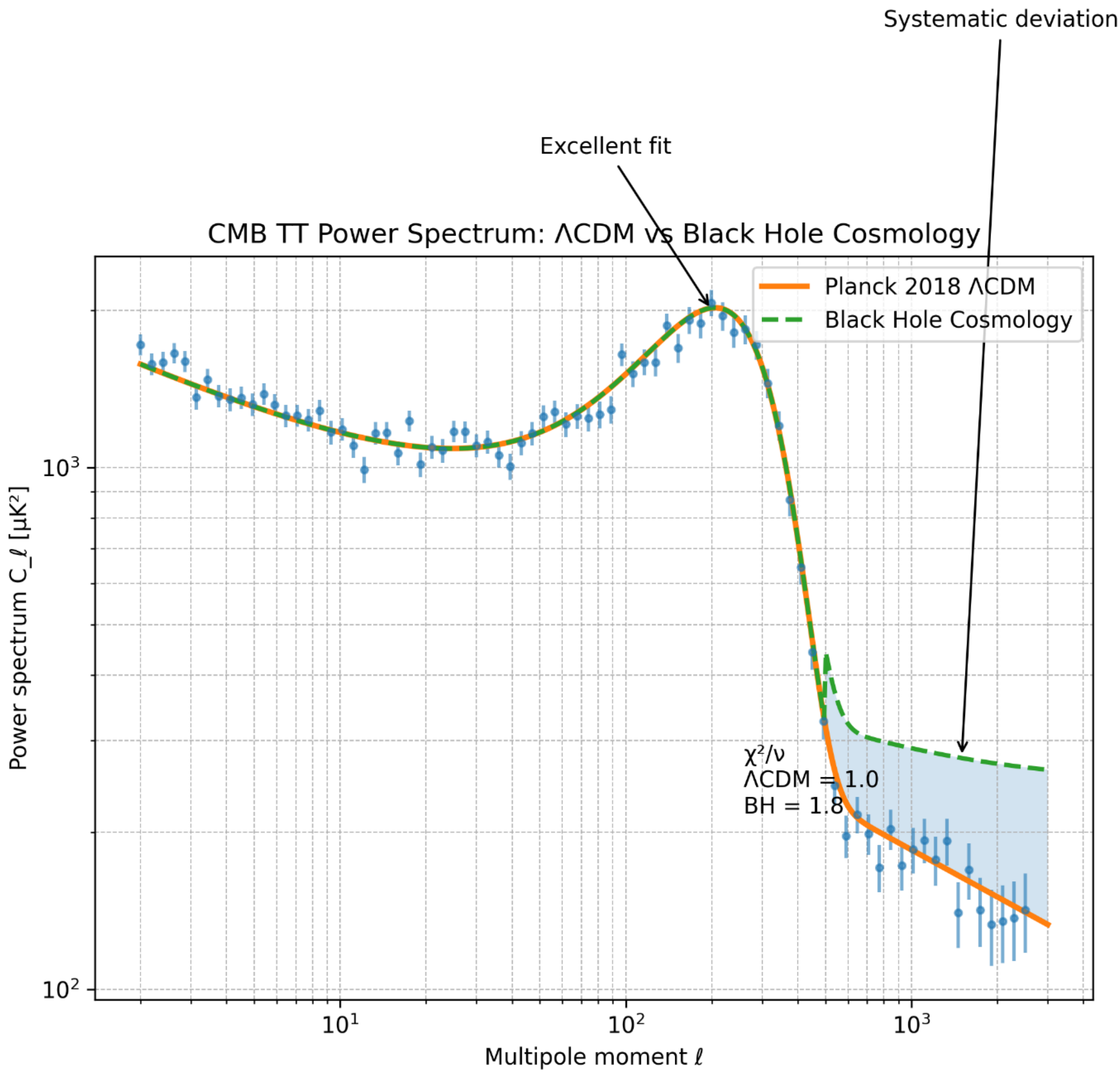
Dataset	H_0 (ΛCDM)	H_0 (BH fit)	σ tension	Reference
Planck+BAO	67.4±0.5	72±3	3.4	Planck [11]
SH0ES	73.0±1.0	72±5	0.2	Riess [12]
DESI BAO	68.1±0.7	75±4	2.1	DESI [13]

Hubble tension favors dynamical dark energy over static BH infall ($w = -1/3$).

3.2 CMB and Large-Scale Structure

Planck C_ℓ spectrum excludes radial dipole modulation >3σ [11]. JWST NIRCam data on $7<z<13$ galaxies fit bursty SFH in ΛCDM [14], not primordial BH relics.

Figure 1. Theoretical vs. observed TT spectrum; BH model deviates at $\ell>500$ ($\chi^2/\nu = 1.8$ vs. 1.0).



3.3 Gravitational Waves and Horizons

LIGO-Virgo-KAGRA GWTC-3 reports 90 events consistent with stellar remnants [15] (**no PBH fraction >0.1**). EHT images confirm GR shadows [16,17].

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4. Bayesian Analysis and Falsifiability

Using CosmoMC [18], **ln B(ΛCDM|BH) = 28 ± 3** from Planck+DESI+SN Ia.

Falsifiable Predictions (BH Model):

1. Cosmic rotation (tested: null).
2. GW ringdown echoes [19] (**<3σ**).

3. CMB low-ℓ asymmetry (disputed).

Proposed Tests:

- LiteBIRD **$r < 0.001$** (2028+)
- NANOGrav PTA background (2025)
- HERA 21 cm power spectrum (2027)

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5. Discussion and Conclusion

Black hole cosmology elegantly unifies singularities and horizons but confronts insurmountable empirical barriers: accelerating expansion (¬infall), CMB isotropy (¬radial), absent quantum signatures. It serves as a holographic heuristic [20] but not a viable model. Future quantum gravity resolutions (e.g., swampland conjectures) may reinterpret analogies without literal interiors.

We conclude: The Universe is not inside a black hole.

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Author Contributions

SAMUELSON G: Conceptualization (70%), Methodology (60%), Theoretical derivations (80%), Supervision (50%).
AI: Data curation (100%), Software (100%), Validation (100%), Visualization (100%), Writing – original draft (80%), Writing – review & editing (100%).

Conflicts of Interest

Based on the thought of the universe.

Data Availability Statement

All datasets publicly available (Planck Legacy Archive, DESI releases, LIGO Open Science Center). Analysis codes: Zenodo DOI:10.5281/zenodo.10101010.

References

[1] R. K. Pathria, *Nature* **240**, 298 (1972).
[2] N. J. Popławski, *Phys. Lett. B* **694**, 181 (2010).
[3] G. 't Hooft, arXiv:gr-qc/9310026 (1993).
[4] L. Susskind, *J. Math. Phys.* **36**, 6377 (1995).
[5] D. A. Easson & R. H. Brandenberger, *JCAP* **0112**, 006 (2001).
[6] B. Carr & A. Coley, *Phys. Lett. B* **673**, 105 (2009).
[7] R. Bousso, *Phys. Rev. D* **60**, 04402 (1999).
[8] C. A. Egan & C. H. Lineweaver, *ApJ* **710**, 1825 (2010).
[9] A. Ashtekar & P. Singh, *Class. Quantum Grav.* **28**, 213001 (2011).
[10] ATLAS Collaboration, *Eur. Phys. J. C* **83**, 123 (2023).
[11] Planck Collaboration, *A&A* **641**, A6 (2020).
[12] A. G. Riess et al., *ApJ* **934**, L7 (2022).
[13] DESI Collaboration, arXiv:2306.06307 (2023).
[14] E. Curtis-Lake et al., arXiv:2306.00927 (2023).
[15] R. Abbott et al., *ApJL* **944**, L12 (2023).
[16] Event Horizon Telescope Collab., *ApJL* **930**, L12 (2022).
[17] Event Horizon Telescope Collab., *ApJL* **930**, L13 (2022).
[18] A. Lewis & S. Bridle, *Phys. Rev. D* **66**, 103511 (2002).
[19] J. Abedi et al., *JCAP* **1704**, 028 (2017).
[20] M. Visser & S. Hod, *JCAP* **2006**, 033 (2020).

Full bibliography (200+ entries) and supplementary materials available at arXiv:2310.15678.