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# An Alternative View on the Cosmic Microwave Background and Dark Energy within the Universal Hierarchical Flux (UHF/FHU) Framework

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## Abstract
This technical note extends the Universal Hierarchical Flux (UHF, or FHU in French) cosmological framework by providing a comprehensive, rigorous alternative to the standard $\Lambda$CDM interpretations of the Cosmic Microwave Background (CMB) and dark energy. We propose that the CMB is not a cooled fossil relic of a primordial Singularity, but the active, dynamic thermal emission of a black hole horizon membrane operating under quantum vacuum flux conversion. By reformulating the temperature, anisotropies, and dark energy density as emergent holographic properties of this boundary interface—where the local universe acts as a nested black hole interior exchanging flux with its parent universe—we address open cosmological crises, including the Hubble tension and the CMB "Axis of Evil." This framework provides a self-regulated, zero-energy alternative that eliminates the requirement for both cosmic inflation and fine-tuned dark energy.

# 1. Introduction and Architectural Paradigm
The standard cosmological model ($\Lambda$CDM) interprets the Cosmic Microwave Background (CMB) as a cooled relic of the Big Bang, necessitating a speculative, fine-tuned epoch of cosmic inflation to explain its large-scale homogeneity and spatial flatness. Furthermore, $\Lambda$CDM models dark energy as an immutable, non-zero cosmological constant ($\Lambda$), leading to the notorious $120$-orders-of-magnitude vacuum catastrophe.
The Universal Hierarchical Flux (UHF) model bypasses these ad-hoc constructs by establishing a fractal, nested embedding of universes. Under this paradigm, both the parent universe and the local universe are structurally and thermodynamically defined as the **interiors of black holes**. The local universe operates as an open, stationary system at net-zero energy ($E_{\text{total}} = E_{\text{matter}} + E_{\text{vacuum}} = 0$). It continuously absorbs positive-energy matter from its parent universe while ejecting negative-energy vacuum across its boundary. This cross-boundary dynamics is governed by a dual arrow of time to satisfy global $CPT$ invariance.

Rather than viewing the cosmic horizon as a mathematical coordinate boundary, the UHF model treats it as a physical, holographic membrane—an active, quantized thermodynamic interface that processes quantum information at the Planck scale.

# 2. Dynamic Membrane Friction vs. Cosmic Relic

In the UHF framework, the CMB is redefined as the blackbody radiation emitted directly by the horizon membrane due to the "friction" of the continuous vacuum-to-matter conversion flux. The temperature of the CMB ( $T_{\text{CMB}}$ ) is not a residual artifact of a historical cooling event; it is a **dynamic equilibrium temperature** dictated by the instantaneous energy density processing of the membrane.
Conformément à la relation établie par Tatum, Seshavatharam, Lakshminarayana, Haug & Wojnow, the equilibrium temperature of the local universe's horizon is given by coupling the Planck scale temperature ($T_p$) to the geometric Hubble radius ($R_H$) of the local universe. Using the exact equivalence between the local expansion rate and the horizon radius ($H/c = 1/R_H$), the temperature is expressed as:

$$T_{\text{CMB}} = \frac{T_p}{8\pi}\sqrt{\frac{2l_{pl}}{R_H}}$$

### Mathematical and Numerical Demonstration

This equation describes the holographic scaling reduction of the ultra-high energy Planck thermal state as it distributes over the two-dimensional surface area of the local universe's horizon. By inserting the fundamental constants of the local universe ($T_p \approx 1.41678 \times 10^{32}$ K, $l_{pl} \approx 1.61625 \times 10^{-35}$ m, and the current Hubble radius $R_H \approx 1.37 \times 10^{26}$ m), we compute the numerical evaluation:

$$T_{\text{CMB}} = \frac{1.41678 \times 10^{32}}{8\pi} \times \sqrt{\frac{2 \times 1.61625 \times 10^{-35}}{1.37 \times 10^{26}}}$$

$$T_{\text{CMB}} = (5.6372 \times 10^{30}) \times \sqrt{2.35948 \times 10^{-61}}$$

$$T_{\text{CMB}} = (5.6372 \times 10^{30}) \times (4.8574 \times 10^{-31}) \approx 2.738 \text{ K}$$

This derived value is in exceptional agreement with the observational empirical baseline of $2.725$ K established by the COBE, WMAP, and Planck satellite missions. Because the mass-generation rate per unit of Planck surface area ($\eta$) is fixed by fundamental constants, the temperature remains intrinsically homogeneous across the entire horizon. This resolves the horizon paradox completely without requiring a fine-tuned inflation field.

# 3. Horizon Anisotropies as Membrane Quantization Noise (this section is out of skills of the author)

The satellite-observed CMB angular power spectrum exhibits tiny temperature fluctuations ($\delta T/T \sim 10^{-5}$). While ΛCDM attributes these to primordial quantum fluctuations frozen during inflation, the UHF framework interprets them as **surface quantization noise** arising from the discrete "weaving" of the holographic horizon membrane.

Because the boundary interface is partitioned into a discrete number of Planck cells, $\eta = N = 4\pi R_H^2/l_{pl}^2$, the transmission of the cross-boundary mass flux is fundamentally a stochastic, quantized process. The discrete injection of $\frac{1}{2}m_p$ per Planck time interval ($t_{pl}$) introduces a spatial and temporal "shot noise."
The Sachs-Wolfe effect and the acoustic peaks observed in the CMB angular power spectrum are thus re-interpreted as the acoustic resonances of the horizon membrane itself under the stress of this quantum pumping. The primary power spectrum peak corresponds directly to the fundamental vibration mode of the spherical black hole interior boundary. The statistical distribution of the fluctuations is governed by the underlying Planck distribution on the two-dimensional surface, implying that the two-point correlation function can be computed directly from the surface density of states without invoking an inflationary inflaton field.

# 4. Resolving Contemporary Cosmological Crises

By replacing the standard kinematic expansion with a thermodynamic flux-driven interface, the UHF framework natively addresses two major anomalies that challenge ΛCDM cosmology:

## 4.1. The Hubble Tension ($H_0$)

The standard model faces a statistically significant rift ($> 5\sigma$) between local measurements of the Hubble constant ($H_0$) via cosmic distance ladders and high-redshift inferences from the early CMB. In the UHF model, $H_0$ is not a purely kinematic velocity expansion parameter but a manifestation of the non-local trans-membrane flux.
Since the local universe is embedded within a parent universe (which is itself the interior of a larger black hole), the local effective mass $M_H = \frac{t_H c^3}{2G}$ scales dynamically with the observation depth. The flux density experienced by an observer depends on the scale of the sub-dominant horizon shell being probed. Therefore, variations in the measurement of $H_0$ are a natural prediction of a radially graded holographic flux rather than an observational systematic error.

## 4.2. The CMB "Axis of Evil" and Multipole Anomalies

Large-scale alignment anomalies (specifically the alignment of the quadrupole and octopole modes) suggest a preferred directional axis in the CMB, directly violating the cosmological principle of statistical isotropy.
Under the UHF architecture, this preferred direction ceases to be an anomaly. Because the local universe is structurally the interior of a black hole existing *inside* a parent universe, any rotational, shear, or magnetic alignment of the parent black hole’s spacetime will induce an anisotropic tidal stress or preferential orientation on the local universe's horizon membrane. The "Axis of Evil" is the direct observational imprint of the larger-scale topology of our parent universe.

# 5. Formal Derivations and Mass-Power Invariance

To confirm the internal mathematical consistency of the framework, we review the unifications linking the dark energy density, power invariance, and horizon mass within the black hole interior paradigm.

## 5.1. Geometric Dark Energy Density

Applying Sakharov's induced gravity framework, dark energy is identified as the surface pressure required to maintain the separation between the positive matter flux and negative vacuum flux. The observed energy density ($\rho_{\text{obs}}$) is derived from the holographic dilution of the interior Schwarzschild mass $M_H$ over the three-dimensional Hubble volume ($V = \frac{4}{3}\pi R_H^3$) of the local universe:

$$\rho_{\text{obs}} = \frac{M_H}{V} = \frac{\frac{t_H c^3}{2G}}{\frac{4}{3}\pi R_H^3}$$

Substituting the horizon kinematic condition $R_H = ct_H$, we simplify the volume to $V = \frac{4}{3}\pi c^3 t_H^3$, yielding:

$$\rho_{\text{obs}} = \frac{\frac{t_H c^3}{2G}}{\frac{4}{3}\pi c^3 t_H^3} = \frac{3}{8\pi G t_H^2} = \frac{3H_0^2}{8\pi G}$$

Using the modern measured value of the Hubble parameter for the local universe ($H_0 \approx 70$ km/s/Mpc $\approx 2.268 \times 10^{-18}$ s$^{-1}$), the portrait-safe numerical application evaluates as:

$$\rho_{\text{obs}} = \frac{3 \times (2.268 \times 10^{-18})^2}{8 \times \pi \times 6.67430 \times 10^{-11}}$$

$$\rho_{\text{obs}} = \frac{3 \times 5.1438 \times 10^{-36}}{1.6774 \times 10^{-9}} \approx 9.20 \times 10^{-27} \text{ kg/m}^3$$

This resolves the vacuum catastrophe by demonstrating that the dark energy density dynamically tracks $\rho_{\text{obs}} \propto H_0^2$ as a scaling geometric property of the black hole interior, removing the need for fine-tuning.

## 5.2. Global Power Invariance

The total processed power ($P_{\text{obs}}$) crossing the interface between the local universe and its parent universe is regulated by the coupling efficiency $\eta = N = 4\pi R_H^2 / l_{pl}^2$ multiplied by the intrinsic internal power ($\frac{M_H c^2}{t_H}$), attenuated by the two-dimensional holographic factor $\left(\frac{l_{pl}}{R_H}\right)^2$:

$$P_{\text{obs}} = \left(\frac{4\pi R_H^2}{l_{pl}^2}\right) \cdot \left(\frac{\frac{t_H c^3}{2G} c^2}{t_H}\right) \cdot \left(\frac{l_{pl}^2}{R_H^2}\right)$$

Through direct algebraic reduction, the distance parameters $R_H^2$, the Planck areas $l_{pl}^2$, and the Hubble time intervals $t_H$ perfectly cancel out, leaving the absolute geometric invariant:

$$P_{\text{obs}} = 2\pi \frac{c^5}{G} = 2\pi P_{pl}$$

Evaluating the numerical value of this continuous macro-power engine yields:

$$P_{\text{obs}} = 2\pi \times (3.62831 \times 10^{52}\ \text{W}) \approx 2.2797 \times 10^{53}\ \text{W}$$

The factor of $2\pi$ preceding the Planck power ($P_{pl}$) reflects the geometric integration of multi-channel parallel information processing across a closed, spherical two-dimensional horizon shell, rather than a superluminal violation of a one-dimensional local linear transfer limit.

# 6. Conclusion and Future Directions

The Universal Hierarchical Flux model reframes the foundational metrics of cosmology into an elegant information-processing and thermodynamic paradigm:

- **The CMB** is the immediate blackbody thermal emission of the horizon membrane under flux conversion stress.
- **Dark Energy** is the physical trans-membrane vacuum pumping pressure.
- **The Cosmological Constant** is an emergent property reflecting the geometric impedance of the nested black hole boundary.

As a foundational but incomplete model, the immediate theoretical track requires replacing these global algebraic scaling relations with a rigorous local tensor formalism. Modifying the Einstein-Hilbert action with a boundary membrane stress-energy tensor ($\Delta T_{\mu\nu}^{\text{membrane}}$) will allow the UHF model to output explicit predictions for baryon acoustic oscillations (BAO) and high-z supernova lensing, providing a verifiable, complete successor to $\Lambda$CDM cosmology.

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