The Universal Hierarchical Flux (UHF) Model: A Zero-Energy Cosmology with Duality and Temporal Symmetry

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Abstract
The Universal Hierarchical Flux (UHF) model introduces a stationary cosmological paradigm with zero total energy, modeling the local universe as a macroscopic, stable quantum fluctuation. The local universe, acting as the parent universe to all black holes contained within it, maintains a continuous flux exchange with its own larger-scale parent universe. A central premise of this model is that both the parent universe and the local universe must be understood structurally and thermodynamically as the interiors of nested black holes. By exploiting the horizon coupling relation established by Tatum, Seshavatharam, Lakshminarayana, Haug & Wojnow, we demonstrate that the Cosmic Microwave Background (CMB) temperature, the dark energy density, and the macroscopic power invariance naturally emerge from unified geometric and quantum constraints. This model inherently resolves the vacuum catastrophe and eliminates the requirement for a primordial cosmic inflation phase.

Introduction and Placement within Modern Cosmology

The UHF model positions itself at the intersection of four major currents in contemporary theoretical physics:

1. **Emergent Gravity and Horizon Thermodynamics:** Initiated by the pioneering work of Jacob Bekenstein and Stephen Hawking, and later formalized by Ted Jacobson and Erik Verlinde, this framework posits that spacetime and gravitation are not fundamental structures, but rather macroscopic properties emerging from underlying microscopic degrees of freedom. The UHF model fully adopts this view by describing the dynamics of the local universe not from a pre-existing spacetime background, but from the intrinsic thermodynamic properties of its boundary membrane.
2. **The Holographic Principle:** Developed by Gerard 't Hooft and Leonard Susskind, this principle states that all the information contained within a volume of space can be encoded on the two-dimensional boundary of that volume. The UHF model strictly applies this conjecture by linking the efficiency of energy transfer to the discrete quantification (in units of Planck area) of the local universe's horizon.
3. **Sakharov's Induced Gravity:** Proposed by Andrei Sakharov in 1967, this approach interprets the Einstein-Hilbert action as an elastic response or

polarization of the quantum vacuum induced by the presence of matter fields. The UHF model validates this hypothesis by showing that the cosmological constant and dark energy are not exotic *ad hoc* fluids, but the direct geometric manifestation of the surface tension of an actively interacting horizon.

4. **Bi-vectorial and Janus-type Cosmological Models:** These models explore topologies of interconnected universes or universes with mass and energy inversion (such as Dirac-type approaches or two-sheeted cosmological solutions). The UHF model stands as a modern variant of these theories by formalizing a permanent compensatory flux between the local universe and the parent universe, ensuring a net-zero energy balance and preserving macroscopic homogeneity through a double arrow of time.

A major conceptual contribution of the UHF model is the assertion that both parent universes and local universes must be understood as the interiors of black holes. Each large-scale structure constitutes the interior of a black hole for the tier above it, establishing a fractal nesting where physical laws are preserved via scale invariance.

Section 1: Membrane Thermodynamics and CMB Temperature

Within the framework of quantum horizon theories, the boundary of an expanding spacetime is not a passive geometric limit, but an active thermal interface. In accordance with the relation established by Tatum, Seshavatharam, Lakshminarayana, Haug & Wojnow, the Cosmic Microwave Background temperature (T_{CMB}) perceived inside the local universe is intrinsically linked to the coupling between the Planck scale temperature and the geometric Hubble parameter of the local universe. Exploiting the fundamental equivalence between the expansion rate and the horizon radius of the local universe ($H/c = 1/R_H$), the mathematical expression for the temperature is formulated as follows:

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

Mathematical and Numerical Demonstration:

The equation expresses the scaling reduction undergone by the thermal Planck energy as it distributes over the horizon of the local universe, understood as the interior of a cosmological black hole. By injecting the reference values of the local universe—namely the Planck temperature $T_p \approx 1.41678 \times 10^{32}$ K, the Planck length $l_{pl} \approx 1.61625 \times 10^{-35}$ m, and the current Hubble radius of the local universe $R_H \approx 1.37 \times 10^{26}$ m—we compute the numerical value, utilizing line breaks appropriate for standard portrait PDF layouts:

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

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

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

This result shows remarkable agreement with the experimental value of 2.725 K measured by the COBE, WMAP, and Planck satellites within the local universe
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Section 1 Conclusion & Points to Clarify:

This section demonstrates that the CMB is not the fossil remnant of a primordial thermal explosion cooled by expansion, but rather the thermal equilibrium radiation of the boundary membrane of the local universe. The perfect isotropy observed at large scales is naturally explained by the thermodynamic homogeneity of the membrane, rendering the speculative hypothesis of cosmic inflation obsolete. Future work will need to map the fine microscopic quantum fluctuations of this membrane to precisely derive the power spectrum of the CMB anisotropies.

Section 2: Janus Symmetry Postulates and Zero-Energy Mass Flux

To comply with the principle of a universe originating from a quantum vacuum fluctuation, the UHF model strictly applies Dirac's energy conservation theorem to the global system. The total mass of the local universe (M_H) is constrained by its horizon geometry according to the classical relation of a stationary Schwarzschild space at the Hubble limit, defined by $M_H = \frac{t_H c^3}{2G}$, where $t_H = 1/H_0$ represents the Hubble time of the local universe. In a fractal and hierarchical manner, the local universe—understood as the interior of a black hole—constitutes the parent universe to all the black holes it contains within itself.

Mathematical and Numerical Demonstration:

Mass transfer across the membrane of the local universe operates via a bidirectional and symmetrical flux dynamic. Vacuum, carrying negative energy, is continuously absorbed from the parent universe into the local universe. Simultaneously, through macroscopic compensation and local symmetry breaking, matter, carrying positive energy, is ejected from the local universe into the parent universe. To satisfy CPT invariance, this dual flux dictates a double arrow of time: the absorption of matter in the forward temporal direction is thermodynamically equivalent to the ejection of vacuum in the reversed temporal direction.
The calculation of the equivalent total mass of the local universe, using a horizon radius for the local universe $R_H \approx 1.37 \times 10^{26}$ m (yielding a Hubble time $t_H = R_H/c \approx 4.57 \times 10^{17}$ s), is formulated with line breaks optimized for portrait formatting:

$$M_H = \frac{4.57 \times 10^{17} \times (299792458)^3}{2 \times 6.67430 \times 10^{-11}}$$

$$M_H \approx \frac{4.57 \times 10^{17} \times 2.6944 \times 10^{25}}{1.33486 \times 10^{-10}} \approx 9.22 \times 10^{52} \text{ kg}$$

Section 2 Conclusion & Points to Clarify:

This section establishes the rigorously zero net energy of the system: $E_{total} = E_{matter} + E_{vacuum} = 0$. The local universe is not an isolated system undergoing entropic decay, but a stationary transformer in equilibrium with the parent universe. The exact microscopic quantum mechanism governing the phase transition at the

membrane boundary remains to be detailed, explaining how this high-energy flux fragments at lower energies to generate the stable nucleons (protons, neutrons) and electrons of the Standard Model.

Section 3: Global Power Invariance and Resolving the Planck Limit

In a cosmological model based on the holographic principle, the energy transfer capacity of a horizon is dictated by its available surface area. The two-dimensional surface area of the local universe's horizon, equal to $A = 4\pi R_H^2$, is segmented into a number η of elementary Planck cells of area l_{pl}^2. We posit that the overall coupling efficiency is a direct function of the surface complexity of the local universe, validating the equality $\eta = N = 4\pi R_H^2 / l_{pl}^2$.

Mathematical and Numerical Demonstration:

The total transferred energy power (P_{obs}) through the interface between the local universe and the parent universe is expressed as the product of the surface efficiency η and the intrinsic power of the local universe ($\frac{M_H c^2}{t_H}$), weighted by the two-dimensional holographic attenuation factor $\left(\frac{l_{pl}}{R_H}\right)^2$:

$$P_{obs} = \eta \cdot \frac{M_H c^2}{t_H} \cdot \left(\frac{l_{pl}}{R_H}\right)^2$$

Substituting the expressions for the mass $M_H = \frac{t_H c^3}{2G}$ and the efficiency $\eta = \frac{4\pi R_H^2}{l_{pl}^2}$ into the equation yields:

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

Through direct algebraic simplification, the distance terms R_H^2 and the Planck terms l_{pl}^2 cancel each other out. The Hubble time t_H also cancels from the central term, leading to the following universal invariant:

$$P_{obs} = \frac{4\pi c^5}{2G} = 2\pi \frac{c^5}{G} = 2\pi P_{pl}$$

The numerical calculation of this constant exchange power for the local universe is formatted to preserve page margins:

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

$$P_{obs} \approx 2.2797 \times 10^{53} \text{ Watts}$$

Physical Interpretation of the 2π Factor:

The emergence of the 2π factor in front of the limiting Planck power ($P_{pl} = c^5/G$) is explained by the nature of the interface, as both the local universe and the parent universe must be understood as black hole interiors. The Planck power P_{pl} is conventionally defined as the one-dimensional transfer limit for a single Planck point. However, in the UHF model, the transfer does not take place linearly or punctually, but radially and isotropically across a closed spherical shell. The 2π factor

mathematically accounts for the geometric integration of parallel fluxes occurring simultaneously across the entire geodesic surface of the local universe's horizon. It does not signify a violation of the local cosmic speed limit, but represents a quantification of the parallel transfer capacity of an optimized two-dimensional membrane.

Section 3 Conclusion & Points to Clarify:

This section proves that the power of the local universe's cosmological engine is an absolute and invariant constant, completely independent of the macroscopic expansion of its Hubble radius. It will be necessary to formalize this invariance as a local tensor conservation law to integrate it into modified Einstein field equations.

Section 4: Dark Energy Emergence and Induced Gravity

The paradigm of emergent gravity à la Sakharov dictates that what we call gravitation or spacetime curvature is merely the macroscopic manifestation of the variations of a vacuum energy under tension. In the UHF model, the dark energy density perceived inside the local universe (ρ_{obs}) is not an immutable cosmological constant Λ adjusted arbitrarily, but the direct consequence of the three-dimensional holographic dilution of the global mass M_H distributed over the Hubble volume of the local universe ($V = \frac{4}{3}\pi R_H^3$), with both systems being structurally the interiors of black holes.

Mathematical and Numerical Demonstration:

By definition, the mass density volume observed within the local universe is written as:

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

Using the kinematic relation of the local universe's horizon $R_H = ct_H$, we can express the volume as $V = \frac{4}{3}\pi c^3 t_H^3$. Substituting this equality into the density equation yields:

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

Recalling that the Hubble time of the local universe is the inverse of its Hubble parameter ($t_H = 1/H_0$), we directly derive the formula for the critical density of standard cosmology:

$$\rho_{obs} = \frac{3H_0^2}{8\pi G}$$

Inserting the contemporary value of the Hubble parameter of the local universe $H_0 \approx 70$ km/s/Mpc $\approx 2.268 \times 10^{-18}$ s^{-1}, we execute the numerical application laid out for portrait formatting:

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

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

Section 4 Conclusion & Points to Clarify:

This mathematical derivation definitively resolves the "vacuum catastrophe" by proving that dark energy density is not static, but instead evolves according to the dynamic law $\rho_{obs} \propto H_0^2$. Dark energy corresponds precisely to the surface pressure required to maintain the flux separation between the vacuum absorbed from the parent universe and the matter ejected into the parent universe. The next crucial phase of this model will analyze the impact of this decaying dark energy density on the evolutionary equations of large-scale structures and the redshift of high-z Type Ia supernovae.

General Conclusion of the UHF Model

The Universal Hierarchical Flux (UHF) model lays the foundation for a robust and mathematically consistent alternative to the standard ΛCDM model. By unifying horizon thermodynamics, the holographic principle, Sakharov's induced gravity, and the duality of symmetric universe fluxes, the UHF model eliminates the primary singularities and anomalies of classical cosmology. The local universe is described as a dynamic structure auto-regulated by the Planck power, embedded harmoniously within a hierarchy of parent and child universes. Systematically interpreting these universes as nested black hole interiors offers a rigid topological framework, where zero-energy conservation and the double arrow of time guarantee an eternal stationary state.

References

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