Ample Evolutionary Vortex Cosmological Relativistic Energy

The AMPLEEV CORE 4π Model

(AMPLEEV: Ample Evolutionary Vortex; CORE: Cosmological Relativistic Energy)

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Abstract

The AMPLEEV CORE 4π model offers a geometric solution to the Hubble tension by replacing the concept of dark energy with centrifugal inertia effects within a 4-dimensional vortex geometry. Rejecting the assumption of global homogeneity, the model describes spacetime as evolving along a helical trajectory inside a 4-dimensional parabolic cone, parameterized by a dimensionless phase variable $H \in [0, 4\pi]$. The non-linear parameterization of time $t = \left(\frac{H}{\pi}\right)^2$ and the dynamic metric coefficient $K(H) = \left(\frac{H}{\pi}\right)^2 + e^{\frac{-1}{H}}$ naturally account for the observed discrepancy between early- and late-Universe Hubble constant measurements. It is demonstrated that the Hubble tension arises from a geometric transition between the narrow and wide turns of the spacetime helix, while the accelerated expansion manifests as an effect of centrifugal inertia. The model predicts large-scale anisotropy of the Hubble constant and resonant structures in matter distribution, providing verifiable observational signatures.

Keywords: cosmology, Hubble tension, dark energy, spacetime geometry, anisotropic Universe.

Introduction

The Hubble tension—a discrepancy of approximately 8% between early-Universe ($H_0 \approx 67{,}4\, km/s/Mpc$) and late-Universe ($H_0 \approx 73\, km/s/Mpc$) measurements of the Hubble constant—remains a major challenge for the standard ΛCDM cosmological model. This paper proposes a geometric solution within the framework of the AMPLEEV CORE 4π concept. A key element of the model is a dimensionless parameter, $H \in [0, 4\pi]$, which describes the evolutionary phase of the Universe along a helical trajectory within a 4-dimensional vortex geometry. This parameter replaces the traditional concept of cosmological time and is directly linked to the observed expansion rate. Unlike the standard ΛCDM model, where the accelerated expansion is attributed to dark energy, the AMPLEEV CORE 4π framework generates a similar effect via centrifugal acceleration along the helical trajectory, parameterized by the time-like variable H within a 4-dimensional cone. The core components of the model include:

- A non-linear parameterization of time, $t = \left(\frac{H}{\pi}\right)^2$;
- A dynamic metric coefficient, $K(H)$, comprising parabolic and exponential terms;
- A scale factor, $\alpha(H) = H^2$, describing the parabolic growth of the cone's cross-section.

This approach unifies the early and late expansion histories of the Universe and predicts an observable anisotropy as a verifiable signature of the model.

2. Mathematical Framework

2.1. Non-linear Time Reparameterization

We introduce a dimensionless parameter $H \in [0, 4\pi]$, interpreted as the rotation angle along the "time helix." The physical time t is related to H via the following relation:

$$t = \left(\frac{H}{\pi}\right)^2.$$

Physically, the parameter H is interpreted as the rotation angle (phase) along the helical trajectory of the Universe's evolution in 4-dimensional spacetime. This helix is wound around a 4-dimensional parabolic cone, where $H = 0$ corresponds to the initial state (singularity) at the apex of the cone.

An increase in H describes the translational motion along the helix coupled with the simultaneous expansion of the cone's cross-section.

This spinor-like symmetry—requiring a rotation of 4π rather than 2π to return to the initial state—reflects a profound connection between spacetime geometry and the quantum properties of matter. The physical time t is a monotonic function of this phase: a larger rotation angle H corresponds to a greater elapsed time.

2.2. Spacetime Metric

The line element is defined by the expression:

$$ds^2 = -K(H)c^2 dH^2 + a(H)^2 d\Omega^2$$

where $K(H)$ is the dynamic time-like metric coefficient given by:

$$K(H) = \left(\frac{H}{\pi}\right)^2 + e^{\frac{-1}{H}}$$

$a(H)=H^2$ is the scale factor describing the parabolic growth of the 4-dimensional cone's cross-section, and $d\Omega^2$ represents the angular component of the metric.

The two terms in $K(H)$ play distinct physical roles:

- The term $\left(\frac{H}{\pi}\right)^2$ determines the global parabolic geometry;
- The term $e^{\frac{-1}{H}}$ ensures a smooth emergence from the singularity and contributes to the accelerated expansion.

2.3. Observer's Proper Time

The proper time $t(H)$ is defined as the accumulated arc length of the helix:

$$t(H)=\int_0^H \sqrt{K(\widetilde{H})}\,d\widetilde{H}$$

For the "bare" geometry (neglecting the $e^{\frac{-1}{H}}$ term), the integration over the interval $[0,4\pi]$ yields a value of 8π, which indicates a topological spinor symmetry (a double-covering of the cycle).

3. Resolution of the Hubble Tension

3.1. Early-Universe Regime (*H*∼0…*π*)

At small values of H, the turns of the helix are narrow, and the cone features high curvature. The metric coefficient is dominated by the exponential term:

$K(H)\approx e^{\frac{-1}{H}}\rightarrow 0$ as $H\rightarrow 0$.

This leads to a slow expansion rate, which corresponds to the value of $H_0\approx 67{,}4\,km/s/Mpc$ derived from the Cosmic Microwave Background (CMB) data.

3.2. Transition Regime (*H*∼*π*…3*π*)

As H increases, the parabolic term $\left(\frac{H}{\pi}\right)^2$ becomes dominant, driving a faster growth of $K(H)$. This geometric transition mimics an accelerated expansion driven by centrifugal inertia along the helical trajectory.

3.3. Late-Universe Regime (*H*∼3*π*…4*π*)

At large values of H, the turns of the helix expand substantially. The scale factor $a(H)=H^2$ grows rapidly, and the metric coefficient approaches the value:

$K(H)=\left(\frac{4\pi}{\pi}\right)^2=16$. An observer located in this domain **(*H*∼3*π*…4*π*)** measures a higher expansion rate, $H_0 \approx 73\, km/s/Mpc$, which is in excellent agreement with local distance ladder measurements.

3.4. Effective Equation of State

The second derivative *K''(H)* determines the effective pressure within the Einstein field equations. At the inflection point of *K(H)*, an effective negative pressure emerges $(\omega \approx -1.0)$, mimicking the action of dark energy without invoking the cosmological constant Λ . This behavior is achieved entirely via the non-linear reparameterization of time $t(H)$. Consequently, the model successfully reproduces dark energy effects without introducing additional fields or constants.

4. Physical Implications and Predictions

4.1. Absence of the Cosmological Constant

The model eliminates the need to invoke the cosmological constant Λ. The accelerated expansion is shown to be a purely geometric effect arising from the helical trajectory and the non-linear reparameterization of time.

4.2. Large-Scale Anisotropy

The vortex structure of the metric predicts a systematic anisotropy in the expansion rate. Specifically, the Hubble constant H_0 is expected to vary depending on the directional orientation, directly following the geometry of the helix. This provides a key verifiable prediction of the framework.

4.3. Quantum-Cosmological Connection

The spinor-like symmetry associated with $H \in [0, 4\pi]$ points to a fundamental connection between spacetime topology and quantum mechanics. Rather than being a mere formal analogy, this symmetry suggests that the quantization of matter is a macroscopic manifestation of the Universe's geometry. Furthermore, it defines discrete "nodes" that may correspond to elementary particle generations, where each generation maps to a stable resonant node on a specific turn of the helix.

5. Observational Tests

The AMPLEEV CORE 4π model yields several key predictions that can be verified through cosmological observations:

- **Anisotropy of H_0:** Measurements of the Hubble constant in different regions of the sky are expected to exhibit a directional dependence that correlates with the axis of the spacetime helix.

- **Resonant Structures:** The three generations of elementary particles may correspond to stable resonance nodes along the helix, potentially leaving imprints on the large-scale structure of the Universe.
- **Modified Perturbation Growth:** The non-linear metric can introduce distinct signatures into the matter power spectrum and cosmic microwave background (CMB) anisotropies.
- **Violation of the Cosmological Principle:** Statistical tests for large-scale inhomogeneity (e.g., hemispherical asymmetries) should provide evidence confirming the underlying vortex geometry.

6. Conclusion

In summary, the AMPLEEV CORE 4π model replaces the conventional concept of dark energy with a geometric effect driven by centrifugal inertia within a 4-dimensional vortex structure. The parameter H serves as the physical phase of the helical evolution, while its bounded domain $[0,4\pi]$ encodes both the transition between different expansion regimes and the fundamental link between quantum and cosmological scales. Future observational assessments of cosmic anisotropies and resonant structures will serve to test the validity of the proposed framework.

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