

The Inverse-Frequency Duality of Spacetime

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Abstract

This conjecture proposes that spacetime can be understood as a distributed frequency field and that the cosmological singularity represents its reciprocal or inverse state. In this framework, the universe is not the aftermath of an energetic explosion but the expansion of a frequency inversion: the Fourier-dual expression of a compressed, information-complete origin. Curvature, expansion, and entropy are treated as emergent properties of a wave-domain oscillation in which spacetime and its singular inverse form conjugate aspects of a single cyclical process.

1. Conceptual Background

Standard cosmological models treat the singularity as a point where the metric fails, implying physical breakdown. The present conjecture instead interprets this condition as a frequency inversion rather than a discontinuity. If the manifold of spacetime is described by a global wave function $\psi(x,t)$, its geometry can be interpreted as the real-space manifestation of a distributed spectral process. The singularity would then correspond to the reciprocal domain of that waveform — not a spatial point but the collapsed frequency image of spacetime itself. Hence, the Big Bang may be viewed as a transformation between conjugate domains: from spectral compression to spatial extension, analogous to an inverse Fourier transform where information encoded in the frequency domain unfolds into the manifold of events.

2. Mathematical Formulation (Heuristic)

Let $\psi(x,t)$ denote the spacetime wavefield. Its spectral dual $\tilde{\psi}(k,\omega)$ is given by the Fourier transform:

$$\tilde{\psi}(k,\omega) = \int \psi(x,t) * \exp[-i(kx - \omega t)] dx dt$$

At the singular limit, distances shrink to zero and curvature tends to infinity. $\psi(x,t)$ thus approaches a delta-like compression in x,t , while its dual $\tilde{\psi}(k,\omega)$ becomes uniformly extended across frequency space — a total superposition of modes. Therefore, the singularity corresponds to maximal frequency and minimal spatial extent, and the universe to minimal frequency and maximal spatial extent. The two are inverses:

$$f_{\text{singularity}} = 1 / f_{\text{universe}}$$

$$\lambda_{\text{universe}} = 1 / \lambda_{\text{singularity}}$$

This reciprocal symmetry defines the inverse-frequency duality. Expansion represents the unfolding of the spectral content of ψ_{\sim} into ψ ; contraction would represent the reverse transform.

3. Physical Interpretation

If curvature R is proportional to frequency f , and spatial scale a proportional to wavelength λ , then:

$$R \propto f$$

$$a \propto 1/f$$

Cosmological evolution can be read as an oscillation between frequency-dominant and wavelength-dominant regimes. The Big Bang and any terminal singularity are conjugate points of this oscillation. Entropy increase reflects the dispersion of coherent spectral information into wider configuration space. The arrow of time arises from the unidirectional phase evolution of the inverse-frequency transformation.

4. Implications

1. Cosmological Symmetry – The origin and endpoint of the universe are mirror states across the frequency domain: infinite curvature and infinite wavelength are dual manifestations of one invariant process. 2. Information Conservation – All spacetime information is conserved through the transformation; creation and annihilation are reciprocal projections. 3. Arrow of Time – Temporal directionality arises from the phase evolution of the wave transformation rather than from an independent temporal parameter. 4. Potential Observables – A residual imprint of the inverse state may persist in the low-frequency tail of the cosmic microwave background spectrum. 5. Philosophical Implication – The singularity is not a void but the reciprocal coordinate frame of existence itself — the universe viewed as its own spectral image.

5. Concluding Statement

The Inverse-Frequency Duality reframes the singularity as the other side of the same equation: the spectral origin from which spacetime is transformed. Expansion, entropy, and time emerge from a single inversion process linking two conjugate domains of existence. The universe becomes the real-space projection of its own spectral inverse — a standing wave of being whose nodes are singularities and whose continuity is existence itself.

References (indicative)

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