Collapse-Length Oscillation and Conservation-Driven Cosmological Expansion

Letter from the Ongoing Work: August 2025

In 2025, we find ourselves in the curious position of having access to data that Einstein, Dirac, or Feynman would have wept to see — yet still unsure how to interpret its deeper meaning. The universe continues to expand, and light from the early cosmos continues to surprise us. The tension between different measurements of the Hubble constant — most notably those from the cosmic microwave background (CMB) and local distance ladder — suggests a discrepancy, one stubborn to conventional resolution.

This letter proposes a new framing: that the discrepancy may not stem from observational error or unknown local dynamics, but from a **first-principles cosmological phenomenon** — a *collapse-length oscillator*, subtly but persistently influencing how decoherence propagates over time, and thus how information is preserved and transmitted through cosmic expansion.

We hypothesize that the decoherence framework introduced in "Decoherence as First Principle" admits a natural dynamical structure: an underdamped harmonic oscillator governing the collapse length, $\ell(t)$, constrained by a conservation law:

The **total classical energy** stored in pointer states **plus** a scaled entropy term remains constant in time:

$$\frac{d}{dt}\left[E_{\mathbf{class}}(t) + k \cdot S(t)\right] = 0$$

This constraint implies a shift of 'reality weight' from deterministic classical structure to thermodynamic uncertainty, and suggests that the very fabric of spacetime might wobble in a way that leaves a measurable fingerprint. The 'collapse length' that defines how classicality emerges from quantum systems could itself oscillate as a function of time — perhaps only once, perhaps with subtle damped cycles, governed by initial conditions at or near the Big Bang.

We model this using the familiar damped harmonic oscillator:

$$\ell''(t) + 2\gamma\ell'(t) + \omega^2\ell(t) = 0$$

where γ is the damping coefficient and ω the natural frequency. Our guiding intuition is that this equation, coupled to the conservation constraint above, gives rise to a time-dependent deviation from a purely geometric expansion — one that might explain the Hubble tension without invoking new particles or dark sectors.

In this framing, light traveling through the universe accumulates its history through a lens subtly modulated by collapse length dynamics — and this modulation introduces tiny distortions in our cosmological measurements. These distortions could be interpreted as mismatches in Hubble measurements — but they may in fact be the long echo of a cosmic oscillator.

This is not an appeal to magic, nor to metaphysics. The beauty of this proposal is that it is testable — if one can formalize the collapse-length evolution function, couple it to entropy production, and simulate its cumulative effect on observationally-derived distances.

We now begin that work, building a software framework to test this model against real redshift data and evaluate whether a simple conservation-guided oscillator could reconcile the measurement divergence. If it does not — so be it. But if it does, it would be a smile-worthy echo of scientific history: not a new particle, not a new force, but a new **frame of interpretation** that links quantum theory, decoherence, entropy, and cosmology.

We do not seek fame, only clarity. Einstein worried not about credit, but correctness. And if we are wrong, let us be gloriously, precisely wrong — with enough rigor that someone else can set it right.

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