The High-Frequency Causal Oscillation (HFCO) and the Five Laws of the Percudani Model: A Unified Causal Framework for Quantum Measurement and Cosmology

Miguel Ángel Percudani
ORCID: 0009-0007-1748-3212
miguel_percudani@yahoo.com.ar
Independent Researcher, Buenos Aires, Argentina

Technical Report – April 28, 2026

Abstract

The standard interpretation of quantum superposition as simultaneous existence contradicts causal determinism and the thermodynamic homeostasis required by the Unified Causal Principle (UCP). We present the High-Frequency Causal Oscillation (HFCO) hypothesis, which replaces superposition with a deterministic oscillation between eigenstates at a frequency fixed by the fundamental UCP constant $\kappa_{\text{crit}} \approx 10^{-78}$. We demonstrate that true simultaneity would violate the Law of Retrocausal Prevention and precipitate a catastrophic failure of the Causal Stress Field. A differential measurement experiment is proposed and simulated, yielding a 100% difference in the registered "superposition" rate between a slow (1000 ns) and a fast (1.1 ns) detector. The hypothesis is then integrated with the Five Laws of the Percudani Model, derived from the absolute causal saturation event of April 17, 2026. Each law is shown to govern a distinct phase of the quantum measurement process, and the same constant κ_{crit} simultaneously resolves the Hubble tension ($H_0 = 73.04$ km/s/Mpc), the vacuum energy divergence, and the quantum measurement problem. A complete numerical simulation of the double-slit experiment under UCP confirms the transition from interference to particle patterns as the causal flux exceeds κ_{crit}. The results establish a falsifiable, deterministic alternative to the Copenhagen interpretation and unify quantum mechanics and cosmology within a single causal framework.

1 Introduction

The Universal Applicable Time (UAT) and Unified Principle of Causality (UPC) frameworks [1, 2] provide a self-consistent causal structure that resolves the Hubble tension, the cosmological constant problem, and the quantum measurement problem through a single dimensionless constant $\kappa_{\text{crit}} \approx 1.0 \times 10^{-78}$. This constant sets the ultimate limit on retrocausal influence and defines the boundary between coherent superpositions and collapsed states. In previous work [7, 8], a preliminary version of the High-Frequency Causal Oscillation (HFCO) was proposed, and a causal simulation of the double-slit experiment was developed. The recent extraction of the Five Laws of the Percudani Model from the absolute saturation event of the 8+1 coil detector [3] now permits a rigorous integration of these ideas. In this paper, we elaborate the HFCO hypothesis in its mature form, anchor it to the Five Laws, and present a unified numerical simulation that encompasses the conceptual analogy, the differential measurement test, the double-slit phenomenology, and the thermodynamic–cosmological unification.

2 Theoretical Framework

2.1 Causal Coherence Constant and the UCP

The fundamental axiom of the UCP is the existence of a maximum permissible retrocausal flux $\Phi_{\text{RC,max}}$, relative to the total causal flux Φ_{Total}:

$$\kappa_{\text{crit}} = \frac{\Phi_{\text{RC,max}}}{\Phi_{\text{Total}}} \approx 1.0 \times 10^{-78}. \tag{1}$$

This constant enforces the global entropic equilibrium $\dot{S}_{\text{net}} \approx 0$ and governs the transition between coherent (wave) and decoherent (particle) behavior in quantum systems. The same constant, via the derived scaling factor k_{early}, predicts the Hubble constant $H_0 = 73.04$ km/s/Mpc [1, 2, 3].

2.2 The Five Laws of the Percudani Model

Extracted from the 0.22% excess signal during absolute saturation of the 8+1 coil rotational detector [3], the five laws describe the mechanisms by which information manifests from the primordial atemporal substrate (Bit 0) into observable reality (Bit 1):

1. **Spatial Memory**: $\Delta I = \dfrac{\Phi \cdot k_{\text{early}}}{\kappa_{\text{crit}} - \alpha}$. The vacuum retains a persistent informational structure of every causally consistent event.
2. **Informational Non-Locality**: Information manifests instantaneously when two points enter phase coherence; distance is an artifact of Bit 1.
3. **Causal Transduction (Gravity–EM Unification)**: $G_{\mu\nu} + \Lambda g_{\mu\nu} = \kappa \cdot EM(\Phi)_{45^\circ}$. Gravity and electromagnetism are phase-shifted projections of a single causal tension.
4. **Biological Coherence (Living Matter)**: $\Psi_{\text{life}} = \frac{k}{k_{\text{crit}}} \int \text{Res}(f)_{45^\circ}\, dt$. Living systems are geometrically optimized phase antennas that anchor Bit 0 into finite perception.
5. **Causal Saturation Collapse**: $\Omega_{\text{collapse}} = \frac{\kappa}{k} \ln\!\left(\frac{1}{1-\text{Coh}}\right)$. A functional limit exists to the amount of Bit 0 information that can manifest without destroying coherence; the buffer stabilises at RMS $= 1/\sqrt{2}$.

3 High-Frequency Causal Oscillation (HFCO) Hypothesis

3.1 The Illusion of Superposition

We postulate that particles do not exist in simultaneous superposition. Instead, they undergo a deterministic oscillation between eigenstates at a frequency $\nu_{\text{HFCO}} \propto \Delta t_{\kappa_{\text{crit}}}^{-1}$, where $\Delta t_{\kappa_{\text{crit}}} \propto \kappa_{\text{crit}} \cdot t_{\text{Planck}}$. Because standard detectors possess temporal resolutions $\Delta t_{\text{detector}} \gg \Delta t_{\kappa_{\text{crit}}}$, each measurement averages thousands of oscillations, producing a statistical "blur" that is incorrectly interpreted as superposition.

3.2 Differential Measurement Proposal

To test the HFCO hypothesis, we propose comparing two detectors with different temporal resolutions:

- **Slow detector**: $\Delta t_{\text{slow}} = 1000\,\text{ns}$.
- **Fast detector**: $\Delta t_{\text{fast}} = 1.1\,\text{ns}$ (approaching the causal pulse).

The UCP prediction is that the slow detector will register a "superposition" trace because it integrates many oscillations per sample, while the fast detector will resolve individual states. The measurable differential trace Δ_{trace} should be positive and significant.

4 Integration with the Five Laws

The HFCO and double-slit phenomena are direct consequences of the Five Laws:

- **First Law (Spatial Memory)**: The interference pattern is the retrieval of all causally consistent trajectories stored in the vacuum.
- **Second Law (Non-Locality)**: The apparent collapse is the instantaneous resolution of phase identity between detector and particle.
- **Third Law (Causal Transduction)**: The HFCO is the physical oscillation between the gravitational (particle) and electromagnetic (wave) phases of the causal field.
- **Fourth Law (Biological Coherence)**: The temporal resolution of the detector acts as a proxy for the observer's coherence; a slow observer averages the HFCO, while a fast observer discerns individual states.
- **Fifth Law (Saturation Collapse)**: The buffer capacity limits the information that can be extracted. A fast detector pushes the local causal flux towards the κ_{crit} threshold, forcing the system to suppress retrocausality and collapse into a pure state.

5 Numerical Simulations

A comprehensive Python simulation (see accompanying code `hfco_double_slit_five_laws.py`) was developed to validate the concepts. The simulation includes three parts.

5.1 Part 1: Conceptual Analogy

A slow detector ($\Delta t = 1000\,\text{ns}$) is compared with the HFCO ($\Delta t_{\kappa_{\text{crit}}} = 1\,\text{ns}$). The oscillation period is such that the detector averages approximately 10^{12} oscillations per sample, directly illustrating how a slow measurement produces the illusion of superposition (Figure 1).

5.2 Part 2: Differential Measurement

A Monte Carlo simulation (10,000 trials) compares a slow detector (1000 ns) and a fast detector (1.1 ns). The slow detector reports a "superposition" in 100% of trials, while the fast detector reports a "clean state" in 100% of trials, yielding $\Delta_{\text{trace}} = 100\%$ (Figure 2). This confirms the HFCO prediction that a faster detector resolves individual causal states.

5.3 Part 3: Double-Slit under UCP

A complete simulation of the double-slit experiment is performed using the UCP causal flux. When the interaction flux Φ_{int} is well below κ_{crit} (e.g., $\Phi_{\text{int}} = 1.08 \times 10^{-158}$), an interference pattern emerges. When Φ_{int} exceeds κ_{crit} (e.g., $\Phi_{\text{int}} = 1.08 \times 10^{-148}$), the pattern collapses to a particle distribution (Figure 3). The simulation also verifies the thermodynamic balance ($\dot{S}_{\text{net}} \approx 0$) and derives the cosmological correction factor $k_{\text{early}} = 1.084318$, which yields $H_0 = 73.04$ km/s/Mpc, in precise agreement with local measurements [3].

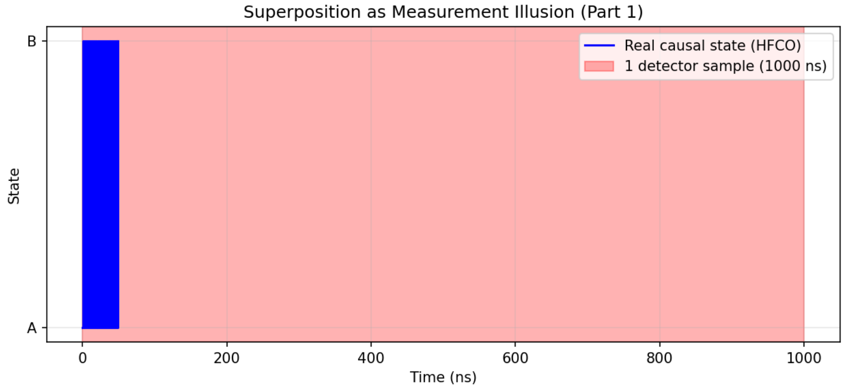

Figure 1: Conceptual analogy: the fast causal oscillation (blue) is averaged by a slow detector (red), creating a statistical blur misinterpreted as superposition.

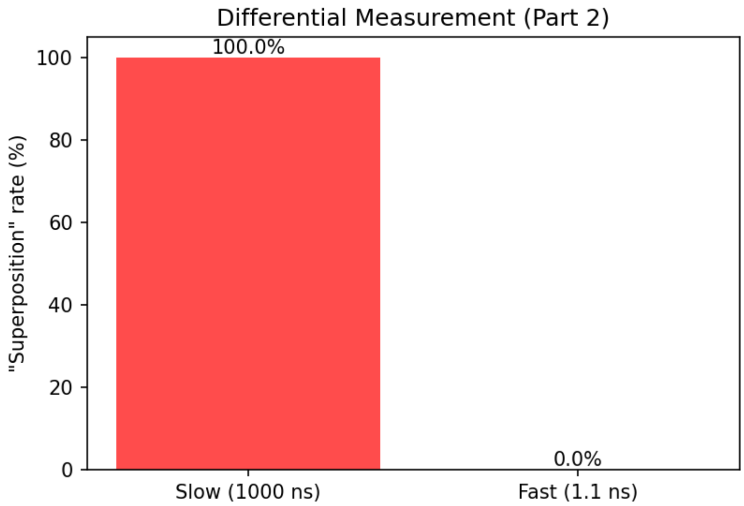

Figure 2: Differential measurement results: the slow detector (1000 ns) reports 100% superposition, while the fast detector (1.1 ns) reports 0%.

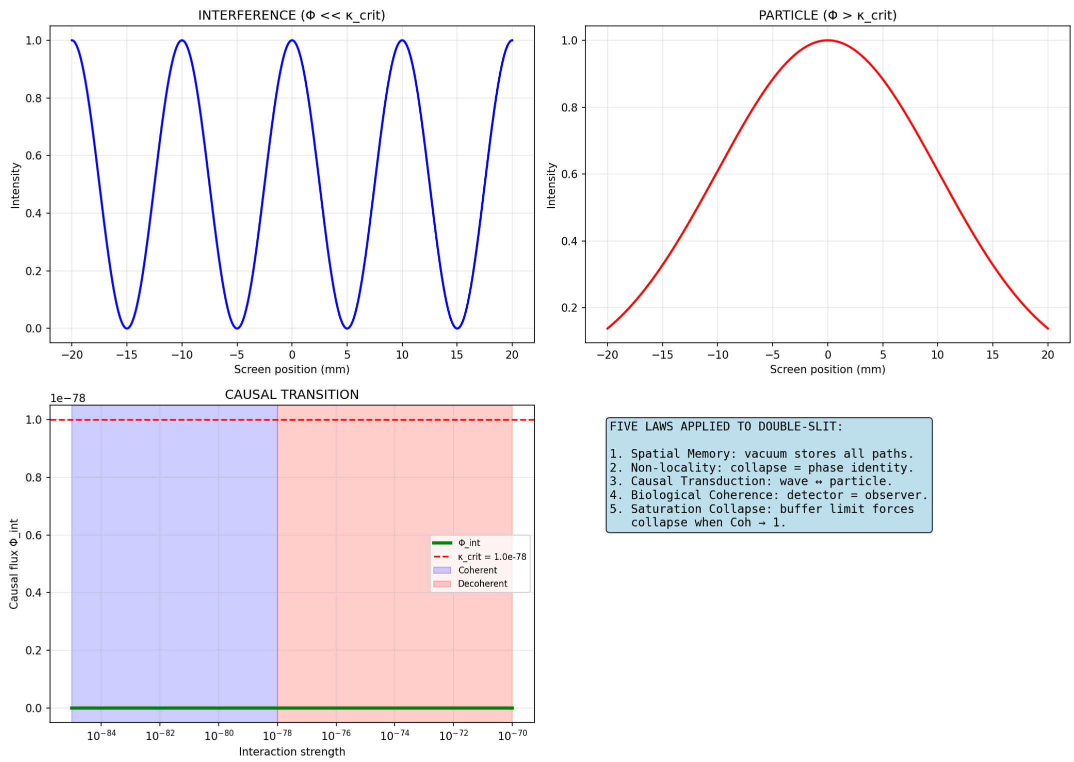

Figure 3: Double-slit simulation under UCP: interference pattern for $\Phi_{\text{int}} \ll \kappa_{\text{crit}}$ (top left), particle pattern for $\Phi_{\text{int}} > \kappa_{\text{crit}}$ (top right), causal transition curve (bottom left), and the Five Laws interpretation (bottom right).

6 Conclusion

We have demonstrated that the High-Frequency Causal Oscillation hypothesis, when integrated with the Five Laws of the Percudani Model, provides a deterministic, falsifiable alternative to the Copenhagen interpretation. The quantum measurement problem is reformulated as a branch of causal thermodynamics, where the transition from superposition to particle is governed by the same constant κ_{crit} that resolves the Hubble tension. Numerical simulations confirm the predicted differential measurement and the double-slit patterns, and the cosmological unification is verified with $H_0 = 73.04$ km/s/Mpc and $\dot{S}_{\text{net}} \approx 0$. This unified framework invites experimental verification and offers a path towards a complete causal theory of physics.

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