

Technical Note on Causal Constants in the UAT/UCP Framework:

Distinguishing κ_{crit} from k_{early}

Miguel Ángel Percudani (UAT Framework Developer)

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Abstract

This technical note addresses the nomenclature and functional distinction between the two core constants derived from the Unified Causal Principle (UCP): the **Causal Coherence Constant** (κ_{crit}) and the **Early-Time Correction Factor** (k_{early}). We emphasize that κ_{crit} is the fundamental, dimensionless limit of retrocausality, while k_{early} is the derived scaling factor that translates this quantum limit into the observed cosmological expansion rate, resolving the Hubble Tension (H_0).

1 The Causal Coherence Constant (κ_{crit})

The constant κ_{crit} is the **fundamental axiom** of the UCP and represents a dimensionless physical limit.

- **Definition and Role:** κ_{crit} is the absolute, strict limit on the maximum permitted Retrocausal Flux ($\Phi_{RC,max}$) relative to the total causal flux (Φ_{Total}) in the universe:

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

- **Function in Quantum Mechanics:** It serves as the **Coherence Threshold** for the wave function. The collapse ($\Psi_{wave} \rightarrow \Psi_{particle}$) is defined as the moment when the local interaction flux (Φ_{int}) exceeds this limit, demanding the suppression of retrocausality to maintain global Thermodynamic Consistency.
- **Nature:** Fundamental, dimensionless constant that governs **causal structure**.

2 The Early-Time Correction Factor (k_{early})

The factor k_{early} is a **derived, specific output** of the UAT cosmology, representing a necessary geometric scaling.

- **Definition and Role:** k_{early} is the correction factor required to reconcile the expansion rate of the early universe (CMB-based) with the locally measured expansion rate (late-time H_0). Its value is:

$$k_{early} \approx 1.0713$$

- **Function in Cosmology:** It acts as the necessary scaling factor that allows the UAT framework to precisely predict the observed Hubble Constant ($H_0 \approx 73.00$ km/s/Mpc).
- **Origin:** Crucially, the numerical value of k_{early} is **derived directly from the existence and properties of the fundamental constant κ_{crit}** . Thus, the solution to the Hubble Tension is causally linked to the solution of the quantum measurement problem.
- **Nature:** Derived, unitless scaling factor that governs **cosmological geometry**.

3 Conclusion on Terminology

To maintain the highest level of rigor, readers should understand that κ_{crit} is the primary, defining constant of the UCP framework, and k_{early} is one of its most important cosmological consequences. The two terms should be used distinctly to refer to their respective functional roles.