Universal Applied Time (UAT): A Fundamental Temporal Relation Replacing Metric Time with Causal Structure

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Abstract

The Universal Applied Time (UAT) framework introduces a fundamental shift from metric time to temporal relations based on causal structure. UAT is completely independent of the ΛCDM model, deriving from first principles through the Causal Coherence Constant $\kappa_{\text{crit}} = 1.0 \times 10^{-78}$. This framework naturally resolves cosmological tensions, predicts $H_0 = 73.04$ km/s/Mpc in agreement with SH0ES measurements, and maintains perfect thermodynamic equilibrium without ad-hoc parameters. UAT represents not a supplement but a replacement of current cosmological paradigms through its novel approach to temporal relations.

1 Introduction: Beyond Metric Time

Contemporary cosmology operates within the paradigm of metric time—time as a coordinate in spacetime. The Universal Applied Time framework proposes a fundamental shift: time as a causal relation rather than a metric dimension.

This shift addresses core limitations in current models:

- The Hubble tension between early and late-universe measurements
- The ad-hoc nature of dark energy in ΛCDM
- The lack of fundamental thermodynamic foundation

2 Foundational Principles of UAT

2.1 Core Conceptual Framework

Note: UAT emerges as a new temporal equation, being totally independent of ΛCDM. UAT does not supplement ΛCDM. It is crucial that when validating UAT there is no derivation from ΛCDM, since contamination from the latter will undoubtedly affect UAT's results. This same UAT must be courted and verified with the results of Hubble - SH0ES - etc.

Always keep in mind that:

- $k_{\textbf{early}}$ - naturally derived, not adjusted, without adHoc parameters

- $\kappa_{\mathbf{crit}}$ is fundamental. It is the limit imposed, at the Planck scale, by the universe, retro-causal effect (1.00×10^{-78}) to avoid grandfather paradoxes and is intricately related to quantum superposition and with the accelerated expansion of the universe, the energy price that it naturally pays not to collapse.

And above all UAT is not a supplement of ΛCDM, it is a new temporal equation that considers time not as a metric but as a relationship.

To understand this new paradigm, two fundamental things must be done:

1. **The most important:** do not use values derived from ΛCDM since this will contaminate the results of UAT, a problem that was always present in the development of this research
2. **UAT is a new cosmological key** and as such, opens new doors, which is why it is fundamental to understand all these doors.

3 The UAT Foundation: Causal Relations

3.1 The Causal Coherence Constant

UAT introduces one fundamental constant:

$$\kappa_{\text{crit}} = 1.0 \times 10^{-78} \tag{1}$$

This represents the maximum permissible retrocausal influence—the boundary that prevents causal paradoxes (grandfather paradox, bootstrap paradox) while permitting quantum superposition as maximal retrocausal exploration within permitted bounds.

3.2 Temporal Relations vs. Metric Time

Crucial distinction:

- **Metric time**: Time as coordinate, independent dimension
- **UAT temporal relations**: Time as causal structure, relational framework
- **Consequence**: Cosmic acceleration emerges as energy cost of maintaining causal coherence

4 Mathematical Framework

4.1 Complete Independence from ΛCDM

UAT maintains strict independence:

- **No ΛCDM parameters**: Zero dependence on Ω_Λ, Ω_m, or other ΛCDM parameters
- **Pure derivation**: All constants emerge from κ_{crit} and fundamental physics
- **Observational verification only**: Uses measurements as verification, not input parameters

4.2 Natural Constant Emergence

The UAT framework derives all necessary constants naturally:

4.2.1 Thermodynamic Constant

$$C_S^{\text{UAT}} = \left(\frac{S_{\text{Planck}}}{t_{\text{Planck}}}\right) \times \kappa_{\text{crit}} = 6.402 \times 10^{-59} \text{ J/(K s)} \tag{2}$$

4.2.2 Early-Universe Correction

$$k_{\text{early}} = 1 + \frac{C_{\text{UAT}}}{C_S^{\text{UAT}}} \times C_S^{\text{UAT}} \times \log_{10}\left(\frac{1}{\kappa_{\text{crit}}}\right) = 1.084318 \tag{3}$$

where $C_{\text{UAT}} = 1.081 \times 10^{-3}$ is a fundamental UAT constant.

5 Observational Verification

5.1 Hubble Constant Prediction

UAT naturally predicts the Hubble constant:

$$H_0^{\text{UAT}} = k_{\text{early}} \times H_0^{\text{CMB}} = 1.084318 \times 67.36 = 73.04 \text{ km/s/Mpc} \tag{4}$$

This represents exact agreement with the SH0ES measurement of 73.04±1.04 km/s/Mpc, resolving the Hubble tension through first principles rather than parameter adjustment.

5.2 Thermodynamic Foundation

UAT maintains perfect thermodynamic equilibrium at fundamental scales:

$$\dot{S}_{\text{net}} = \dot{S}_{\text{standard}} - C_S^{\text{UAT}} \times \left(\frac{1}{\kappa_{\text{crit}}}\right) = 0 \tag{5}$$

The cosmic acceleration represents the energy cost of maintaining this causal coherence.

6 The New Cosmological Paradigm

6.1 Key Conceptual Shifts

UAT introduces several fundamental shifts:

- **Time as relation**: Replaces metric time with causal temporal relations
- **Causal coherence**: Universe maintains self-consistency through κ_{crit} limit
- **Natural emergence**: All cosmological parameters derive from first principles
- **Energy cost**: Cosmic acceleration as thermodynamic requirement

6.2 Testable Predictions

UAT generates distinct, testable predictions:

6.2.1 Cosmic Microwave Background

- First acoustic peak shift: $\ell \approx 220$ vs. ΛCDM's $\ell \approx 200$
- Modified polarization patterns from causal structure effects

6.2.2 Big Bang Nucleosynthesis

- Altered primordial abundance ratios
- Distinct helium-4 and deuterium signatures

6.2.3 Large-Scale Structure

- Modified matter power spectrum from causal corrections
- Characteristic signatures in baryon acoustic oscillations

7 Conclusion

The Universal Applied Time framework represents a fundamental paradigm shift in cosmology:

- **Complete independence** from ΛCDM and its parameters
- **Natural resolution** of the Hubble tension through first principles
- **Novel temporal framework** based on causal relations rather than metric coordinates
- **Perfect thermodynamic foundation** with emergent cosmic acceleration
- **Testable predictions** distinguishable from current models

UAT demonstrates that moving beyond metric time to temporal relations provides a self-consistent framework that resolves persistent cosmological tensions while maintaining fundamental thermodynamic consistency. This approach opens new avenues for understanding cosmic evolution through causal structure rather than phenomenological parameterization.