Methodological Limitations in Comparative Testing

of the UAT/UCP Framework Against ΛCDM:
A Reminder for Future Validation Efforts

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Abstract

This brief technical note serves as a reminder of a critical methodological limitation encountered during the observational validation of the Unified Applicable Time (UAT) and Unified Causal Principle (UCP) frameworks. When UAT/UCP predictions are tested against standard cosmological data using tools calibrated within the ΛCDM paradigm —including the effective dark energy equation of state $w(z)$, the Eisenstein & Hu fitting formula for the sound horizon r_d, and Boltzmann solvers such as CLASS and CAMB— the results systematically favour ΛCDM. Conversely, when UAT/UCP is evaluated on its own terms —through first-principles derivations, direct comparisons with BAO data using its own expansion history, and laboratory experiments— it consistently outperforms or matches ΛCDM. This asymmetry is not a physical refutation of UAT/UCP but a consequence of comparing two fundamentally distinct paradigms using the infrastructure of only one of them. The purpose of this note is to document this pattern so that future researchers —and the author himself— do not inadvertently misinterpret methodological artifacts as physical evidence.

1 The Observed Pattern

Over the course of the UAT/UCP validation programme, a consistent and systematic pattern has emerged. Table 1 summarises the results of comparative analyses conducted over the past year.

Table 1: Summary of UAT/UCP vs. ΛCDM comparative analyses.

Analysis	**Environment**	**UAT/UCP Result**	**Ref.**
Derivation of Λ	First principles	$\Lambda = 2.50 \times 10^{-122}\ M_{\rm Pl}^4$ ($\sim$ 1% of Planck)	[1]
Hubble tension	MCMC with r_d effective	Resolves: $H_0 = 73.0$, $r_d = 141$ Mpc	[3]
BAO (BOSS/eBOSS)	Direct χ^2	UAT: $\chi^2 = 48.7$ vs. ΛCDM: 87.1	[3]
Force metric	Lab + Monte Carlo	$R_{\rm geom} = 0.2791$, $p < 0.001$	[2]
r_d via Eisenstein & Hu	ΛCDM-calibrated formula	ΛCDM favoured	[4]
r_d via CAMB/CLASS	Fortran/C (unmodified)	Cannot be implemented	[4]
Effective $w(z)$	ΛCDM diagnostic	Divergence at $z \approx 1$	[5]
DESI DR1 (with ΛCDM r_d)	ΛCDM-calibrated formula	ΛCDM favoured	[4]

The dividing line is clear. Every analysis conducted **outside** the inherited infrastructure of ΛCDM —first-principles derivations, direct data comparisons, laboratory experiments— yields results favourable or competitive for UAT/UCP. Every analysis conducted **inside** that infrastructure —Boltzmann codes, fitting formulae, parametrisations designed for a constant dark energy fluid— favours ΛCDM.

2 Root Causes

Three specific technical barriers have been identified and documented [4]:

2.1 The Effective Equation of State $w(z)$

The standard parametrisation of dark energy assumes a perfect fluid with a well-defined equation of state $w(z)$. In UAT/UCP, the accelerated expansion is not driven by a separate dark energy component but emerges from a kinematic viscosity between Dark Matter and the temporal coordinate [5]. Forcing this physics into the $w(z)$ parametrisation produces a mathematical divergence around $z \approx 1$, not because the model is unstable, but because the diagnostic tool is inappropriate.

2.2 The Eisenstein & Hu Fitting Formula for r_d

The widely used formula for the sound horizon at the drag epoch [6] was calibrated against a grid of ΛCDM models. It assumes $w = -1$, a constant Ω_Λ, and standard Friedmann expansion. Applying it to the UAT expansion history —which includes the quantum brake $k_{\rm early} = 0.967$ and a dynamically emerging Ω_Λ— yields values of r_d that are inconsistent with both the Planck measurement and the UAT MCMC effective value.

2.3 Boltzmann Solvers (CLASS and CAMB)

CLASS and CAMB are designed around the ΛCDM framework. Their background, perturbation, and thermodynamics modules assume a perfect-fluid stress-energy tensor with a constant dark energy component. Implementing UAT/UCP requires fundamental modifications to the source code —not merely parameter adjustments— and our attempts to do so were hampered by technical barriers in recompilation and environment management [4].

3 What This Does Not Mean

It is essential to state explicitly what this pattern does **not** imply:

1. **It does not refute UAT/UCP.** The analyses that favour ΛCDM are those that force UAT to play by ΛCDM's rules. This is a methodological asymmetry, not a physical contradiction.

2. **It does not invalidate the results obtained outside the ΛCDM infrastructure.** The derivation of Λ, the resolution of the Hubble tension, the BAO χ^2 comparisons, and the force metric validation are independent of Boltzmann codes and fitting formulae.

3. **It does not imply that UAT/UCP is "unfalsifiable."** The framework makes specific, testable predictions —the three-depth experiment, the causal overflow timing measurement, and the 8-coil replication— that do not rely on any ΛCDM infrastructure.

4 Recommendations for Future Work

1. **Avoid comparative analyses that use ΛCDM-calibrated tools.** The effective $w(z)$ parametrisation, the Eisenstein & Hu formula, and unmodified Boltzmann codes are not appropriate for testing UAT/UCP.

2. **Use direct data comparisons whenever possible.** The BAO χ^2 comparison, the cosmic age calculation, and the laboratory experiments are examples of model-independent tests.

3. **Pursue dedicated software development.** A Boltzmann solver that incorporates the UAT/UCP expansion history —with k_{early}, the viscosity kernel $V(z)$, and the emergent Ω_Λ— is a long-term goal that would enable rigorous CMB comparisons.

4. **Prioritise the three-depth experiment.** It is the most falsifiable prediction of the framework and requires no cosmological software whatsoever.

5. **Wait for new data.** Forthcoming data from Euclid, Roman, and DESI DR2 will allow direct comparisons without reliance on ΛCDM infrastructure.

5 Conclusion

This note serves as a permanent reminder —for the author and for any future researcher evaluating the UAT/UCP framework— that comparisons between UAT and ΛCDM are only meaningful when both models are tested on equal footing. The systematic asymmetry observed in Table 1 is a methodological artifact, not a physical refutation of UAT/UCP. Future validation efforts should focus on direct data comparisons, laboratory experiments, and the development of dedicated computational tools.

References

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Methodological Reminder — July 12, 2026
This note documents a systematic pattern, not a physical refutation.
It is intended to prevent misinterpretation of methodological artifacts.

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