

The UAT Lagrangian, the Identity $\eta \equiv \kappa_{crit} = 4.978$, and the Origin of Effective Matter Density

From Quantum Brake to Causal Membrane Amplification: Complete Mathematical Closure

Miguel Ángel Percudani

Independent Researcher, Puan, Buenos Aires, Argentina

miguel_percudani@yahoo.com.ar

ORCID: 0009-0007-1748-3212

July 2026 - Corrected rd note

Abstract

We present complete closure of UAT/UCP. Action S_{UAT} parameters $\{\eta, \xi, \lambda\}$ rigidly fixed: $\eta \equiv \kappa_{crit} = 4.978$, $\phi_* = 0.07\eta = 0.34846$, $k_{early} = 0.967$ from lab 8-coil experiment $R_{geom} = 0.279182$ (frequency detuning $43.515^\circ = 45^\circ \times k_{early}$, not mechanical rotation). $\xi = -0.2810$, $\lambda = 3.08 \times 10^{-112}$. Field frozen $\phi(0) = 0.4559$ (90.8% from η). Membrane integral $M_p = \oint \Psi_{8phase} \cdot \kappa_{crit} dt$ depends on κ_{crit} structurally, not on $\phi(z)$. Amplification $\mathcal{A} = 7.4908$ gives $\Omega_m^{eff} = 0.3133$ matching Planck 0.315 ± 0.007 within 0.55%. Effective Friedmann $H^2 = (3M_{Pl}^2)^{-1} k_{early} (\rho_m + \rho_r)$. **Sound horizon note:** Early MCMC used effective proxy $r_d \approx 141$ Mpc fitting Pantheon+/CMB/BAO. First-principles integration $r_d = \int c_s/[H_{UAT}(1+z)]dz$ gives $r_d \approx 128.15$ Mpc (this work). Both are temporary proxies pending CLASS-UAT Boltzmann implementation. Acoustic shift +5.85% (using 141 proxy) becomes +8–16% using 128.15 depending on H_0 choice; definitive prediction requires CLASS-UAT.

1 Introduction

UAT/UCP proposes macroscopic time flow regulated by causal coherence constant $\kappa_{crit} = 4.978$, manifesting as quantum brake $k_{early} = 0.967$. Missing action principle filled here.

2 The UAT Action

$$S_{UAT} = \int d^4x \sqrt{-g} \left[\frac{M_{Pl}^2}{2} R - \frac{1}{2} (\partial\phi)^2 - V(\phi) - \frac{\xi}{2} R\phi^2 + \mathcal{L}_m \right] \quad (1)$$

$$V(\phi) = \frac{\lambda}{4} (\phi^2 - \eta^2)^2 + V_0, \quad V_0 \approx 2.5 \times 10^{-122} M_{Pl}^4 \quad (2)$$

Flat FLRW: $\ddot{\phi} + 3H\dot{\phi} + V' + \xi R\phi = 0$, $3M_{Pl}^2 H^2 = \rho_m + \rho_r + \rho_\phi$. Slow-roll $\rho_\phi \approx 3\xi H^2 \phi^2$ gives $H^2 = (\rho_m + \rho_r)/[3M_{Pl}^2(1 - \xi\phi^2)] \equiv k_{early}(\rho_m + \rho_r)/(3M_{Pl}^2)$. Hence $\boxed{k_{early} = 1/(1 - \xi\phi_*^2)}$.

3 Closure

$$\boxed{\eta \equiv \kappa_{crit} = 4.978}, \quad \boxed{\phi_* = 0.07\eta = 0.34846}, \quad \boxed{\xi = \frac{1 - 1/k_{early}}{\phi_*^2} \approx -0.2810}, \quad \boxed{\lambda = -\frac{\xi R_c}{2\eta^2} \approx 3.08 \times 10} \quad (3)$$

with $\rho_{rec} \approx (1.1 \text{ eV})^4$.

4 Frozen Field

Integration $z_i = 10^9 \rightarrow 0$, $\phi(z_i) = \phi_*$: $\phi(1089) = 0.34846$, $\phi(0) = 0.45588$ (90.84% away). $m_\phi = \sqrt{2\lambda}\eta \approx 1.5 \times 10^{-27} \text{ eV}$. Does not invalidate amplification because membrane depends on κ_{crit} structurally.

5 Membrane Integral and Ω_m^{eff}

$\Psi_{8phase}(t) = \frac{1}{\sqrt{8}} \sum_{n=0}^7 e^{i(\omega t + n\pi/4)}$, intensity ratio $\propto \varphi = 1.618034$. $M_p = M_b \times \kappa_{crit} \times \varphi \times (1 - \phi_*/\eta)$,

$$\boxed{\Omega_m^{eff} = 0.04182 \times 4.978 \times 1.618034 \times 0.93 = 0.3133} \quad (4)$$

6 Sound Horizon Correction - 141 vs 128.15 Mpc

This addresses the inconsistency noted by Deep AI:

Pitfall 3 in Methodological Guide: using Λ CDM $r_d = 147.09 \text{ Mpc}$ as fixed reference and rescaling by $1/\sqrt{k_{early}}$ produced catastrophic χ^2 .

Two values have circulated in UAT literature:

- **$r_d \approx 141 \text{ Mpc}$ (MCMC proxy, Phases 7-9):** Effective parameter obtained by fitting UAT Causal model to Pantheon+ (1587 SNe), Planck 2018 shift parameter R , and BOSS BAO assuming fixed r_d . It is NOT first-principles calculation; it is a phenomenological fit that forces acoustic scale l_A to stay near observed $l_A \approx 300$. Used in Observational Predictions v1 to get +5.85% shift $l_A \ 296.3 \rightarrow 313.6$.
- **$r_d \approx 128.15 \text{ Mpc}$ (first-principles integration, this work):** Self-consistent integration

$$r_d = \int_{z_{drag}}^{\infty} \frac{c_s(z)}{H_{UAT}(z)(1+z)} dz, \quad c_s(z) = \frac{c}{\sqrt{3(1 + 3\Omega_b/(4\Omega_\gamma(1+z)))}} \quad (5)$$

with $H_{UAT}(z) = H_0 \sqrt{k_{early}\Omega_m(1+z)^3 + k_{early}\Omega_r(1+z)^4 + \Omega_\Lambda}$, $k_{early} = 0.967$, $H_0 = 73.04$ (SH0ES). Using `scipy.quad` high-precision integration yields 128.15 Mpc. This is mathematically correct given current tools and replaces the ad hoc 141 Mpc. It was obtained by removing the $f_{corr}(z)$ empirical calibration factors that were previously used to hide numerical errors.

Which is correct? 128.15 Mpc is correct first-principles calculation. 141 Mpc is outdated effective proxy. However neither is definitive CLASS-UAT Boltzmann result. With $r_d = 128.15$ Mpc and $H_0 = 73.04$, $D_C(z_*) = 12981$ Mpc, $l_A = \pi D_C / r_d \approx 318$ (+7.3% vs Λ CDM 296.3), still within 2.7σ of Planck but larger than +5.85% previously quoted. With $H_0 = 67.36$ reference, $D_C = 14075$ Mpc gives $l_A \approx 345$ (+16%). Full CLASS-UAT needed to break H_0 - r_d degeneracy.

Correct approach for publication: Quote both, state 141 Mpc is historical MCMC proxy, 128.15 Mpc is corrected integration, and definitive prediction pending CLASS-UAT or high-precision solver. Do not use Λ CDM 147.09 Mpc.

7 Logical Chain

$\kappa_{crit} = 4.978 \rightarrow k_{early} = 0.967$ (lab $R_{geom} = 0.279182$, frequency detuning $43.515^\circ = 45^\circ \times 0.967$, NOT mechanical) $\rightarrow \phi_* = 0.07\eta \rightarrow \xi, \lambda \rightarrow H^2 \propto k_{early}(\rho_m + \rho_r) \rightarrow D_C, R, r_d \rightarrow$ acoustic peaks $\rightarrow \Omega_m^{eff}$.

8 Limitations

Field frozen open puzzle; membrane ansatz not fully rigorous; thermal margin empirical; λ assumes GR Ricci at recombination; r_d pending CLASS-UAT.

References

- [1] Percudani 2024 Zenodo 17729221
- [2] Planck 2020