

TITLE

UAT/UCP: Unified Applied Time Gravity - A New Theory Independent of Λ CDM
Resolving H_0 and S_8 Tensions with Exact Acoustic Horizon $r_d=128.15$ Mpc and
Late-Time $G_{\text{eff}}=1.062G$

DESCRIPTION

UAT/UCP: Unified Applied Time Gravity - A New Theory Independent of Λ CDM

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Abstract

We present UAT/UCP, a new gravity theory born from Applied Time (AT) concept, not a supplement of Λ CDM. The framework operates under different temporal axioms ($\kappa_{\text{crit}}=4.978$, $R_{\text{geom}}=0.279182$, $\phi=1.618$) and is equal to Λ CDM in predictions but with different time concepts. Forcing UAT into CLASS C architecture written with Λ CDM axioms (Ω_{Λ} constant, $\mu=1$ fixed) always results in a hybrid model, limiting its true descriptive nature.

The theory introduces a unified effective gravitational constant $G_{\text{eff}}(z)=G/(1+\xi\phi^2(z))=1.062G$ at $z=0$ confined to late universe ($z\lesssim 1$) via tanh field transition $\phi(z)=0.456\cdot 0.5[1-\tanh((z-z_c)/\Delta z)]$, $z_c=0.8$, $\Delta z=0.3$. This gives $k_{\text{eff}}(z)=1+\xi\phi^2$, $k_{\text{eff}}(z>2)=1$, $k_{\text{eff}}(0)=0.9415$, preserving early CMB physics with exact acoustic horizon $r_d=128.15$ Mpc (not 141 Mpc approx) and resolving both H_0 and S_8 tensions simultaneously:

- **S_8 Tension Resolved:** Sub-horizon friction $C_{\phi}=-\gamma(k)\delta'$ with $\gamma(k)=\gamma_0(k/k_{\text{cut}})^2/(1+(k/k_{\text{cut}})^2)$, $\gamma_0=0.149\pm 0.05$, $k_{\text{cut}}=0.1$ h/Mpc $^{-1}$ damps excess growth, bringing S_8

from falsified 0.855 to 0.759 exactly required by DES Y3 (0.759 ± 0.025).

- **H₀ Tension Resolved:** Geometric constancy $r_d \cdot H_0 = 9359 \text{ Mpc} \cdot \text{km/s/Mpc}$ allows exact $r_d = 128.15 \text{ Mpc}$ to coexist with local $H_0 = 73.04 \text{ km/s/Mpc}$, preserving Planck angular scale θ_* .
- **Gravitational Isolation:** Tanh transition confines 6.2% G_{eff} increase to late universe, protecting recombination physics.

This release closes the 7-block roadmap (PDFs 1-7) as main theory. All attempts to force UAT into CLASS C are saved as supplementary, proving incompatibility. Developing native C library for UAT takes years, out of current reach. Main theory is pure Python (numpy/scipy/matplotlib), working better than Λ CDM.

Corrections Made in First 5 PDFs (CORRECTED v2.1)

Previous versions contained approximate values and Λ CDM library contamination. Corrections:

PDF 1 - Perturbation Equations:

- G_{eff}/G corrected from ~ 1.04 approx to exact $1.062G$ ($\xi = -0.2810$, $\phi_0 = 0.456$, $k_{\text{eff}}(0) = 0.9415$, $1/k_{\text{eff}} = 1.062$)
- Previous used linear $\phi(z)$ approximation, now $\tanh \phi(z) = 0.456 \cdot 0.5[1 - \tanh((z - 0.8)/0.3)]$ from exact numerical solution
- Growth equation added C_ϕ damping term from $S_{\text{coherence}}$, missing in v1

PDF 2 - Modified Einstein M_{eff}^2 :

- $M_{\text{eff}}^2 = M_{\text{Pl}}^2 + \xi\phi^2$ corrected denominator: $M_{\text{Pl}}^2 + \xi\phi_0^2 = 0.9415$, not 1.0
- Slip $\Phi - \Psi = \xi\delta(\phi^2)/(M_{\text{Pl}}^2 + \xi\phi_0^2)$ factor corrected to -0.2985, previously assumed 0
- Background $H_{\text{UAT}}^2 = H_{\text{LCDM}}^2/k_{\text{eff}}(z)$ corrected, previously used $H_{\text{LCDM}}^2 \cdot k_{\text{eff}}$

PDF 3 - Plasma Thermodynamics:

- Sound speed $c_s^2=1/[3(1+R_b)]$ with $R_b=3\Omega_b/[4\Omega_\gamma(1+z)]$ corrected
 $\Omega_b=0.04182$, $\Omega_\gamma=5.38e-05$ (previously 0.022)
- Integration limits for r_d corrected from z_{rec} to 20000, not 1100 to 3000, giving exact 128.15 Mpc vs 141 Mpc approx
- $\Omega_m=7.79398e-05$ corrected, previously $9e-05$

PDF 4 - Recombination:

- $z_{\text{rec}}^{\text{UAT}} = z_{\text{rec}}^{\text{LCDM}}(1+\delta_{\text{rec}})$ with δ_{rec} from α drift and T_{UAT} corrected
- Previous used Saha equilibrium Λ CDM, now Peebles with UAT
 $T_{\text{UAT}}(z)=T_{\text{LCDM}}\cdot k_{\text{eff}}^{-1/4}$
- Helium fraction Y_p corrected for G_{eff} variation

PDF 5 - Primordial Spectrum:

- $P_{\text{UAT}} = A_s(k/k_*)^{n_s-1}[1+\epsilon \cos(k/k_{\text{osc}}+\delta)]$ with ϵ modulation from boundary sector corrected $\epsilon=0.02$, not 0.05
- $k_{\text{osc}} = \kappa_{\text{crit}}\cdot H_0/c$ corrected $\kappa_{\text{crit}}=4.978$, previously 5.0
- Phase δ corrected from time AT , not coordinate time

PDF 6 - Background Dynamics (new exact):

- Previous $r_d=141$ Mpc effective value, now exact $r_d=128.15$ Mpc (norm 0.03122, $c/H_0=4104.5$ Mpc)
- Branch $\phi_*=0.348$ early shown tachyonically unstable ($k_{\text{eff}}<0$ at $z=0$), only de-excited $\phi\approx 0$ early is physical, therefore tanh late transition used
- Product $r_d\cdot H_0=9359$ corrected, previously 9913

PDF 7 - MCMC Results (Closure):

- S_8 without damping corrected from 1.05 falsified to 0.855 exact with $G_{\text{eff}}=1.062G$ ($S_{8,\text{LCDM}}\cdot\sqrt{G_{\text{eff}}}$)
- Best $\gamma_0=0.149\pm 0.05$ from DES Y3 + RSD $f\sigma_8$ + BAO, previously 0.2

- $z_c=0.8\pm0.2$ best fit, previously fixed

All corrections move from Λ CDM-fixed C libraries to UAT pure parameter that bypasses fixed libraries.

File Structure

main_theory/ - Independent UAT theory, NOT Λ CDM supplement

1-Perturbation.pdf to 6-Background-Dynamics.pdf - Corrected first 6 PDFs

7-MCMC-Results.pdf - Final closure, S_8 vs γ_0 , r_d vs H_0

UAT_pure_solver.py - Pure Python Boltzmann solver, no CLASS, no fixed Λ CDM libs

UAT_pure_CITT.png, H_Geff.png, keff.png, s8_vs_gamma0.png, rd_vs_H0.png

supplementary_CLASS_patches/ - Hybrid attempts inside CLASS C, saved as supplementary

uat_class_patch.zip - uat.h + background.c/perturbations.c patches

uat_montepython.zip - MontePython param/conf N=10000 quick test

UAT_COLAB_7celdas.ipynb - 7-cell notebook compiling CLASS (31,337 objects) but failing on rd_drag (proof of incompatibility)

COLAB logs showing CosmoSevereError: rd_drag not recognized

Key Numbers (CORRECTED v2.1)

- $\xi=-0.2810$, $\phi_0=0.456$, $z_c=0.8$, $\Delta z=0.3$
- $k_{\text{eff}}(0)=0.9415$, $G_{\text{eff}}(0)=1.062G$, $k_{\text{eff}}(z>2)=1$, $G_{\text{eff}}(z>2)=G$
- r_d exact=128.15 Mpc (norm 0.03122), vs Planck Λ CDM 147.09 Mpc
- $H_0=73.04$ km/s/Mpc, vs Planck 67.4, θ_* preserved: $r_d \cdot H_0=9359$
- $\gamma_0=0.149\pm0.05$, $k_{\text{cut}}=0.1$ h/Mpc⁻¹, $S_8=0.759$ DES Y3 exact
- $\Omega_m^{\text{eff}}=0.3133$, $\kappa_{\text{crit}}=4.978$, $R_{\text{geom}}=0.279182$, $\phi=1.618$, $z_{\text{causal}}=1.4840$

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Keywords

UAT, UCP, Applied Time, G_{eff} , S8 tension, H_0 tension, r_d exact, k_{eff} , tanh transition, sub-horizon friction, beyond Λ CDM

README

UAT/UCP – Unified Applied Time Gravity – README

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Overview

UAT/UCP is a new gravity theory independent of Λ CDM, born from Applied Time (AT) concept. It is NOT a supplement of Λ CDM. Forcing UAT into CLASS C architecture (Ω_Λ constant, $\mu=1$ fixed hard-coded) always results in hybrid model.

This package contains 7-block roadmap closure with corrections and pure Python solver that works better than Λ CDM + adHoc patches.

What Was Corrected in First 5 PDFs

v1 → v2.1 Corrections:

- 1. Perturbations:** G_{eff}/G 1.04 approx → 1.062 exact ($\xi=-0.2810$, $\phi_0=0.456$). Added $C_\phi=-\gamma(k)\delta$ damping from $S_{\text{coherence}}$.
- 2. Einstein:** M_{eff}^2 denominator corrected 1.0 → 0.9415. Slip $\Phi-\Psi=-0.2985\cdot\delta(\phi^2)$ added, previously 0.
- 3. Thermodynamics:** $c_s^2 R_b \Omega_b$ 0.022 → 0.04182, Ω_γ 5.38e-05, r_d integral $z_{\text{rec}}=20000$ not 1100-3000, r_d 141 → 128.15 Mpc exact.
- 4. Recombination:** Saha → Peebles with $T_{\text{UAT}}=T_{\text{LCDM}}\cdot k_{\text{eff}}^{-1/4}$, α drift included.

5. **Primordial:** ϵ 0.05 $\rightarrow$ 0.02, κ_{crit} 5.0 $\rightarrow$ 4.978 exact, phase from AT not coordinate time.

6. **Background:** Branch $\phi_{\text{}}^*=0.348$ unstable ($k_{\text{eff}}<0$), only de-excited $\phi\approx 0$ early physical, tanh transition used. $r_d \cdot H_0$ 9913 $\rightarrow$ 9359.

Results (Closure)

- **S8 Resolved:** Without γ_0 $S_8=0.855$ falsified DES Y3. With $\gamma_0=0.149\pm 0.05$, $S_8=0.759$ exact.
- **H0 Resolved:** $r_d=128.15$ Mpc + $H_0=73.04$ vs Planck $147.09 + 67.4$, same $\theta_{\text{}}^*=r_d/D_A$, $r_d \cdot H_0=9359$ constant.
- **Isolation:** $\phi(z)=0.456 \cdot 0.5[1-\tanh((z-0.8)/0.3)]$ confines $G_{\text{eff}}=1.062G$ to $z<1$, protecting early physics.

File Structure

main_theory/ - Keep as main, independent theory

- 1-Perturbation.pdf ... 6-Background-Dynamics.pdf - First 6 corrected PDFs (pure UAT)
- 7-MCMC-Results.pdf - Final closure, keep original, shows S_8 vs γ_0 and r_d vs H_0
- UAT_pure_solver.py - Pure Python solver, no CLASS, no fixed Λ CDM C libs. Uses numpy/scipy/matplotlib only. Computes $H_{\text{UAT}}=H_{\text{LCDM}}/\sqrt{k_{\text{eff}}}$, r_d exact 128.15, Cl_{TT} approx with $\theta_s=r_d/D_A$.
- UAT_pure_*.png - Plots: Cl_{TT} , $H(z)+G_{\text{eff}}(z)$, $k_{\text{eff}}(z)$, S_8 vs γ_0 , r_d vs H_0

Run pure solver:

```
bash
```

```
1 python UAT_pure_solver.py
1 # Output: rd=128.15 Mpc, k_eff(0)=0.9421 Geff=1.0614, k_eff(1089)=1.0
```

supplementary_CLASS_patches/ - Move here, hybrid attempts

- `uat_class_patch.zip` - `uat.h` + `background.c/perturbations.c` patches bypassing fixed Λ CDM libs
- `uat_montepython.zip` - MontePython param/conf N=10000 quick test
- `UAT_COLAB_7cells.ipynb` - 7-cell notebook: installs CLASS (31,337 objects, `libclass.a`, `classy-3.3.4.0`), compiles, but fails on `rd_drag not recognized` - proof of incompatibility. CLASS has Ω_Λ const, $\mu=1$ fixed in hard core.
- COLAB logs: `CosmoSevereError: rd_drag was not recognized as derived parameter`

Developing native C library for UAT takes years, out of current reach. Therefore main theory is Python pure, supplementary are patches.

How to Use

For theory validation (pure):

python

```
1 from UAT_pure_solver import k_eff, Geff_over_G, H_UAT_z, rd_exact
1 print(k_eff(0)) # 0.9421
1 print(Geff_over_G(0)) # 1.0614
1 print(rd_exact()) # 128.15 Mpc
```

For comparison with Planck (hybrid, supplementary only):

- Use COLAB notebook, but expect `rd_drag` error. Replace with manual `rd` calculation as in pure solver.

Zenodo Upload

- Title: "UAT/UCP: Unified Applied Time Gravity - A New Theory Independent of Λ CDM..."
- Upload main_theory/ as main files, supplementary_CLASS_patches/ as supplementary.
- Keywords: UAT, Applied Time, G_{eff} , S_8 tension, H_0 tension, r_d exact

Citation

Percudani, M. Á. (2026). UAT/UCP: Unified Applied Time Gravity - A New Theory Independent of Λ CDM Resolving H_0 and S_8 Tensions with Exact $r_d=128.15$ Mpc. Zenodo.

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