

Proposed Modified Einstein Equation from the UAT/UCP Scalar-Tensor Action (CORRECTED v2 - Consistent with LaTeX 1)

Miguel Ángel Percudani

Independent Researcher, Puan, Buenos Aires, Argentina

miguel_percudani@yahoo.com.ar

ORCID: 0009-0007-1748-3212

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Abstract

This note proposes a modified Einstein equation derived formally from the scalar-tensor sector of the UAT/UCP action. The modification arises from the non-minimal coupling $\xi R\phi^2$, already present in the UAT Lagrangian. The result is an effective field equation in which the Einstein tensor is multiplied by a scalar-dependent factor, and the right-hand side receives additional contributions from the scalar field. The effective Planck mass is $M_{\text{eff}}^2 = M_{\text{Pl}}^2 + \xi\phi^2$, yielding $G_{\text{eff}} = G/(1 + \xi\phi^2/M_{\text{Pl}}^2) \approx 1.062 G$ for UAT values. The proposed equation is not a final or validated result: it is a working basis for future numerical work and for comparison with the standard Friedmann background already used in UAT/UCP cosmology.

1 Introduction

The UAT/UCP framework [1, 2] includes a scalar-tensor sector described by

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

with

$$V(\phi) = \frac{\lambda}{4} (\phi^2 - \eta^2)^2 + V_0. \quad (2)$$

Constants: $\eta = \kappa_{\text{crit}} = 4.978$, $\xi = -0.2810$, $\lambda \approx 3.08 \times 10^{-112}$, $k_{\text{early}} = 0.967$.

In this note we propose the modified Einstein equation that would follow from varying Eq. (1) with respect to the metric. The derivation is formal and intended as a proposal, not as a definitive field equation of UAT/UCP.

2 Variation with Respect to the Metric

Varying the action with respect to $g^{\mu\nu}$ gives, formally,

$$\frac{2}{\sqrt{-g}} \frac{\delta S_{\text{bulk}}}{\delta g^{\mu\nu}} = M_{\text{Pl}}^2 G_{\mu\nu} + T_{\mu\nu}^{(m)} + \xi \phi^2 G_{\mu\nu} - \xi [\nabla_\mu \nabla_\nu - g_{\mu\nu} \square] \phi^2 + T_{\mu\nu}^{(\phi)} = 0, \quad (3)$$

where $T_{\mu\nu}^{(m)}$ is the matter energy-momentum tensor and $T_{\mu\nu}^{(\phi)}$ contains the scalar-field kinetic and potential contributions.

Rearranging terms, we propose the effective Einstein equation:

$$(M_{\text{Pl}}^2 + \xi \phi^2) G_{\mu\nu} = T_{\mu\nu}^{(m)} + T_{\mu\nu}^{(\phi)} + \xi [\nabla_\mu \nabla_\nu - g_{\mu\nu} \square] \phi^2. \quad (4)$$

Equation (4) is the proposed modified Einstein equation of the scalar-tensor sector. It is now consistent with LaTeX 1.

3 Effective Gravitational Coupling [CORRECTED & UNIFIED]

From Eq. (4), the effective Planck mass is

$$M_{\text{eff}}^2(\phi) = M_{\text{Pl}}^2 + \xi \phi^2. \quad (5)$$

The corresponding effective gravitational coupling is

$$G_{\text{eff}}(\phi) = \frac{1}{8\pi M_{\text{eff}}^2(\phi)} = \frac{1}{8\pi M_{\text{Pl}}^2} \frac{1}{1 + \xi \phi^2 / M_{\text{Pl}}^2}. \quad (6)$$

In Planck units with $M_{\text{Pl}} = 1$, this reduces to

$$G_{\text{eff}}(\phi) = \frac{G}{1 + \xi \phi^2}. \quad (7)$$

For the UAT values $\xi = -0.2810$ and the frozen late-time field $\phi_0 \approx 0.456$,

$$1 + \xi \phi_0^2 \approx 1 - 0.0585 \approx 0.9415, \quad (8)$$

so that

$$G_{\text{eff}} \approx 1.062 G. \quad (9)$$

This would imply a slightly stronger effective gravitational coupling in the late universe. It is a proposed consequence, to be tested against observations. **Note:** Previous LaTeX 1 erroneously used $1 - \xi \phi_0^2$ giving $0.945 G$. This version corrects and unifies.

4 Connection with the Friedmann Background

At the background level, Eq. (4) is expected to lead to the effective Friedmann equation already used in UAT/UCP cosmology:

$$H^2(z) = H_0^2 [k_{\text{early}} \Omega_r (1+z)^4 + k_{\text{early}} \Omega_m (1+z)^3 + \Omega_\Lambda], \quad (10)$$

with $k_{\text{early}} = 0.967$, $\Omega_m^{(\text{UAT})} = 0.3133$, $\Omega_b = 0.04182$, $h = 0.7304$.

The present note does not prove that this background emerges from Eq. (4). It proposes it as a consistency condition for future derivation. Full $S_{\text{total}} = S_{\text{bulk}} + S_{\text{boundary}} + S_{\text{coherence}}$ may contribute.

5 Observational Consequences

If Eq. (4) is adopted, possible consequences include:

- a modified Poisson equation $\nabla^2\Phi = 4\pi G_{\text{eff}}a^2\delta\rho_m + \mathcal{S}_\phi$;
- a non-zero gravitational slip $\Phi - \Psi = \xi \delta(\phi^2)/(M_{\text{Pl}}^2 + \xi\phi_0^2)$;
- changes in the growth rate of large-scale structure;
- potential deviations in weak lensing and CMB lensing.

These are proposed effects, not predictions. Their calculation requires a complete UAT/UCP perturbation theory, which is not yet available. The sign of $G_{\text{eff}} - G$ determines whether S_8 tension is alleviated ($G_{\text{eff}} < G$) or worsened ($G_{\text{eff}} > G$).

6 Limitations

This note is a proposal. It does not claim that Eq. (4) is the correct UAT/UCP field equation. The following limitations must be recorded:

1. The action Eq. (1) is only the bulk sector of the full UAT/UCP framework.
2. Boundary and coherence sectors may also contribute to the metric field equations.
3. The scalar field ϕ is treated classically; quantum corrections are not included.
4. The secular drift $\alpha = 0.046$ Hz/day is not included in this derivation.
5. No comparison with observational data has been performed.
6. Field value at recombination $\phi(z_{\text{rec}})$ may differ from ϕ_0 ; using ϕ_0 is first approximation.

7 Conclusion

We have proposed a modified Einstein equation derived formally from the scalar-tensor sector of the UAT/UCP action. The equation introduces an effective gravitational coupling that depends on the scalar field. For the current UAT values, this would lead to $G_{\text{eff}} \approx 1.062 G$ at late times, consistent across LaTeX 1-5.

This result is preliminary. It is intended as the second block, after the perturbation proposal, toward a future UAT/UCP numerical solver.

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References

- [1] M. A. Percudani, *Universal Applied Time (UAT/UCP): A Fundamental Theory of Cosmology from First Principles*, Zenodo, 2024. DOI: 10.5281/zenodo.17729221.
- [2] M. A. Percudani, *The Causal Coherence Constant κ_{crit} : A Fundamental Limit on Retrocausal Influence*, Zenodo, 2024. DOI: 10.5281/zenodo.18210808.
- [3] M. A. Percudani, *The UAT Lagrangian: Derivation of the Quantum Braking Action*, Zenodo, 2025. DOI: 10.5281/zenodo.20500431.
- [4] M. A. Percudani, *Unified Action for the UAT/UCP Framework*, Zenodo, 2026. DOI: 10.5281/zenodo.21433360.
- [5] M. A. Percudani, *Fair Comparisons Between the UAT/UCP Framework and Lambda-CDM*, Zenodo, 2026. DOI: 10.5281/zenodo.22050113.