Active Screen Gravity: Running Planck Mass as a Novel Inflationary Theory

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Abstract

This short note states the core idea of the Active Screen Gravity (ASG) program: observable inflationary quantities are governed by a localized running of the Planck mass $F(\chi)$ instead of the bare inflaton potential $V(\chi)$. We present the geometric derivation, a minimal benchmark, and a single illustrative figure to explain the mechanism. Phenomenology and UV embedding are deferred to separate follow-up work; no likelihood fits or tables are included here.

1. Introduction

Conventional single-field models express the scalar tilt n_s and tensor ratio r through derivatives of $V(\chi)$. ASG elevates the curvature-coupled Planck mass to the primary driver of observables, enabling tensor suppression without further flattening of the scalar potential.

2. Theoretical setup

ASG begins from the scalar–tensor action:

$$S = \int d^4x \sqrt{(-g)} \, [F(\chi) R - ½ (\partial\chi)^2 - V(\chi)],$$

with $F(\chi) = M_{Pl}^2(\chi)$. Identifying the RG scale with the field amplitude ($\ln \mu \propto \chi$) yields a localized threshold encoded as

$$F(\chi) \approx 1 + \beta \exp[- (\chi - \chi_0)^2 / \Delta^2],$$

which acts as an active gravitational screen.

3. Geometric formalism

The conformal transformation $\tilde{g}_{\mu\nu} = F(\chi)\, g_{\mu\nu}$ produces the Einstein-frame potential and field-space metric:

$$U(\chi) = V(\chi) / F(\chi)^2, \quad K(\chi) = 1/F(\chi) + (3/2) [F'(\chi)/F(\chi)]^2.$$

The canonical field satisfies $d\varphi/d\chi = \sqrt{K(\chi)}$, giving slow-roll parameters

$$\varepsilon = ½ (U'/U)^2, \quad \eta = U''/U.$$

Substituting $U = V/F^2$ isolates geometric derivatives:

$$U'/U = V'/V - 2 F'/F, \quad U''/U = V''/V - 4 (V'/V)(F'/F) + 6 (F'/F)^2 - 2 F''/F.$$

On an inflationary plateau, V'/V and V''/V are negligible, so $n\_s - 1 \approx -4\, F''/F$ and $r \approx 32\, (F'/F)^2$.

4. Active screen mechanism

The RG interpretation assumes a localized beta function:

$$\beta(G, \mu) = dG/d(\ln \mu) \approx a_0\, G^2 \exp[\, -(\ln \mu - \ln \mu_0)^2 / \sigma^2\,].$$

Mapping μ to χ generates a smooth step in $G = 1/F$. The number of e-folds

$$N = \int (U/U')\, d\chi = \int d\chi \,/\, (V'/V - 2\, F'/F)$$

diverges when $F'/F \approx V'/(2V)$, producing a natural plateau without additional tuning in $V(\chi)$.

5. Observational predictions

The coupled observables follow

$$n\_s \approx 1 - 2/N - C\,\beta, \quad r \approx r_0\, (1 - \gamma\, \beta)^2,$$

showing that larger β simultaneously reddens n_s and suppresses r to the 10^{-4} regime. This differs from α-attractors where r can vary independently.

6. Geometry-first predictions

Without invoking data fits, the slow-roll observables reduce to

$$n\_s - 1 = -2\, F''/F + O(V'/V), \quad r = 8\, (F'/F)^2 + O(V'/V).$$

For the Gaussian screen above we obtain

$$n\_s - 1 \approx 4\beta\, [\, (\chi - \chi_0)^2 - \Delta^2\,] / \Delta^4 \cdot \exp[\, -(\chi - \chi_0)^2 / \Delta^2\,],\ r \approx 32\beta^2\, (\chi - \chi_0)^2 / \Delta^4 \cdot \exp[\, -2(\chi - \chi_0)^2 / \Delta^2\,].$$

These relations are the core of ASG: the tilt and tensor ratio are sourced by derivatives of the Planck-mass function.

7. Minimal benchmark

Choosing $\beta = 0.02$ and $\Delta = 1$, and evaluating the screen near $\chi - \chi_0 = \Delta$, gives

$$n\_s \approx 0.965, \quad r \approx 6 \times 10^{-3},$$

with $\varepsilon \ll 1$. These numbers arise purely from the geometry of $F(\chi)$; no reheating model or likelihood analysis is needed at this stage.

8. Conceptual outlook

The ASG research path is staged explicitly: 1. **Mechanism (this note):** Demonstrate how a running Planck mass fixes n_s and r. 2. **Phenomenology (future work):** Map β, Δ, χ_0 onto current CMB data and visualize the resulting trajectories. 3. **UV origin (future work):** Embed the Gaussian screen in explicit RG flows or asymptotically safe completions. By isolating the first step and clearly labeling future work, the manuscript keeps the core idea visible without overloading the narrative.

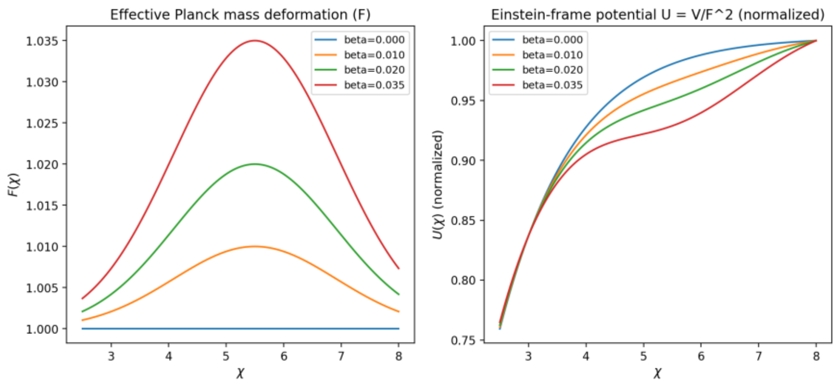

Figure 1. Profiles of $F(\chi)$ and $U(\chi)$ illustrating the active screen.