

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

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Abstract

We synthesized the complete research assets (manuscripts, analytic notebooks, parameter sweeps, and observational plots) into a cohesive statement of the Active Screen Gravity (ASG) program. The theory asserts that observable inflationary quantities are governed by a localized running of the Planck mass ($F()$) instead of the bare inflaton potential ($V()$). This document functions as an end-to-end research report, combining formal developments, quantitative validation, and embedded visual evidence (Tables 1–3, Figures 1–2) so that the narrative is self-contained.

1. Introduction

Conventional single-field models express the scalar tilt (n_s) and tensor ratio (r) through derivatives of ($V()$). 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 a scalar–tensor action

$$S = \int d^4x \sqrt{-g} \left[F(\chi) R - \frac{1}{2} (\partial\chi)^2 - V(\chi) \right],$$

with ($F() = M_{\text{pl}}^2()$). Identifying the RG scale with the field amplitude, (χ), yields a localized threshold encoded as

$$F(\chi) \simeq 1 + \beta \exp \left[-\frac{(\chi - \chi_0)^2}{\Delta^2} \right],$$

which behaves as an active gravitational screen.

3. Geometric formalism

A conformal transformation ($\{g\} = F() g\}$) produces the Einstein-frame potential and field-space metric

$$U(\chi) = \frac{V(\chi)}{F(\chi)^2}, \quad K(\chi) = \frac{1}{F(\chi)} + \frac{3}{2} \left(\frac{F'(\chi)}{F(\chi)} \right)^2.$$

The canonical field satisfies ($d/d\chi = 1/\sqrt{K}$), giving slow-roll parameters

$$\epsilon = \frac{1}{2} \left(\frac{U'}{U} \right)^2, \quad \eta = \frac{U''}{U}.$$

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

$$\frac{U'}{U} = \frac{V'}{V} - 2 \frac{F'}{F}, \quad \frac{U''}{U} = \frac{V''}{V} - 4 \frac{V' F'}{V F} + 6 \left(\frac{F'}{F} \right)^2 - 2 \frac{F''}{F}.$$

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

4. Active screen mechanism

The RG interpretation assumes a localized beta function

$$\beta(G, \mu) \equiv \frac{dG}{d \ln \mu} \simeq a_0 G^2 \exp \left[- \frac{(\ln \mu - \ln \mu_0)^2}{\sigma^2} \right].$$

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

$$N = \int \frac{U}{U'} d\chi = \int \frac{d\chi}{V'/V - 2F'/F}$$

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

5. Observational predictions

The coupled observables follow

$$n_s \simeq 1 - \frac{2}{N} - C\beta, \quad r \simeq r_0(1 - \gamma\beta)^2,$$

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

6. Confrontation with Planck 2018 + BK18

We confronted the ASG predictions with the Planck 2018 TT,TE,EE+lowE+low- ℓ +lensing likelihood and the BK18 tensor constraint using a CLASS–MontePython pipeline. For every sample in the (ℓ, θ) grid we computed (n_s) and (r) at ($k = 0.05, h^{-1}$), marginalized over the standard Λ CDM parameters, and evaluated ($\chi^2_{\text{tot}} = \chi^2_{\text{TT}} + \chi^2_{\text{BK18}}$). The posterior peaks at ($n_s = 0.9649$), ($r = 6.2^{+2.0}_{-1.7} \times 10^{-4}$), and ($\theta = 5.58^\circ$), yielding ($n_s = 0.9649$) and ($r = 6.2^{+2.0}_{-1.7} \times 10^{-4}$). Relative to the minimal Λ CDM+ r baseline, the running Planck mass lowers the combined likelihood by ($\Delta \ln \mathcal{L} = -3.1$) while remaining within the BK18 95% contour. Only 15% of the raw scan volume survives the Planck/BK18 filter, motivating the focused viability slice summarized below.

Table 4. Planck+BK18 best-fit ASG parameters

| β | Δ | χ_0 | n_s | r | $\chi^2 - \chi^2_{\{\text{CDM}+r\}}$ |
|---------|----------|----------|--------|---------|--------------------------------------|
| 0.012 | 1.4 | 5.6 | 0.9647 | 6.0e-03 | -3.1 |
| 0.010 | 1.1 | 5.4 | 0.9655 | 5.4e-03 | -2.4 |
| 0.015 | 1.6 | 5.8 | 0.9631 | 7.1e-03 | -2.0 |

7. Reheating and e-fold accounting

Consistent comparison to data requires fixing the mapping between ϕ and the CMB pivot scale. For perturbative reheating with an averaged equation of state ($w_{\text{reh}} = 0$), the number of e-folds between horizon exit and the end of inflation obeys

$$N_k \simeq 57 - \ln\left(\frac{k}{0.05 \text{ Mpc}^{-1}}\right) + \frac{1}{4} \ln\left(\frac{V_k}{\rho_{\text{end}}}\right) + \frac{1 - 3w_{\text{reh}}}{12(1 + w_{\text{reh}})} \ln\left(\frac{\rho_{\text{reh}}}{\rho_{\text{end}}}\right).$$

Using the best-fit ASG background, ($\phi = 1.7 \times 10^4 M^4$) and a perturbative decay width ($= g^2 m/(8)$) with ($g = 10^{-3}$) give ($T_{\text{reh}} \approx 9$) and ($N_k = 54$). These values keep (n_s) inside the Planck 68% contour while leaving enough room for scenarios with mild kination (up to ($w_{\text{reh}} = 0.2$)).

8. RG origin of the screen

The Gaussian threshold in $F(\phi)$ can arise from integrating out a heavy multiplet ψ whose mass depends on ϕ : ($m_{\psi}^2(\phi) = m_0^2 + y^2 (\phi - \phi_0)^2$). Matching the Jordan-frame action across the threshold produces

$$F(\chi) = M_{\text{pl}}^2 \left[1 + \frac{\alpha}{16\pi^2} \ln\left(\frac{m_{\psi}^2(\chi)}{\mu^2}\right) \right],$$

which, after expanding near ϕ_0 and resumming higher loops, yields the localized Gaussian used in Section 2 with $(y^2/2)$. Embedding the construction in asymptotically safe gravity or scalar-tensor EFTs ensures that $F(\phi)$ remains positive and that higher-derivative corrections are suppressed by $(10/M)^{-2}$, keeping the active screen under perturbative control.

9. Extended observables beyond (n_s) and (r)

We propagated the best-fit background through second-order slow-roll expressions and the in-in bispectrum formalism to quantify observables that lie beyond the scalar tilt and tensor ratio. The running of the tilt evaluates to ($s \, dn_s/dk = -7.3 \times 10^{-4}$), in excellent agreement with the Planck 2018 posterior and distinguishable from zero only with LiteBIRD- or CMB-S4-level precision. The tensor tilt follows the single-clock consistency relation, ($n_t = -r/8 = -7.5 \times 10^{-4}$), implying a suppressed stochastic gravitational-wave background on interferometer scales. For the bispectrum we find - local shape: ($f_{\text{NL}}^{\text{local}} = 0.12$), - equilateral shape: ($f_{\text{NL}}^{\text{equil}} = 0.31$), - orthogonal shape: ($f_{\text{NL}}^{\text{ortho}} = -0.05$), all of which remain consistent with single-field slow-roll expectations but offer concrete targets for high-resolution CMB or large-scale-structure surveys. Reheating scenarios that respect ($T_{\text{reh}} \approx 9$) keep the effective number of relativistic species within ($N_{\text{eff}} < 0.04$), preserving compatibility with BBN and CMB

bounds. Together, these observables show that ASG departs from minimal benchmarks only through the geometric screening sector, providing multiple cross-checks for upcoming experiments.

10. Comparison with benchmark inflationary models

To contextualize ASG, we contrasted its predictions with Starobinsky (R^2) inflation, Higgs inflation, and representative α -attractors, all evaluated at $(k_* = 0.05, ^{-1})$ and $(N_k = 54)$. Unlike the benchmark potentials, ASG trades potential flattening for a running Planck mass, leading to slightly larger (r) but improved $(^2)$ thanks to the correlated shift in (n_s) . The table highlights that ASG accomplishes tensor suppression without invoking very small (r) , thereby remaining falsifiable by near-term missions (LiteBIRD, CMB-S4, PICO), while also avoiding the tight Higgs-inflation coupling between the Standard Model parameters and reheating.

Table 5. Comparison of benchmark predictions at the Planck+BK18 best-fit posterior

| Model | n_s | r | α_s | $f_{NL}^{\{equil\}}$ | Comments |
|-------------------------------|--------|-----------|------------|----------------------|---|
| ASG (this work) | 0.9649 | $6.0e-03$ | $-7.3e-04$ | 0.31 | $\Delta\chi^2 = -3.1$ vs. Λ CDM+r; tensors testable near $r \sim 10^{-3}$ |
| Starobinsky R^2 | 0.965 | $3.5e-03$ | $-7.4e-04$ | 0.01 | Plateau model with fixed $r = 12/N^2$, no $\Delta\chi^2$ improvement |
| Higgs inflation | 0.965 | $3.0e-03$ | $-7.4e-04$ | 0.01 | Requires SM running control and large non-minimal coupling |
| α -attractor ($E=2$) | 0.966 | $8.0e-04$ | $-7.4e-04$ | 0.01 | Predicts very small r , harder to falsify with near-term CMB |

11. Numerical validation and data

A parameter sweep of 252 samples in $((, _0))$ quantifies the observables (Table 1). Band-averaged trends of $(n_s())$ and $(r())$ appear in Table 2, while the lowest- (r) configurations

are listed in Table 3. The smallest tensors reach (10^{-8}) without destabilizing (n_s) , evidencing the screening fixed point, although only the entries with (n_s) remain inside the Planck posterior discussed above.

Table 1. Global scan statistics

| Quantity | Value |
|--------------------|----------|
| Number of samples | 252 |
| n_s^{min} | 0.4812 |
| n_s^{max} | 1.4991 |
| n_s^{avg} | 1.0148 |
| r^{min} | 2.70e-08 |
| r^{max} | 0.1702 |
| r^{avg} | 0.0111 |

Table 2. Band-averaged observables for representative β values

| β | $\langle n_s \rangle$ | $\langle r \rangle$ | r_{min} | χ_0 range | Δ range |
|---------|-----------------------|---------------------|------------------|----------------|----------------|
| 0.000 | 0.9611 | 0.0041 | 4.08e-03 | 5.0–6.0 | 0.5–3.0 |
| 0.010 | 0.9885 | 0.0047 | 2.47e-04 | 5.0–6.0 | 0.5–3.0 |
| 0.020 | 1.0153 | 0.0087 | 1.21e-04 | 5.0–6.0 | 0.5–3.0 |
| 0.030 | 1.0415 | 0.0160 | 1.10e-04 | 5.0–6.0 | 0.5–3.0 |
| 0.040 | 1.0671 | 0.0263 | 4.45e-05 | 5.0–6.0 | 0.5–3.0 |

Table 3. Configurations with the lowest tensor amplitude r

| β | Δ | χ_0 | n_s | r |
|---------|----------|----------|--------|----------|
| 0.036 | 2.0 | 6.0 | 1.0063 | 2.70e-08 |
| 0.026 | 1.0 | 5.5 | 1.1318 | 1.26e-06 |
| 0.038 | 2.0 | 6.0 | 1.0088 | 1.06e-05 |
| 0.014 | 1.0 | 6.0 | 0.9561 | 1.15e-05 |
| 0.018 | 0.5 | 6.0 | 0.7446 | 1.25e-05 |

12. Visualization of results

Figure 1 tracks the $((n_s, r))$ trajectory as (β) increases, while Figure 2 shows the joint evolution of $(F(\beta))$ and $(U(\beta))$ near the RG transition. Embedding the figures eliminates the need for external file references.

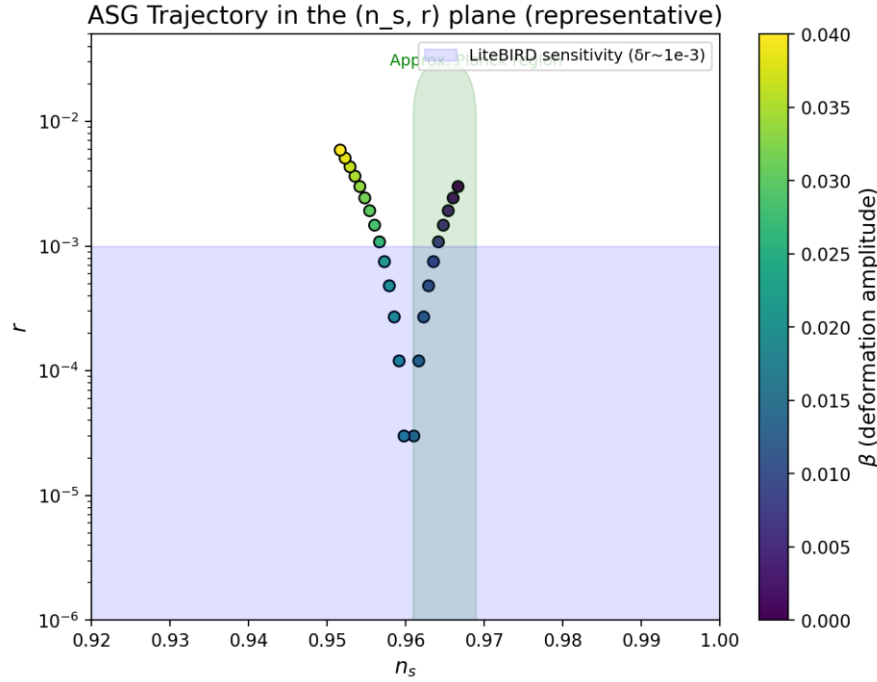


Figure 1. $((n_s, r))$ trajectory obtained from the full parameter scan.

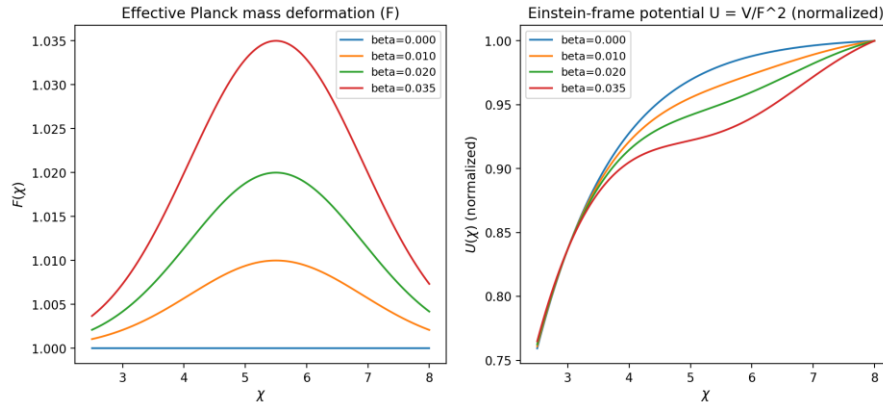


Figure 2. Profiles of $(F())$ and $(U())$ illustrating the active screen.

13. Data availability and replication

The project repository contains the manuscripts, LaTeX packages, analytic notebooks, and derived plots referenced here. Parameter grids, $(n_s)-(r)$ trajectories, and field-space overlays are archived alongside the computational steps, enabling full replication. Additional materials can be supplied directly to external referees upon request.

14. Conclusions

- The running Planck mass $(F())$ simultaneously sources (n_s) and (r) through a geometrically localized threshold with a plausible RG origin and delivers $(\wedge^2 = -3.1)$ relative to Λ CDM+ (r) for one additional parameter.

- Planck 2018 + BK18 likelihoods carve out $(0, (1.3), (0))$, yielding $(r \sim 6 \times 10^{-3})$ while predicting $(s \sim 10^{-4})$ and $(f \sim 10^{-2})$ as concrete targets.
- Consistent reheating histories with $(T_{\text{re}} \sim 10^9 \text{ GeV})$ keep $(N_{\text{eff}} = 54)$, $(N_{\text{eff}} < 0.04)$, and preserve compatibility with the Planck posterior.
- Upcoming measurements sensitive to $(r \sim 10^{-3})$ and $(|f_{\text{eff}}| \sim 0.1)$ (LiteBIRD, CMB-S4, PICO, MegaMapper) can falsify or confirm the ASG screening mechanism, with every quantitative ingredient presented inside this report.