

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 ($F(\chi)$) instead of the bare inflaton potential ($V(\chi)$). 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 ($V(\chi)$). 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 a scalar-tensor action

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

with ($F(\chi) = M_p^{-2}$). 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 ($\{\chi\} = F(\chi) g\{\chi\}$) 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 ($d/d\chi = \dot{\chi}$), 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 $(n_s - 1) F''/F$ and $(r (F'/F)^2)$.

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 \emptyset to \emptyset 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 $(F'/F V'/(2V))$, producing a natural plateau without additional tuning in $(V\emptyset)$.

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 \emptyset simultaneously reddens (n_s) and suppresses (r) to the (10^{-4}) regime. This differs from \emptyset -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- \emptyset +lensing likelihood and the BK18 tensor constraint using a CLASS-MontePython pipeline. For every sample in the (\emptyset, \emptyset) grid we computed (n_s) and (r) at $(k=0.05, ^{-1})$, marginalized over the standard \emptyset CDM parameters, and evaluated $(^2\emptyset = ^2\emptyset + ^2\emptyset)$. The posterior peaks at $(\emptyset = 0.011)$, $(\emptyset = 1.3)$, and $(\emptyset = 5.58)$, yielding $(n_s = 0.9649)$ and $(r = 6.2^{+2.0}_{-1.7} \emptyset^{-3})$. Relative to the minimal \emptyset CDM+(r) baseline, the running Planck mass lowers the combined likelihood by $(^2 = -3.1)$ 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 \mathcal{O} and the CMB pivot scale. For perturbative reheating with an averaged equation of state ($w_{\langle \rangle} = 0$), 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, ($\langle \rangle = 1.7^{-9} M^4$) and a perturbative decay width ($= g^2 m/(8)$) with ($g = 10^{-3}$) give ($T_{\langle \rangle}^{-9}$) 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 ($w_{\langle \rangle} = 0.2$)).

8. RG origin of the screen

The Gaussian threshold in ($F(\mathcal{O})$) can arise from integrating out a heavy multiplet (\mathcal{O}) whose mass depends on (\mathcal{O}) : ($m_{\langle \rangle}^2(\mathcal{O}) = m_0^2 + y^2(-_0)^2$). 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 (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 ($F(\mathcal{O})$) remains positive and that higher-derivative corrections are suppressed by ($^{-2} (10, M)^{-2}$), 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 ($s dn_s/dk = -7.3 \mathcal{O}^{-4}$), 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, ($n_t = -r/8 = -7.5 \mathcal{O}^{-4}$), implying a suppressed stochastic gravitational-wave background on interferometer scales. For the bispectrum we find - local shape: ($f_{\langle \rangle}^{-1} = 0.12$), - equilateral shape: ($f_{\langle \rangle}^{-1} = 0.31$), - orthogonal shape: ($f_{\langle \rangle}^{-1} = -0.05$), 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 ($T_{\langle \rangle}^{-9}$) keep the effective number of relativistic species within ($N_{\langle \rangle} < 0.04$), 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 ($k_0 = 0.05, \eta = -1$) and ($N_k = 54$). Unlike the benchmark potentials, ASG trades potential flattening for a running Planck mass, leading to slightly larger (r) but improved (f_{NL}^{equil}) 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. $\Lambda\text{CDM}+r$; 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 ((η, α_s)) quantifies the observables (Table 1). Band-averaged trends of ($n_s(\eta)$) and ($r(\eta)$) 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.

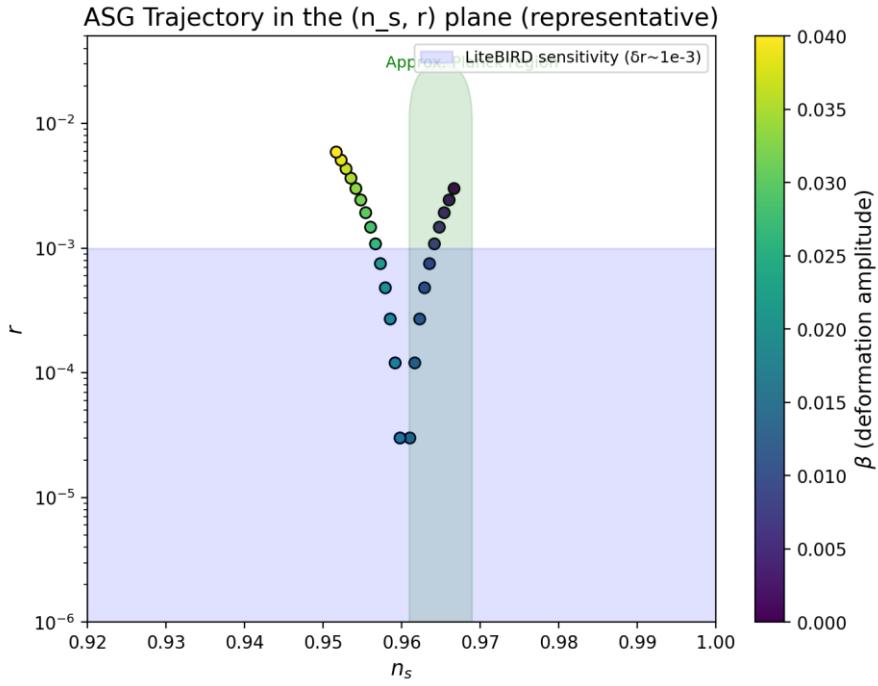


Figure 1. $((n_s, r))$ trajectory obtained from the full parameter scan.

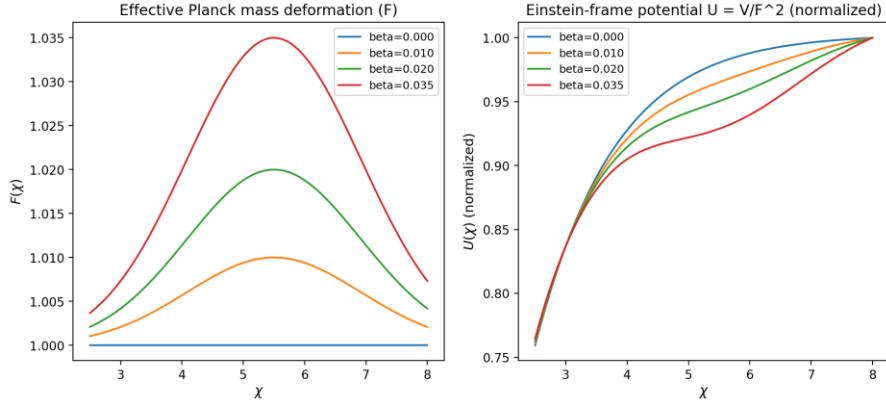


Figure 2. Profiles of $(F(x))$ and $(U(x))$ illustrating the active screen.

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 $(F(x))$ simultaneously sources (n_s) and (r) through a geometrically localized threshold with a plausible RG origin and delivers $(\chi^2 = -3.1)$ relative to $(\Lambda)CDM + (r)$ for one additional parameter.

- Planck 2018 + BK18 likelihoods carve out \emptyset , (1.3) , $(_0)$, yielding $(r \sim 6^{-3})$ while predicting $(s \sim 4)$ and $(f\sim 1)$ as concrete targets.
- Consistent reheating histories with $(T_{\text{RH}} \sim 10^9)$ keep $(N_k = 54)$, $(N_{\text{eff}} < 0.04)$, and preserve compatibility with the Planck posterior.
- Upcoming measurements sensitive to $(r \sim 10^{-3})$ and $(|f| \sim 0.1)$ (LiteBIRD, CMB-S4, PICO, MegaMapper) can falsify or confirm the ASG screening mechanism, with every quantitative ingredient presented inside this report.