Active Screen Gravity (ASG)

Running Planck Mass as the Origin of the Inflationary Attractor

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1. Conceptual Starting Point

Standard single–field inflation determines observable quantities primarily from the inflaton potential $V(\chi)$. The slow-roll parameters

$\epsilon_V = 1/2 (V'/V)^2 \quad \eta_V = V''/V$

lead to the well-known predictions

$n_s \approx 1 - 6\epsilon_V + 2\eta_V \quad r = 16\epsilon_V$

Therefore almost every inflation model reduces to shaping $V(\chi)$.

Active Screen Gravity (ASG) proposes a different premise:

> The geometry of gravity — not the potential — determines the observables.

We promote the Planck mass to a field-dependent quantity

$M_{Pl}^2 \to F(\chi)$

so the action becomes a scalar–tensor theory

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

The physical content of ASG is not merely scalar-tensor gravity. The claim is stronger:

Inflationary attractor behavior arises from a localized RG running of the gravitational coupling.

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2. Einstein Frame Dynamics

Apply conformal transformation

$\hat{g}_{\mu\nu} = F(\chi) g_{\mu\nu}$

The Einstein-frame action becomes

$S_E = \int d^4x \sqrt{-\hat{g}} [R/2 - 1/2 K(\chi)(\partial\chi)^2 - U(\chi)]$

where

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

Canonical field φ is defined by

$d\varphi/d\chi = \sqrt{K(\chi)}$

Thus inflation effectively occurs in a curved field-space metric even with a trivial kinetic term in the Jordan frame.

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3. Slow-Roll Geometry

In terms of U(χ):

$\varepsilon = 1/2\, (U'/U)^2$ $\eta = U''/U$

Using $U = V/F^2$:

$U'/U = V'/V - 2F'/F$ $U''/U = V''/V - 4(V'/V)(F'/F) + 6(F'/F)^2 - 2F''/F$

In plateau models $V'/V \ll 1$ and $V''/V \ll 1$ so

$\eta \approx -2F''/F$ $\varepsilon \approx 2(F'/F)^2$

Therefore

$n_s - 1 \approx -4F''/F$ $r \approx 32(F'/F)^2$

Key physical result:

Tilt ↔ curvature of Planck mass Tensor ↔ slope of Planck mass

This creates a deterministic relation between observables.

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4. Renormalization Group Origin

We assume gravitational coupling runs with energy scale μ

$G = 1/F$

$dG/d \ln \mu = \beta(G)$

Near a threshold scale μ_0 the beta function is localized

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

Integrating:

$\Delta G(\mu) \approx G_0^2 \int a(\mu)\, d \ln \mu$

This produces a smooth step in G(μ):

$G(\mu) \approx G_0 [1 + A\, \mathrm{erf}((\ln \mu - \ln \mu_0)/\sigma)]$

Identifying the field amplitude as the RG scale

$\ln \mu \propto \chi$

The derivative becomes Gaussian

$\partial\chi G \propto \exp[-(\chi - \chi_0)^2 / \Delta^2]$

Hence

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

Thus the Gaussian deformation is the leading field-space imprint of a gravitational RG threshold.

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5. Attractor Mechanism

The number of e-folds is

$N = \int U/U'\, d\chi$

Substitute U'/U:

$N = \int 1/(V'/V - 2F'/F)\, d\chi$

When $F'/F \approx V'/(2V)$

Denominator approaches zero → plateau formation

Therefore inflation automatically stabilizes near the RG transition scale χ_0.

This creates a dynamical fixed trajectory rather than a tuned point.

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6. Perturbations (Mukhanov–Sasaki)

Scalar perturbations obey

$v_k'' + (k^2 - z''/z)\, v_k = 0$

where

$z = a \varphi'/H$

Because $\varphi'(\chi)$ depends on F'/F, the effective mass term becomes

$z''/z \approx a^2H^2(2 + 6(F'/F)^2 - 4F''/F)$

Therefore curvature of the running Planck mass directly modifies the scalar spectrum.

Tensor modes obey

$u_k'' + (k^2 - a''/a) \nu_k = 0$

and depend only on $H^2 \propto U$, so suppression of ε suppresses r.

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7. Observational Prediction

ASG predicts a trajectory in the (n_s , r) plane:

$n_s \approx 1 - 2/N - C\beta$ $r \approx r_0(1 - \gamma\beta)^2$

Therefore decreasing r forces n_s to shift red.

This differs fundamentally from α-attractors where r is independently adjustable.

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8. Physical Interpretation

Inflation occurs while the scalar field climbs a gravitational screening barrier produced by RG flow.

The universe we observe corresponds to the location where the RG transition balances the potential slope.

Hence cosmic microwave background observables encode a property of quantum gravity running rather than the inflaton potential.

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9. What the Theory Proves

The model demonstrates:

1) Inflationary attractors can arise from gravitational coupling flow 2) Observables can depend on geometry rather than matter dynamics 3) Tensor suppression does not require flattening the scalar potential 4) The spectral index measures the curvature of quantum gravitational running

Thus ASG reframes inflation as a probe of gravitational renormalization physics rather than particle physics model building.

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10. Falsifiability

Predictions:

If $r \approx 0.003$ → potential-driven inflation If $r \ll 10^{-3}$ with slightly redder n_s → ASG-type running gravity

Future CMB missions provide a decisive test.