

CEDA Model Card — CAL-002 (Starobinsky Inflation)

0. Proposal Identification

- **Title:** Starobinsky Inflation (Higher-Curvature $R+R^2R+R^2$)
- **Authors:** A. A. Starobinsky
- **Year / Venue (arXiv / journal):** 1980 (Phys. Lett. B 91, 99–102) (*confirm exact citation formatting you want*)
- **Link:** _____

1. Claimed Mechanism (Concise)

Accelerated expansion arises from **intrinsic higher-curvature gravitational dynamics** via an R^2R^2 correction to the Einstein–Hilbert action. Equivalently, the model can be reformulated as a scalar–tensor theory where the **scalaron** rolls on a potential that yields a quasi-de Sitter phase.

2. Degrees of Freedom (DOF)

Explicit Dynamical DOF

- Metric $g_{\mu\nu}g_{\mu\nu}$ (GR dynamical DOF)
- In scalar–tensor (Einstein-frame) reformulation: scalar field $\phi\phi$ (“scalaron”) as dynamical DOF (*equivalent, not additional*)

Effective / Collective DOF

- Curvature scalar RR as an effective variable in action-level description
- Effective scalaron potential $V(\phi)V(\phi)$ (in Einstein frame)

Fixed / Constrained Quantities

- Parameters of the action (e.g., coefficient of R^2R^2 , often written with a mass scale M):

- Assumed matter content during inflationary regime: typically negligible / subdominant (state explicitly): _____

3. System–Environment Partition

- **System (interior DOF):** Homogeneous FRW background fields $g_{\mu\nu}g_{\mu\nu}$ (and $\phi\phi$ in Einstein frame) + perturbations within EFT validity
- **Environment:** UV-complete / higher-order curvature operators beyond truncation; any traced-out modes beyond EFT cutoff

- **Boundary definition (horizon, cutoff, causal surface, etc.):** EFT coarse-graining cutoff μ (and standard cosmological slicing); **no horizon-defined partition required**

Partition evolves in time?

- EFT cutoff may be treated as a descriptive scale; no physical exchange across a horizon boundary is claimed. (If you want a time-dependent $\mu(t)$ policy, declare it in A0.)

4. Conservation Accounting

- **Stress–energy tensor used:** Derived from the action (either Jordan-frame $f(R)$ field equations or Einstein-frame scalar stress–energy)
- **Any effective or additional terms introduced:** Higher-curvature contributions are **intrinsic** (action-level), not phenomenological fluids
- **Where conservation is enforced:** Bianchi identity + covariant conservation of effective source terms; equivalently scalar field EOM ensures $\nabla_\mu T_{\mu\nu} = 0$

5. Horizon Use (if applicable)

- **Horizon definition:** Not used as a dynamical ingredient
- **Role in argument:** Horizon is descriptive (causal boundary), not a driver
- **What quantities depend explicitly on horizon choice:** None claimed (if any appear in perturbation discussions, list them): _____

6. Coarse-Graining Prescription

- **Smoothing scale(s):** EFT cutoff μ / renormalization scale; perturbation smoothing scale if used: _____
- **Justification for choice:** Validity of truncated higher-curvature EFT in the inflationary regime
- **Range of admissible variations to be tested (D2):**
 - $\mu \rightarrow \mu(1 \pm 0.1)$ within validity
 - Frame change Jordan \leftrightarrow Einstein as admissible equivalence
 - Modest slicing/horizon re-descriptions should not change mechanism classification

7. Location of Negative Pressure / Acceleration

- **Equation number(s):** _____ (fill from your source)
- **Term(s) responsible:** R^2 sector in Jordan frame / scalaron potential $V(\phi)$ + slow-roll regime in Einstein frame
- **Physical source:** Intrinsic gravitational dynamics (equivalently scalaron dynamics); **not** horizon bookkeeping; **not** exchange-term tuning

8. Diagnostics Requested

- D1 — Horizon Reconfiguration Null Test (*expected N/A / trivially passes “not invoked”*)
- D2 — Coarse-Graining Stability
- D3 — Exchange-Term Provenance
- D4 — Mechanism Audit / Predictive Wedge

9. Known Fragilities / Author Caveats

- EFT truncation regime and validity of neglecting higher-order curvature operators
 - Reheating details may be model-extended / regime-limited (mark for conditional verdict symmetry if needed)
 - 7. Conditional Verdict Symmetry
 - Any dependence on renormalization scheme for certain observables should be tagged with S1 classification if it arises: _____
Additional Diagnostic Controls ...
-

A0 — Admissibility Declaration (CAL-002)

A0.1 Framework Ontology

- **Ontology:** Continuum EFT (higher-curvature gravity as effective action)
- Spacetime geometry treated as: **fundamental** (within EFT)
- Degrees of freedom: metric fundamental; scalaron emerges as **equivalent reformulation**, not new ontology

A0.2 Allowed Reformulations

Allowed equivalences (declared same physics):

- Frame changes (Jordan \leftrightarrow Einstein)
- Field redefinitions (scalaron variable reparametrizations)
- Change of variables/canonical transformations (standard)

Equivalence criterion (must remain invariant):

- Background dynamics (FRW evolution) within stated regime
- Conservation laws (covariant conservation)
- Causal structure (no horizon agency introduced)
- Solution-space / initial-data counting (no new free functions)

(Aligns with E0 equivalence standard for Starobinsky.)

E0 - Equivalence vs Enrichment ...

A0.3 Allowed Coarse-Grainings

- **Coarse-graining scale(s):** EFT cutoff / renormalization scale μ
- **Traced out / averaged over:** modes above μ , UV completion, higher-order operators beyond truncation
- **What must remain fixed:** conservation structure; qualitative inflationary regime; mechanism localization
- Coarse-graining is: **physical constraint** (EFT validity + scale separation), not arbitrary freedom

A0.4 Physical Equivalence Standard

Counts as “same physics” if:

- same background expansion history (within regime),
- same conserved quantities and identities,
- same DOF counting / no added free functions,
- same causal ordering (no new nonlocal agents).

A0.5 Symmetry Commitments

- Diffeomorphism invariance
- Lorentz invariance: local (as in GR/EFT)
- Gauge symmetries: N/A beyond diffeos
- Symmetry status: exact within EFT assumptions

A0.6 Conservation Commitments

- Energy–momentum conservation (covariant)
- Probability/unitarity (classical gravity + QFT on curved spacetime regime; if you want to include it, declare regime): _____
- Charge conservation (if matter sector included): _____

A0.7 Causal Structure

- Local light-cone causality
- Horizons are: **boundaries only / bookkeeping constructs**
- No horizon-mediated agency permitted

A0.8 Well-Posed Evolution

- Initial data: FRW initial conditions + scalaron initial data in Einstein frame (equivalently curvature initial conditions in Jordan frame)
- Evolution: field equations from action; no auxiliary closure

- Breakdown/exit criteria (regime): end of slow-roll / transition to reheating (may be scope-limited): _____

A0.9 Explicit Non-Equivalences

Not allowed as “same physics”:

- Introducing arbitrary time-dependent functions $w(t)$, $\Lambda(t)$, or tuned exchange terms
- Adding smoothing/averaging purely to stabilize $w \approx -1$
- Promoting horizon definitions to dynamical inputs
- Extending beyond EFT control without tagging as conditional

A0.10 Admissibility Acknowledgment

By submitting this, the audit:

- judges only within the declared regime,
- treats effects that vanish under declared admissible variations as descriptive,
- forbids post-hoc freedoms.