Diagnostic Results from Conservation-Honest Audits of Inflation-Adjacent Early-Universe Models

Abstract

This work reports diagnostic outcomes obtained by applying the Cosmological Explanation Diagnostic Audit (CEDA), a conservation-honest framework designed to distinguish genuine dynamical mechanisms from descriptive reinterpretations in early-universe cosmology. CEDA does not propose a cosmological model, introduce new degrees of freedom, or adjudicate the observational adequacy of inflationary ΛCDM. Instead, it enforces explicit accounting of active degrees of freedom, system–environment partitions, exchange terms, and coarse-graining stability in effective early-universe descriptions.

When applied to a representative set of constructions—including a canonical horizon-mediated null control, established inflationary mechanisms, and horizon- or entropy-driven proposals—a consistent diagnostic pattern emerges. Horizon-only and accessibility-based constructions fail to generate sustained accelerated expansion under conservation-honest accounting. When admissible variations in coarse-graining and horizon definition are enforced, such models retain radiation-like behavior or exhibit order-unity instability. Inflation-like behavior appears only when additional structure is introduced implicitly through tuned accessibility weights, privileged coarse-graining choices, or outcome-stabilizing exchange terms, at which point the construction reduces to inflation mimicry rather than a novel mechanism.

By contrast, inflationary models that introduce explicit dynamical structure—such as propagating scalar degrees of freedom or higher-curvature terms—produce negative pressure that remains robust under admissible reformulation and pass all relevant diagnostic tests. In cases where no admissible interior effective description remains stable, CEDA records a Causal Description Transition, indicating descriptive non-existence rather than physical pathology. These results demonstrate that conservation discipline and coarse-graining stability provide a sharp, reproducible boundary between mechanism-level physics and bookkeeping-dependent reinterpretation in early-universe modeling.

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1. Introduction

Early-universe cosmology contains a wide variety of constructions that reproduce inflation-like expansion histories. In many cases, however, the physical provenance of the accelerating

behavior is not made explicit. Horizon reweighting, entropy-based language, effective stress–energy insertion, and privileged coarse-graining choices are frequently employed to reinterpret otherwise radiation-like dynamics as sources of accelerated expansion. While such constructions may be algebraically consistent, their explanatory status often remains ambiguous.

The purpose of the Cosmological Explanation Diagnostic Audit (CEDA) is to address this ambiguity. CEDA is a diagnostic framework, not a cosmological model. It introduces no new dynamics and does not compete with inflationary ΛCDM. Its sole function is to audit early-universe proposals by enforcing conservation-honest accounting and by distinguishing intrinsic dynamical mechanisms from descriptive bookkeeping.

CEDA asks a narrow but decisive set of questions:
Where does the claimed dynamics reside?
Which degrees of freedom are genuinely dynamical, and which are descriptive?
Does the accelerated behavior survive admissible reformulation, or does it rely on privileged representation?

This work presents results from a sequence of CEDA audits applied to inflation-adjacent proposals. The goal is not to rank models by observational success, but to clarify the mechanism-level content of the constructions themselves.

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2. Diagnostic Framework Overview

CEDA operates through a structured audit protocol consisting of a Run Validity Gate followed by a sequence of diagnostic tests. The protocol requires explicit declaration of:

- active degrees of freedom and their dynamical roles
- system–environment partitioning
- exchange terms and conservation laws
- coarse-graining prescriptions and horizon definitions

The diagnostic tests are applied in a fixed order and admit no post-hoc reinterpretation after verdict assignment.

2.1 Run Validity Gate

The Run Validity Gate enforces minimal physical admissibility. Models must supply a closed accounting of stress–energy, specify how exchange terms arise, and demonstrate consistency under admissible reformulation. Constructions that fail at this stage are not evaluated further.

2.2 Diagnostic Tests

The diagnostics applied in this work include:

- **D1: Horizon Reconfiguration Null Test**
  Evaluates whether horizon evolution alone can generate negative pressure without additional structure.

- **D2: Coarse-Graining Stability Test**
  Tests whether effective behavior is invariant under admissible changes in coarse-graining or slicing.

- **D3: Exchange Term Provenance Test**
  Determines whether effective stress–energy arises from physical exchange or descriptive reassignment.

- **D4: Mechanism Audit**
  Assesses whether the construction contains intrinsic dynamical structure capable of sourcing accelerated expansion.

A classification layer is used to distinguish stable mechanisms, conditional mechanisms, and descriptive failures.

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3. Baseline and Calibration Cases

3.1 Horizon-Mediated Null Control

A canonical null control is constructed in which horizon evolution and accessibility reweighting are permitted, but no new dynamical degrees of freedom are introduced. Under D1 and D2, this construction retains radiation-like behavior. No sustained negative pressure emerges, and any apparent acceleration depends on representational choices rather than physical exchange.

This null result establishes that horizon reconfiguration alone does not constitute a mechanism for accelerated expansion.

3.2 Inflationary Calibration Models

Standard slow-roll inflationary models and higher-curvature inflationary constructions are used as calibration cases. These models introduce explicit dynamical structure—propagating scalar fields or curvature-driven terms—that source negative pressure at the level of the action.

Under all diagnostics, these constructions remain stable. Accelerated expansion persists under admissible reformulation, and exchange terms are physically grounded. These cases define the benchmark for a genuine mechanism under CEDA.

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4. Diagnostic Results: Inflation-Adjacent Proposals

4.1 Horizon- and Entropy-Driven Constructions

A class of proposals attributes inflation-like behavior to horizon thermodynamics, entropy maximization, or accessibility weighting. Under D1, these constructions fail to generate negative pressure without additional structure. Under D2, effective acceleration proves unstable with respect to coarse-graining choice. Under D3, apparent stress–energy terms are traced to descriptive reassignment rather than physical exchange.

In all audited cases, sustained acceleration appears only after the introduction of tuned accessibility weights or privileged slicing. These additions functionally reintroduce inflationary dynamics under alternative language.

4.2 Exchange-Stabilized Effective Descriptions

Some constructions introduce effective exchange terms that stabilize accelerated behavior. When the provenance of these terms is examined, they are found to encode hidden reservoirs or retrospective bookkeeping choices. Under D4, no independent dynamical mechanism is identified.

These constructions are classified as descriptive inflation mimicry rather than novel mechanisms.

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5. Causal Description Transitions

In several audits, no admissible interior effective description remains stable once conservation-honest accounting is enforced. In such cases, CEDA records a **Causal Description Transition (CDT)**. A CDT indicates that the descriptive framework fails to correspond to a stable physical system under the declared constraints. It does not imply physical inconsistency or observational falsification, only descriptive non-existence at the effective level.

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6. Interpretation and Scope

The diagnostic outcomes reported here do not challenge the empirical success of inflationary ΛCDM. They clarify why inflationary models require genuine dynamical structure to function. Constructions that rely on horizon reweighting, entropy language, or coarse-graining privilege do not supply such structure and therefore fail under conservation-honest audit.

CEDA does not rank models by plausibility or correctness. It distinguishes mechanisms from reinterpretations. The interpretation of these distinctions is left to the broader theoretical community.

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7. Conclusion

Across all audited cases, a consistent boundary emerges. Accelerated expansion survives conservation-honest accounting only when sourced by explicit dynamical structure. Horizon-only, entropy-based, and accessibility-weighted constructions fail to generate inflation-like behavior without importing such structure implicitly.

These results demonstrate that conservation discipline and coarse-graining stability provide a sharp diagnostic separation between mechanism-level physics and descriptive bookkeeping in early-universe modeling. CEDA formalizes this separation as an audit procedure, enabling reproducible, interpretation-free evaluation of inflation-adjacent proposals.

Version Note

This draft reflects **CEDA v1.3 narrative alignment**, with no changes to diagnostic protocol, tests, or verdict criteria relative to v1.2.