AUDIT 009 - DIAGNOSTIC CARD

Paper: *On Average Properties of Inhomogeneous Fluids in GR I*
Author: Thomas Buchert
Audit Context: Division 1 — Backreaction / Averaging
CEDA Version: v1.2 (frozen)

On Average Properties of

Diagnostic Set Applied

By protocol for this class of model:

- **D2 — Coarse-Graining Stability Test** ✅ REQUIRED
- **C1 — Functional Redundancy / Free-Function Test** ✅ REQUIRED
- **D1 — Null Baseline** ❌ NOT APPLICABLE (no horizon/entropy agency claimed)
- **D3 / D4** ❌ NOT APPLICABLE at this stage (no explicit novelty beyond averaging)

D2 — Coarse-Graining Stability Test

D2.a Definition (CEDA)

A model passes D2 if its claimed physical effect is invariant (or convergent) under admissible variations of coarse-graining scale, domain choice, and averaging prescription **within its declared regime**.

D2.b Application to Buchert (2000)

Declared structure:

- Averaging performed over arbitrary compact comoving domains
- Effective dynamics explicitly **domain-dependent**
- No claim of scale invariance or convergence
- No privileged averaging scale identified

Observed behavior:

- $aD(t)$aD(t), $QD(t)$QD(t), and $\langle R\rangle D(t)$⟨R⟩D(t) change with:
  - domain size
  - domain shape
  - domain location
- The formalism allows:
  - FRW-like behavior for some domains
  - strong deviations for others
- No mechanism is provided to select a physically preferred coarse-graining

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D2.c Result

D2 Outcome: ⚠️ CONDITIONAL FAIL (By Design)

Reason:
The paper does *not* claim coarse-graining stability—and explicitly acknowledges domain dependence. The effect therefore **does not survive scale variation** as a universal physical mechanism.

CEDA Interpretation:
This is **not an error**. It is a **structural limitation**: the effect is descriptive and scale-relative, not globally dynamical.

C1 — Functional Redundancy / Free-Function Test

C1.a Definition (CEDA)

A model fails C1 if its effective dynamics can be reparameterized as an arbitrary function of time (e.g., an effective $w(t)$w(t)) without new predictive constraints, indicating descriptive relabeling rather than mechanism.

C1.b Application to Buchert (2000)

Key object under test:
Backreaction scalar $QD(t)$QD(t)

Properties:

- Defined as a variance aggregate of expansion and shear
- Not governed by an independent evolution equation

- Coupled to $\langle R \rangle D$⟨R⟩D via an integrability condition
- System remains **underdetermined** without extra assumptions

Critical observation:

- Choosing a functional form for $QD(t)$QD(t) (or equivalently $\langle R \rangle D(t)$⟨R⟩D(t)) **closes the system**
- Different closures yield different effective expansion laws
- These choices are external to the formalism

C1.c Result

C1 Outcome: ❌ FAIL — FUNCTIONAL REDUNDANCY

Reason:
Absent a closure principle, $QD(t)$QD(t) functions as a **free effective source**, capable of mimicking multiple expansion histories without additional physical DOF.

CEDA Classification:

> Descriptive freedom, not earned dynamics

Diagnostic Summary Table

Diagnostic	Result	Notes
D2 — Coarse-Graining Stability	⚠️ Conditional Fail	Domain dependence explicit
C1 — Functional Redundancy	❌ Fail	Underdetermined effective source
D1 — Null Baseline	N/A	No forbidden agency
D3 / D4	N/A	No novel mechanism claimed

Verdict (CEDA v1.2 Language)

Final Classification:

Reinterpretation — Scale-Dependent Bookkeeping Framework

Meaning (precise):

- The paper provides a **mathematically consistent averaging formalism**
- It does **not** supply a closed physical mechanism for modified expansion
- Apparent dynamical effects arise from **coarse-grained variance reorganization**
- No violation of conservation, locality, or GR is identified

This is a **clean, non-pathological failure**: the framework does what it says, but what it says is *descriptive*, not mechanistic.