

Testing a Multilevel Oscillatory Hierarchy

A Finite-Work Toy Model, Negative Results, and Open Physical Bridges

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Abstract

Earlier work introduced a multilevel oscillatory hierarchy (MOH) as a conceptual architecture in which a lower cosmological order may collapse and renew from a history-bearing residue while a higher-order sector continues along its own trajectory. Here we test that architecture with a staged finite-work toy model. The construction does not yield a physically closed or predictive cosmological renewal model. The R channel carries the working concept of inherited sensitivity: prior history can change the later realized response of an otherwise comparable residue. In the tested model, history-correlated residue changes first-passage accessibility relative to matched shuffle controls. Within an expanded-state description, however, the implemented inherited sensitivity is representable as history-dependent hidden-state dynamics; the present test therefore does not establish independent physical content or predictive superiority for the R/H decomposition, and its physical carrier and readout law remain open. Within the chosen reciprocal-energy/positive-mobility model class, a reciprocal higher-order/formation functional generates formation work dynamically and satisfies an exact work identity. A scale-free relational map from premetric proto-organization to a traceless homogeneous shape variable provides a conditional candidate for newborn intrinsic geometry, with dimensionality and coframe promotion kept explicit as assumptions. When a positive homogeneous geometry burden is inserted into the same common work account, the predeclared strict no-retuning gate fails at every tested positive load at the frozen formation thresholds. This rejects the tested friction-like homogeneous-geometry bridge, not geometry emergence in general. No mechanism is obtained that generically produces a low-Weyl cosmological initial state: the homogeneous construction remains conditional and the inhomogeneous low-Weyl extension remains blocked. Subsequent normalization and stress-closure audits show that direct canonical continuation of the higher-order coordinate into the newborn scale factor fails, already-accounted higher-order work cannot be spent again, and the post-emergent mean stress required for accelerated expansion remains undetermined. The paper therefore reports a controlled model-development attempt, preserving both consistency checks and negative results, and identifies the independent physical bridges that would be required before stronger cosmological claims are justified.

Keywords: multilevel oscillatory hierarchy; cosmological renewal; inherited sensitivity; nonequilibrium self-organization; emergent geometry; Weyl curvature; backreaction; dynamical accessibility; stress-energy closure

Results at a glance

Component	Status	What this paper establishes
Reciprocal finite-work formation	PASS	Within the chosen reciprocal-energy/positive-mobility model class, the work identity closes and backreaction is explicit; no cosmological carrier is established.
History-sensitive R/H readout	CONDITIONAL	History-correlated residue changes accessibility relative to matched controls, but the implementation is representable as hidden-state dynamics in an expanded state space.
Homogeneous intrinsic-shape map	CONDITIONAL	W2 gives a scale-free volume/shape separation; three-dimensionality, coframe promotion and physical normalization remain assumptions.
Positive geometry-load proxy	FAIL	Every predeclared positive friction-like load fails the frozen T1.1 persistence gate; this rejects that proxy bridge only.
Direct $q_H \rightarrow \alpha$ continuation	FAIL	The naive canonical identification encounters the wrong kinetic sign and is not a licensed emergence map.
Trace/stress closure	OPEN	Current provenance does not determine the trace normalization, p_E/w_E or the boundary volume-response Jacobian.
W3 / acceleration prediction	BLOCKED	The inhomogeneous low-Weyl extension and numerical acceleration gate await independent normalization and post-E* constitutive stress-energy.

1. Scope and Relation to Previous Work

The broader idea of inherited dynamical sensitivity was introduced in the Principle of Dynamical Sensitivity framework [1] and developed cosmologically in the second edition of the MOH essay [2]. The subsequent article *Must an Ordered Cosmological Beginning Be History-Free?* [3] recast that concept into two analytically separable channels—a history-bearing residue R and a continuing higher-order state H —and framed the model burden against Penrose’s low-gravitational-entropy/Weyl-curvature problem [4]. It left the low-Weyl initial state and complete cosmological dynamics as open targets. Closely related quantitative mechanism classes already exist outside MOH: slow-passage memory near bifurcations [13], phase-dependent tipping in cyclic systems [14], state-encoded memory in matter [15], driven adaptive resonance [16], and non-adiabatic state selection during phase transitions [17]. MOH does not claim priority for those mechanisms. The specific question tested here is whether the stage-separated R/H renewal architecture yields useful calculable structure beyond generic history-dependent state-space dynamics.

The present paper does not present a physically closed cosmological theory. It reports a model-development attempt and the points at which that attempt succeeds as a mathematical construction, fails under frozen tests, or becomes blocked by missing physical relations. The earlier comparison with conformal cyclic cosmology, eternal inflation and other historically embedded beginnings remains in the conceptual article [3]. Here the focus is the sequence of constructions that turns the R/H architecture into a calculable model: why each construction is introduced, what it inherits from established physics, what is chosen as an ansatz, what follows from the equations, which outcomes are only consistency checks, and which negative results remain frozen.

1.1 Claim and provenance discipline

A compact provenance code is used throughout the derivation ledger. D denotes a result derived from the stated equations or a previous frozen output without fitting to the new outcome; I denotes an inherited quantity from an earlier model gate; P denotes a physically motivated form whose normalization or carrier is not yet independently derived; A denotes an ansatz or selected functional form; N denotes a normalization or convention; and F denotes outcome-dependent fitting, which is not accepted for a main claim. In addition, EXT marks equations imported from established external physics rather than derived by MOH. This distinction is essential once general relativity is introduced after emergence.

The status words PASS, CONDITIONAL, FAIL, OPEN and BLOCKED also have precise meanings. PASS means that a predeclared mathematical or numerical gate is satisfied inside the stated model class. For analytic control gates, PASS denotes internal consistency with the declared external equations or assumptions; it is not a claim of physical novelty or independent support for MOH. CONDITIONAL marks a construction that works but still depends on an unresolved carrier, sign, normalization or bridge. FAIL is preserved and is not erased by later retuning. OPEN denotes a missing physical relation. BLOCKED denotes a calculation whose prerequisite relation is missing; it is distinct from a failed physical hypothesis. Descriptive phrases such as “structurally underdetermined” or “not derived” are not additional statuses; when a required physical relation is absent, the status is OPEN.

Object	Source	Provenance	Role / limitation
Higher-order oscillator and reciprocal coupling	MOH model construction	A/P	Tests finite reciprocal work transfer; not a claim about a literal cosmological oscillator.
Positive-mobility gradient flow	Standard dissipative model class	EXT + A/N	Used as a coarse-grained relaxation law; no microscopic Onsager derivation is claimed [5–7].
Einstein/ADM equations after E*	General relativity	EXT	Used only after a newborn metric/time are assumed to exist [8,9].
Bianchi-I restriction	Homogeneous GR test class [10]	EXT + A/P	Used to isolate homogeneous anisotropic/shear structure before any inhomogeneous Weyl test; not a claim that the Universe is Bianchi I.
P→B→h shape map	MOH construction; standard matrix logarithm [11]	A/P	Conditional intrinsic shape map. Three relational directions, coframe promotion and physical normalization remain assumptions.
Null/reversal/shuffle tests	Diagnostic controls	N/control	Used to test whether an effect was inserted by construction or survives matched alternatives.
λ_g in the executed geometry gate	MOH coarse-grained stress bridge	A/N	Relative additional formation resistance in that bridge only; the positive scan is a frozen stress test, not a gravity-strength calibration.
C_g and $1/(16\pi G)$	Post-emergent geometry normalization	EXT + A/P	MOH/W1 fixes sign/quadratic structure only. Standard GR supplies $C_g=1/(16\pi G)$ after E*.
f_E and $\mathcal{M}_E$	Emergence matching	A/OPEN	Energy-completeness and invariant trace-normalization combinations. Neither is fixed by the active premetric dynamics.

2. Stage-Separated Ontology and Notation

2.1 Renewal sequence

The model distinguishes an organized lower order L_n , a continuing higher-order sector H, a transformed history-bearing residue R_n , an intermediate proto-organization P_{n+1} , and an emergence event E^* . The working sequence is

$$\begin{aligned} L_n(t_n) + H(\tau) &\rightarrow R_n(\tau) + H(\tau) \rightarrow \\ P_{n+1}(\tau) + H(\tau) &\rightarrow [E^*] L_{n+1}(t_{n+1}=0) + H(\tau) \end{aligned} \quad (1)$$

This equation is an ontology map, not a field equation. Its purpose is to prevent later mathematics from silently identifying variables that belong to different stages. L_n is allowed to cease as an organized lower-order regime. R_n is not the old geometry stored in latent form and is not an energy reservoir. It is a history-bearing state description whose energetic role, if any, must enter

through explicit potentials or interaction terms. H continues through the transition and therefore supplies the parameter τ used to describe pre-emergent evolution.

2.2 Clock separation

The old lower-order clock t_n terminates with L_n . During $R_n \rightarrow P_{n+1}$, the variables are parametrized by τ because H remains dynamical. This parametrization carries neither the old lower-order proper time nor a second lower-order time dimension. A new lower-order clock begins only after emergence through a local map

$$t'L = T(\tau; \tau_E), \quad T(\tau_E) = 0, \quad N_E = (dt'L/d\tau)|_{E^+} \quad (2)$$

The quantity N_E is therefore a post-emergent clock-rate bridge. It must not be extrapolated into the premetric interval or fitted as a hidden normalization. Constant rescalings of τ can change N_E and pre-emergent rates, so only reparametrization-invariant combinations may later carry physical meaning.

2.3 Premetric restrictions

Before E^* , the active lower-order model contains no physical spatial metric, proper distance, lower-order proper time, physical frequency or wavelength, scale factor $\alpha = \ln a$, Hubble rate, ADM extrinsic curvature, or Weyl curvature. Premetric variables may possess ordering, correlation, generalized phase, vector orientation, or dimensionless relational structure, but those quantities are not to be interpreted as already-existing lower-order spacetime observables.

This stage separation governs the later identifications. A higher-order coordinate q_H cannot simply be treated as the newborn scale factor, an old lower-order frequency is not transported through the transition, and ADM equations enter only on E^+ . The earlier mass-clock discussion motivated this separation; the model now uses it as a working rule.

2.4 Open physical inputs

The open physical inputs are the microscopic identity of H , the physical carrier of R , the number of independent relational directions in P , the mechanism establishing E^* , and the map from emergence energy to a post-emergent stress-energy tensor. The model tests which of these can be constrained by finite-work dynamics and which require new physical input.

Reading rule: Whenever a later section uses an external equation, the text states the domain in which that equation is valid, the assumptions required for its use, and which variables are supplied by MOH. A reader should be able to replace or challenge any bridge without confusing it with a result derived inside the toy model.

3. Discriminating R/H Dynamics and Historical Accessibility

3.1 Trigger, endogenous collapse, and first-passage accessibility

Section 3 records the minimum genealogy needed to motivate the later finite-work model. A1 showed that a history-dependent residual stability threshold can be crossed after a prescribed release of higher-order load, although the direction of the effect was partly built in by the chosen positive load and H -dependent gain; a sign-neutral control also admitted reverse transitions. A2 removed the prescribed collapse schedule and introduced an old- L order parameter x , an internal support q_A , a continuing higher-order amplitude h and a residual state r . The historical A2 symbols are relabelled here as q_A and κ_A to avoid collision with the later T -branch q and κ :

$$\begin{aligned} dx/d\tau &= x[q_A - q_c - \kappa_A h^2 + x^2 - x^4], \\ dq_A/d\tau &= -\varepsilon x^2 q_A, \\ dh/d\tau &= P - \gamma h - \beta h^3 - \sigma x^2 h, \\ dr/d\tau &= [-I + (g_0 + g_1 h)]r - \lambda ||r||^2 r + \xi \end{aligned} \quad (3)$$

The strict A2 trigger required R to remain stable throughout the pre-collapse interval and to become persistently unstable only after the endogenous collapse of x. Directed and symmetric ensembles produced $26/10,074 = 0.258\%$ and $34/10,074 = 0.338\%$ strict triggers respectively, while the skew control produced none. Removing the old-L load on H ($\sigma=0$) or the H-dependent residual gain ($g_1=0$) removed the trigger, and suppressing depletion ε largely removed endogenous collapse. The construction therefore retained an R/H-dependent existence region without a prescribed schedule. Robustness was poor: under 10% scalar perturbations at fixed J, strict-trigger retention averaged about 14–15%, and no trigger case retained at least 50%. A2 is an existence PASS and a robustness/genericity FAIL, so its role is an existence result rather than a universal collapse law.

The robustness failure changed the diagnostic. A2b held the residue fixed and tested whether recurrent H dynamics could reach and dwell in the trigger region. If α_R is the instantaneous residual growth indicator, define

$$T_R = \{H: \alpha_R(H) > 0.05\}, \quad \tau^* = \inf\{\tau: H(\tau) \text{ remains in } T_R \text{ for } \Delta\tau_{\text{dwell}}\} \quad (4)$$

In the recorded toy dynamics the static threshold corresponded to an approximately 15.5% drive increase. Slowly or moderately varying periodic H reached the trigger region for amplitudes around $A \approx 0.16$ –0.20, whereas faster motion required more amplitude. A near-threshold quasiperiodic case with $A=0.16$ occupied the trigger region for less than 1% of the time but every tested initial phase reached it by $\tau=1000$ and returned repeatedly; $A=0.15$ produced no trigger even in the long run. Thus a thin instantaneous basin can remain dynamically accessible, but eventual triggering is not guaranteed. Accessibility depends on the H attractor, crossing speed and dwell time.

3.2 History-bearing residue and matched controls

A2c and its bounded-remix extension then tested whether history can change future accessibility without merely increasing the total coupling strength. A realized proto-state P_n was allowed to leave a correlated trace in the residual coupling structure J_n , while a bounded H-dependent orthogonal remix U_n could change orientation. The Frobenius norm was held fixed by the normalization operator $\mathcal{N}_F$:

$$J_{n+1} = \mathcal{N}_F[U_n((1-\rho)J_n + \rho S(P_n))U_n^T] \quad (5)$$

This construction made the discrimination test explicit. In the no-memory control, trigger occupancy remained near 2.1% and median first-passage time did not shorten systematically. With concordant memory at $\rho=0.08$, median occupancy rose from about 2.1% to 8.3% by cycle 5, 16.5% by cycle 10 and about 26% by cycle 19. A shuffled update of comparable magnitude did not reproduce that trend, while anti-correlated memory rapidly destroyed accessibility. The later bounded-remix variant kept the residue norm finite but did not independently derive a natural saturation law. These numbers are model diagnostics, not physical probabilities.

Within this model, inherited sensitivity has an operational meaning. Two trials may share the same selected macroscopic state, subsequent higher-order forcing and residual norm, yet differ in how a history-formed residual orientation is paired with the current context. That history-dependent pairing can change future first-passage accessibility inside the declared ansatz. This is a CONDITIONAL realization of inherited sensitivity at the model level, used in continuity with the conceptual lineage [1–3]. Because the orientation/coupling state is itself part of an enlarged state description, the same dependence can in principle be represented as generic hidden-state dynamics. The present test therefore establishes operational distinguishability from matched controls, not predictive superiority of the R/H decomposition over an unrestricted expanded-state model. A stronger claim would require an independently motivated carrier/update law or a demonstrated reduction, compression or prediction unavailable to the generic baseline. The

physical carrier of R, the update law, its sign and its energetic cost remain open, so the result supplies no microscopic or universal inheritance law.

3.3 Finite source and transition to explicit work accounting

The accessibility models still lacked a sufficiently explicit source ledger. A3 replaced the phase-only higher-order backreaction by a finite excitation reservoir $\mathcal{E}_H$. Existing old-L order loads that reservoir through x , and a realized formation event may deplete it:

$$d\mathcal{E}_H/d\tau = P_{in} - \gamma_E \mathcal{E}_H - \Lambda x^2 \mathcal{E}_H, \quad \mathcal{E}_H^+ = \mathcal{E}_H^- - \Delta\mathcal{E}_{event} \quad (6)$$

Cycle-by-cycle bookkeeping closed numerically at approximately 10^{-11} in the recorded runs, and the dual/H-only event removed a median of about 29% of the available excitation. The resulting two-channel model admitted bounded selective evolution instead of the earlier runaway accessibility. The event-depletion rule $\Delta\mathcal{E}_{event}$ was still prescribed rather than derived from a reciprocal common functional. A3 therefore PASSES as finite-source accounting and FAILS as a derivation of the event drain law. Its historical event-work value is not carried forward as a reusable expansion or geometry budget.

A3b supplied the other side of that event transfer as a deliberately coarse-grained formation/free-energy test. It used

$$\Phi_L(y) = K[1/2 y^2 - (b/3)y^3 + 1/4 y^4] \quad (7)$$

with positive-mobility driven relaxation

$$\dot{y} = M[f - \partial\Phi_L/\partial y], \quad T\sigma = M[f - \partial\Phi_L/\partial y]^2 \geq 0 \quad (8)$$

and the event ledger

$$\Delta\mathcal{E}_H = \Delta\Phi_R + \Delta\Phi_L + T\Sigma_{form} + Q_{direct}, \quad \Delta\Phi_R = c_{mem} V_R^2 \quad (9)$$

For the inherited baseline $c_{mem}=4$ and $V_R \approx 0.1681$, the memory free-energy cost is approximately 0.113. Event work 0.224 failed to form the new state in all three tested branches; 0.448 crossed the barrier even in the stored-order branch; 0.672 left a larger dissipation/export channel. In the conservative stored-order example, 0.448 was decomposed approximately as 0.113 memory cost + 0.114 stored lower-order free energy + 0.170 formation dissipation + 0.051 direct heat. Negative mobility is a thermodynamically inadmissible control. A3b therefore gives a CONDITIONAL existence result in which finite formation work, explicit memory cost and non-negative entropy production coexist. Its scope is thermodynamic compatibility within the toy assumptions; the effective bath, free-energy functional and numerical event scale remain model inputs.

The remaining deficit defines the transition to Section 4. A3/A3b establish the need for a finite source, backreaction, a dissipative formation path and an explicit memory-energy scale, while the event transfer itself is still prescribed. Section 4 replaces that event budget by a reciprocal common functional in which the work is generated dynamically.

4. Reciprocal Finite-Work Formation

4.1 Why a reciprocal carrier is needed: T0

A3/A3b showed that finite work can drive a lower-order formation coordinate across a barrier, while the driving pulse remained externally prescribed. T0 tests the minimum reciprocal mechanical structure in which H acts as a finite dynamical source, changes state when work is transferred, and shares one energy account with a proto-lower coordinate and their interaction.

T0 represents the two channels by generalized coordinates q_H and q_P in a reciprocal compression/storage normal form parametrized by τ . No spatial tube interpretation is assigned to these coordinates. The model chooses

$$L = (M_H/2)\dot{q}_H^2 + (M_P/2)\dot{q}_P^2 - V_H(q_H) - \Phi_P(q_P) - U(\Delta) \quad (10)$$

$$\Delta = q_P - c q_H, \quad U(\Delta) = (\kappa/2)\Delta^2 \quad (11)$$

Together with a Rayleigh-type dissipation function $R_{\text{diss}} = (\gamma_H/2)\dot{q}_H^2 + (\gamma_P/2)\dot{q}_P^2$, the equations of motion are

$$M_H \ddot{q}_H + \gamma_H \dot{q}_H + V'_H(q_H) - cU'(\Delta) = F_H(\tau) \quad (12)$$

$$M_P \ddot{q}_P + \gamma_P \dot{q}_P + \Phi'_P(q_P) + U'(\Delta) = 0 \quad (13)$$

The important point is not the quadratic coupling itself; that is an ansatz. The important bookkeeping correction follows from treating U as part of the state. Defining the two directed interaction powers

$$J(H \rightarrow \text{int}) = -cU'(\Delta)\dot{q}_H, \quad J(\text{int} \rightarrow P) = -U'(\Delta)\dot{q}_P \quad (14)$$

$$dU/d\tau = J(H \rightarrow \text{int}) - J(\text{int} \rightarrow P) \quad (15)$$

$$d(E_H + E_P + U)/d\tau = F_H \dot{q}_H - \gamma_H \dot{q}_H^2 - \gamma_P \dot{q}_P^2 \quad (16)$$

Thus an instantaneous loss from H need not equal an instantaneous gain by P . The interaction can store and later return energy. A direct $\pm J$ bookkeeping is valid only as a reduced description over intervals in which the change of interaction energy is negligible. Conservative numerical controls closed the energy balance to approximately 1.8×10^{-10} , and an equal-energy phase scan produced both H -loss and H -gain cases. T0 therefore rejects automatic one-way suction while retaining reciprocal work exchange as a viable model class.

4.2 T1: replacing the external formation force by H

T0 tests the carrier but not the documented formation barrier. T1 replaces the placeholder proto-potential by the A3b formation normal form and asks whether the same reciprocal coupling can generate the event work that A3b had supplied externally. The selected potentials are

$$V_H(q) = \frac{1}{2}q^2 + (\beta_H/4)q^4, \quad \beta_H = 0.05 \quad (17)$$

$$\Phi_b(y) = \frac{1}{2}y^2 - (b/3)y^3 + \frac{1}{4}y^4 \quad (18)$$

$$U_{\text{int}}(q, y) = -\kappa q y \quad (19)$$

Here q is the T0 higher-order carrier, y is a scalar formation coordinate, b controls the shape of the metastable formation potential, and κ is the reciprocal coupling strength. The forms are model assumptions; β_H , b and κ are not presented as cosmological constants. The coupling $-\kappa q y$ is the lowest-order bilinear term used in this model that vanishes when either channel is absent.

The total model energy is

$$E = \frac{1}{2}\dot{q}^2 + V_H(q) + \Phi_b(y) - \kappa q y \quad (20)$$

and the mixed conservative/dissipative dynamics are

$$\ddot{q} = -\partial E / \partial q, \quad \dot{y} = -M_y \partial E / \partial y, \quad M_y > 0 \quad (21)$$

The q sector is conservative, whereas y follows positive-mobility gradient flow. This law is used as a coarse-grained representative of the broad Onsager/gradient-system family [5–7], without assuming a microscopic Onsager derivation for MOH. The numerical T1 gate used the dimensionless normalization $M_y = 1$. With that normalization,

$$dE/d\tau = -\dot{y}^2 \leq 0 \quad (22)$$

More generally the same equations give $dE/d\tau = -\dot{y}^2/M_y$. This matters because the later N0.1 audit showed that mobility changes the numerical κ threshold. The published κ values must therefore be read as protocol-specific thresholds, not physical predictions.

The work delivered through the reciprocal term is

$$W(H \rightarrow P; \tau) = \int \kappa q \dot{y} d\tau \quad (23)$$

$$W(H \rightarrow P) = \Delta \Phi_b + \int \dot{y}^2 d\tau = -\Delta(E_H + U_{\text{int}}) \quad (24)$$

Equation (24) is the main T1 result. Formation work is generated by the state of H and the reciprocal interaction; it is not inserted as a prescribed event budget. The same coupling that drives y also depletes the H-plus-interaction source. A control in which backreaction was removed did not satisfy the corresponding source-energy identity, so reciprocal backreaction is required for closure inside this model class.

T1 branch	$\kappa 50$	persistent phases	median generated work
stored-order	0.40	83.3%	0.633
near-degenerate	0.40	95.8%	0.600
renewal-favored	0.35	91.7%	0.471

The open region above $\kappa 50$ establishes existence within the defined toy model. The frozen T1 scan sampled 24 initial H phases at equal initial H energy and scanned κ in increments of 0.05; the reported persistence percentages are therefore discrete phase fractions rather than continuous probabilities. The physical coupling scale remains open because the microscopic carrier and dimensional normalization of q and κ are not yet fixed.

4.3 T1.1: memory inside the same work budget

T1.1 brings the previously estimated R-memory cost into the same common functional by introducing a dynamical memory coordinate r . The inherited memory cost is preserved rather than reduced to favor formation.

$$s = y/y_{\text{org}}, \quad \Phi_R(r) = c_{\text{mem}} r^2 \quad (25)$$

$$U_{\text{mem}}(r, s) = (k_R/2)(r - A_R s)^2 \quad (26)$$

The baseline uses $c_{\text{mem}}=4$, $V_R=0.1681$ and $k_R=2c_{\text{mem}}=8$. A_R is not fitted to T1.1 success. It is fixed so that the minimum reversible memory energy at $s=1$ equals the inherited A3b lower-bound cost $c_{\text{mem}} V_R^2=0.11303044$, giving $A_R=0.237729$.

$$E = \frac{1}{2}q^2 + V_H(q) + \Phi_b(y) - \kappa q y + \Phi_R(r) + U_{\text{mem}}(r, s) \quad (27)$$

$$\ddot{q} = -\partial E/\partial q, \quad \dot{y} = -M_y \partial E/\partial y, \quad \dot{r} = -M_r \partial E/\partial r \quad (28)$$

For the frozen numerical gate $M_y=M_r=1$, so

$$dE/d\tau = -\dot{y}^2 - \dot{r}^2 \quad (29)$$

$$W(H \rightarrow PR) = \Delta \Phi_b + \Delta E_{\text{mem}} + \int \dot{y}^2 d\tau + \int \dot{r}^2 d\tau \quad (30)$$

The numerical residuals of the total energy, work decomposition and source-depletion identities were all below 7×10^{-10} in the recorded scan. More importantly, the old T1 thresholds were frozen before the memory coordinate was activated. At those exact thresholds the persistence criterion failed in all three branches. Memory is therefore not a cost-free decoration of the T1 result.

branch	frozen T1 $\kappa 50$	T1.1 persistence there	shifted T1.1 $\kappa 50$	persistence at shifted $\kappa 50$
stored-order	0.40	0.0%	0.50	75.0%
near-degenerate	0.40	0.0%	0.45	79.2%
renewal-favored	0.35	16.7%	0.40	87.5%

Recomputing κ for the stricter model produces a nearby open region, while the frozen-threshold failure remains unchanged. The T1.1 gate retained the same 24-phase sampling protocol used in T1. T1.1 therefore gives an energetically closed existence region and, simultaneously, a frozen

failure of the original T1 threshold prediction once memory cost becomes dynamical. Later mobility audits further identify the $\kappa 50$ values as model-protocol diagnostics rather than dimensionful physical predictions.

4.4 T1.2: testing structured history beyond memory magnitude

T1.1 contains only a scalar memory coordinate and therefore cannot distinguish two residue states with equal stored memory energy but different history-formed orientation. T1.2 adds a low-rank orientation u while keeping the scalar memory-energy channel unchanged. The gate is explicitly discriminating: history and shuffle contain the same unit vectors and norms; only their pairing with the current H context differs.

$$a = h_{\text{current}} \cdot u_{\text{inherited}} \quad (31)$$

$$U_{\text{orient}} = -\chi s a, \quad \chi = c_{\text{mem}} V_{\text{R}}^2 = 0.11303044 \quad (32)$$

The magnitude χ is inherited from the already declared memory-energy scale, not fitted to T1.2. In the source test the inherited orientation is quasi-static during one formation event. The source test used 64 neutral initial two-phase contexts. Under the source-anchored timing, history-correlated memory shifted $\kappa 50$ by $+0.05$ relative to the matched shuffle in all three branches. Forty independent shuffle permutations preserved the memory vectors and norms; $\chi=0$ removed the distinction; reversing the sign of χ reversed the directional effect. The retained $\kappa 50$ scan is grid-resolved at 0.05 increments, so the repeated $+0.05$ difference establishes a consistent directional shift at the resolution of the scan, not a continuous effect-size estimate. A refined interpolation or interval estimate belongs to the reproducibility extension and is not claimed here. The result establishes operational distinguishability inside the ansatz, while the physical sign and microscopic form of the $R \times H$ readout remain open.

4.5 Current minimum after the orientation-energy audit

The quasi-static T1.2 readout leaves the energy cost of writing or rotating orientation unresolved. Later tests introduced a larger interaction-storage sector and then removed variables that were not required by the surviving model. The present active minimum promotes the orientation angle θ to a dynamical coordinate without introducing a separate reusable work reservoir:

$$E_{\text{active}} = E_{\text{T1.1}} - \chi s \cos \theta \quad (33)$$

$$p\theta = \chi s \sin \theta, \quad \theta = -m\theta p\theta \quad (34)$$

$$dE_{\text{active}}/d\tau = -\dot{y}^2 - \dot{r}^2 - m\theta p\theta^2 \quad (35)$$

This is the current finite-work backbone used before the post-emergent geometry and normalization audits. A more elaborate reversible storage coordinate z was tested and is frozen as an optional side branch because no current formation or geometry deficit requires it. The active model therefore retains only the degrees of freedom required by demonstrated deficits.

Section 4 status: What is robust here is not the physical identity of q , y , r or θ . It is the bookkeeping structure: finite source, reciprocal interaction, explicit storage, positive dissipation, backreaction, and preserved no-retuning failures. Microscopic carrier and dimensional calibration remain OPEN.

5. Candidate Emergence Geometry

5.1 Geometric bridge and post-emergent use of GR

The earlier W0 blind-null test showed that history-selection alone does not bias an independently generated geometry toward a smoother state: across the blind maps, the history-selected ensemble remained centered close to the random control. The result rules out history alone as a low-Weyl mechanism and makes an explicit geometric bridge necessary. In that null construction, candidate

geometry was generated independently of the history-selected P state, so any low-Weyl bias would have had to arise from history selection alone.

General relativity enters here as an external post-emergent framework. The premetric MOH interval contains no lower-order spatial metric, ADM foliation, extrinsic curvature, Hubble rate or Weyl tensor. Once E^* establishes a newborn metric and lower-order clock, standard 3+1/ADM geometry can test whether candidate initial data have the sign and quadratic structure required by general relativity [8,9]. The low-Weyl target follows Penrose's restriction of free gravitational degrees of freedom at the beginning [4]; it is used here as a geometric target rather than as a claim that the model supplies a complete or uniquely defined gravitational-entropy functional. GR is marked EXT throughout, and the Einstein equations and the coefficient $1/(16\pi G)$ remain external inputs.

We begin with the spatially homogeneous Bianchi-I class [10]. This class removes spatial-curvature and gradient structure and separates the isotropic expansion/trace mode from homogeneous shear. It serves as the homogeneous anisotropy gate. Because Bianchi I removes spatial inhomogeneity by construction, W1/W2 do not test Penrose's full low-Weyl problem; they are homogeneous precursor audits only. General inhomogeneous Weyl curvature belongs to the later W3 problem.

Convention: We write $K_{ij} = H h_{ij} + \sigma_{ij}$ with $\sigma^i_i = 0$. Reversing the overall sign convention for K_{ij} reverses H and σ together but leaves the quadratic combination used below unchanged.

5.2 W1: the homogeneous ADM sign and quadratic-form audit

For a newborn spatial metric h_{ij} , decompose the extrinsic curvature into its trace and traceless parts,

$$K_{ij} = H h_{ij} + \sigma_{ij}, \quad \sigma^i_i = 0, \quad K = 3H \quad (36)$$

so that simple contraction gives

$$K_{ij} K^{ij} - K^2 = \sigma_{ij} \sigma^{ij} - 6H^2. \quad (37)$$

The combination $K_{ij} K^{ij} - K^2$ is the kinetic combination appearing in the ADM form of the Einstein-Hilbert action [8,9]. Equation (37) fixes one limited but useful fact independently of the desired low-Weyl outcome: at fixed trace/volume mode, homogeneous shear enters quadratically with the opposite sign to the isotropic trace contribution. W1 uses this relative sign and quadratic dependence. The interpretation of σ^2 as a separately conserved positive gravitational energy is not assumed, and the GR normalization remains external to MOH. Here K_{ij} is the extrinsic curvature of newborn spatial slices; it is not an H/L shell or junction curvature.

Positive, zero and reversed-sign controls behaved in the expected directions throughout the W1 stress test. W1 therefore receives PASS status as a consistency check for the homogeneous ADM sign/quadratic-form bridge. The ADM identity itself is EXT; the PASS states only that the candidate bridge uses its sign and quadratic structure consistently. Its low-Weyl interpretation remains CONDITIONAL because Bianchi I contains homogeneous shear but no general tidal or inhomogeneous Weyl degrees of freedom.

5.3 W2: a scale-free relational map to newborn intrinsic shape

W1 supplies a post-emergent geometric criterion; W2 tests how premetric proto-organization P could provide newborn geometric data. Let $P \in \mathbb{R}^{(3 \times m)}$ collect three candidate relational directions over m features. The three-row choice matches the target three-dimensional spatial slice and remains an explicit emergence assumption.

The first object is the row Gram matrix

$$G = (1/m) P P^T. \quad (38)$$

If P has rank three, G is symmetric positive definite. Orthogonal relabelling of the feature columns leaves G unchanged, while an orthogonal change of the three-row basis maps G by conjugation. A global rescaling $P \rightarrow cP$ gives $G \rightarrow c^2G$, so amplitude scale can be removed before any geometric interpretation:

$$\bar{G} = G/(\det G)^{1/3}, \quad \det \bar{G} = 1. \quad (39)$$

W2 then uses the principal matrix logarithm [11] to define a symmetric traceless shape generator

$$B = (1/2) \log \bar{G}, \quad \text{Tr } B = (1/2) \log \det \bar{G} = 0. \quad (40)$$

For positive-definite $\bar{G}$ the principal logarithm is real and symmetric. Here it provides a one-to-one parametrization of positive-definite unit-determinant shape. At the newborn slice, the candidate intrinsic metric is

$$h_f = a_f^2 \exp(2B) = a_f^2 \bar{G}. \quad (41)$$

Hence $\det[\exp(2B)] = 1$ while $\det h_f = a_f^6$. The construction therefore separates shape from isotropic scale; it does not impose incompressibility or a fixed physical volume. Rank-deficient P is rejected by this map because it cannot produce a non-degenerate three-dimensional metric. This separation of an isotropic scale from traceless anisotropy is structurally analogous to the standard Misner parametrization of homogeneous cosmologies [19]; W2 does not inherit its dynamics from that parametrization.

To connect the static shape to the W1 shear test, W2 uses a minimal post-emergent shape turn-on parameter s . With $h(t) = a^2(t) \exp[2s(t)B]$ and B held fixed during the local test, the corresponding mixed-index extrinsic-curvature decomposition has the form

$$K^i_j = H \delta^i_j + \dot{s} B^i_j, \quad \sigma^i_j = \dot{s} B^i_j, \quad (42)$$

and therefore

$$\sigma_{ij} \sigma^{ij} = \dot{s}^2 \text{Tr}(B^2). \quad (43)$$

The normalization of $\dot{s}$ relative to the premetric parameter τ is not fixed by W2; this becomes the N0 clock/normalization problem. The promotion of the three relational rows to a spatial coframe is likewise an emergence-bridge assumption. W2 is therefore a CONDITIONAL as a scale-free intrinsic-shape map, with the physical dimensionality and normalization left explicit.

Within the restricted Bianchi-I class, the shear/Weyl relation is part of standard homogeneous GR kinematics [10,20]. The strong rank correlation between the homogeneous Weyl proxy C^2 and the shear selector in the tested ensembles is therefore expected as a consistency consequence of that restriction, not an independent second piece of evidence for a low-Weyl mechanism.

6. Integrated Homogeneous Geometry Test: A Frozen Negative Result

6.1 Coupling the geometry burden to T1.1

Section 6 tests whether the W1/W2 homogeneous burden can coexist with the last fully closed formation-and-memory account. T1.1 is used because its scalar memory cost is dynamical and its work identity closes exactly. T1.2 is outside this frozen gate because its multi-component orientation-writing cost had not yet been closed when the protocol was declared. Later orientation/storage variants belong to separate branches and cannot alter this result.

The test represents the W1/W2 burden by an additional positive resistance on the same formation coordinate y rather than by inserting the Einstein-Hilbert action into the premetric model. Since ADM shear is defined only after E^* , this resistance is not interpreted as a literal pre- E^* ADM stress. It is a coarse-grained interface proxy for the extra work/resistance associated with producing a candidate homogeneous geometry. The specific question is whether persistent formation survives that proxy burden without an external event budget. Define the baseline generalized drive

$$X_y = \kappa q - \partial_y[\Phi_b(y) + E_{\text{mem}}(r, y)], \quad (44)$$

and a normalized shape burden

$$g(B) = \{\text{Tr}(B^2)/y_{\text{org}}^2\}/G_{\text{ref}}, \quad \zeta_y(B) = 1 + \lambda_g g(B). \quad (45)$$

G_{ref} is fixed once so that the median source-like W2 ensemble has unit normalized burden. The parameter λ_g is a dimensionless resistance ratio inside this Onsager bridge. It is distinct from Newton's constant and carries no calibrated gravity-strength interpretation.

The modified formation law and its explicitly booked geometry-associated dissipation are

$$\dot{y} = X_y/\zeta_y(B), \quad \dot{D}_{\text{geom}} = [\zeta_y(B) - 1]\dot{y}^2, \quad (46)$$

$$dE_{\text{T1.1}}/d\tau = -\dot{y}^2 - \dot{D}_{\text{geom}} - \dot{r}^2. \quad (47)$$

This construction makes the geometric load backreact on the trajectory that forms the new regime and writes memory. It also removes an earlier common-budget inconsistency: the gate contains no external A3/A3b event envelope, $e_0=0.448$ transfer, or post-event leftover work reservoir.

6.2 Frozen protocol and strict result

Before execution, the T1.1 thresholds were frozen at $\kappa_{50}=0.50, 0.45$ and 0.40 for the stored-order, near-degenerate and renewal-favoured branches. The positive normalized loads $\lambda_g=0.25, 0.5, 1$ and 2 were also predeclared. A strict pass required at least 50% persistent formation at the frozen κ_{50} ; later κ rescans were declared diagnostic only. The $\lambda_g=0$ row therefore corresponds to the same $N=24$ initial-phase sample inherited from T1.1.

λ_g	stored-order	near-degenerate	renewal-favoured
0	75.0%	79.2%	87.5%
0.25	13.3%	13.7%	34.8%
0.5	4.4%	4.8%	15.4%
1	0.8%	0.9%	4.5%
2	0.07%	0.07%	0.59%

The $\lambda_g=0$ null reproduces the T1.1 frozen-threshold result, and timestep reduction leaves the headline persistence fractions unchanged while improving the numerical closure residual to approximately 10^{-10} . Every predeclared positive load, however, reduces persistence below 50% in every branch. The strict integrated gate therefore FAILS.

Positive λ_g does preferentially retain lower- $\text{Tr}(B^2)$ survivors, and this selection direction survives neighboring priors and a neighboring scale-free map. That observation does not rescue the gate. It shows that the inserted resistance acts in the intended direction while simultaneously making persistent formation too difficult at the frozen formation thresholds.

6.3 Interpretation of the failure

The failed gate is permanent for this model and protocol. Increasing κ can reopen formation diagnostically, but the frozen result remains FAIL. A post-hoc search for smaller λ_g is likewise excluded because λ_g had no independent physical calibration.

The FAIL applies to one specific bridge: a friction-like Onsager representation in which the homogeneous ADM/W2 burden is paid as additional irreversible formation resistance. It is therefore a negative result for that proxy bridge, not evidence against geometry emergence or the general low-Weyl hypothesis. The subsequent N0.2 audit identifies another physically admissible interpretation in which ADM shear belongs to geometric/kinetic storage, so the entire burden need not be dissipative. Section 7 examines that storage/normalization issue as a new audit; it leaves the Section 6 FAIL intact.

Section 6 verdict: Common-budget accounting and the $\lambda_g=0$ null PASS; the strict positive-load gate FAILS for every predeclared λ_g ; low- B^2 selection is a conditional directional result; W3 remains BLOCKED, not failed, until an independently justified homogeneous coupling/normalization is available.

7. Normalization and Stage-Separation Audits

7.1 N0.1: what the failed λ_g scan actually measured

Section 6 used unit formation mobility as a dimensionless normalization. N0.1 reopens that hidden normalization before assigning physical meaning to the geometry coefficient. For the T1.1 gradient-flow coordinates, write

$$\dot{y}=M_y X_y, \quad \dot{r}=M_r X_r, \quad dE/d\tau=-\dot{y}^2/M_y-\dot{r}^2/M_r. \quad (48)$$

Equivalently, with $\zeta_y=1/M_y$, the y channel obeys $\zeta_y \dot{y}=X_y$. The executed friction-only geometry gate used $\zeta_y(B)=\zeta_{y,0}[1+\Lambda_g \text{Tr}(B^2)/y_{\text{org}}^2]$, or $\lambda_g=G_{\text{ref}}\Lambda_g$ in the normalized notation of Section 6. Within that model λ_g measures the extra reference resistance relative to baseline formation resistance. The scanned values 0.25, 0.5, 1 and 2 correspond to +25%, +50%, +100% and +200% reference resistance; they are not physical gravitational-coupling values.

This distinction matters because the mobility itself is dimensional before normalization. If $Y=Y_*y$, $E_{\text{phys}}=E_*E$ and $\Theta=\Theta_*\tau$, with Θ a dimensional parameter of the continuing H sector, then a physical gradient law $dY/d\Theta=-M_Y^{\text{phys}} \partial E_{\text{phys}}/\partial Y$ gives

$$M_y = M_Y^{\text{phys}} E_* \Theta_*^2 / Y_*^2, \quad (49)$$

$$Z_Y^{\text{phys}} \equiv 1/M_Y^{\text{phys}} = (E_* \Theta_*^2 / Y_*^2) (1/M_y).$$

Thus $M_y=1$ fixes the unit convention but leaves the physical mobility/resistance undetermined. Earlier mobility stress tests also shifted $\kappa 50$ materially. The failed λ_g scan therefore cannot supply a physical geometry coefficient by itself.

7.2 N0.2-N0.5: stored geometry, dissipation, and the emergence clock

The next audit separates the strongest modelling assumption in Section 6 from the part supplied by W1. W1 establishes a positive relative homogeneous shear burden in the ADM kinetic structure; whether that burden is irreversibly dissipated while P forms is a separate physical question. Once E^* establishes a lower-order clock, define a one-sided local map

$$t'_L = T(\tau; \tau_E), \quad T(\tau_E) = 0, \quad N_E = (dt'_L/d\tau)|_{(E^*+)}. \quad (50)$$

Using the W2 convention $s=y/y_{\text{org}}$, the post-emergent shear associated with the local turn-on rate is then

$$\sigma_{ij} \sigma^{ij} = (1/N_E^2) (ds/d\tau)^2 \text{Tr}(B^2), \quad E_\sigma = V_f \sigma_{ij} \sigma^{ij} / (16\pi G). \quad (51)$$

The factor $1/(16\pi G)$ in E_σ comes from the post-emergent GR normalization [8,9]. E_σ represents stored geometric/shear burden, whereas an irreversible coarse-graining loss D_{cg} is a separate term. The minimal bookkeeping is therefore

$$J_g(\tau) = dE_\sigma/d\tau + \dot{D}_{\text{cg}}(\tau). \quad (52)$$

This distinction changes the interpretation of the Section 6 bridge. Converting the entire ADM-associated burden into $\lambda_g \dot{y}^2$ is a coarse-graining ansatz. A dissipative reduction becomes justified only if an independently identified sink relaxes the stored geometry fast enough.

$$\Xi_g = \hat{\Gamma}_{\text{cg}}(\tau) \Delta \tau_E. \quad (53)$$

Here $\Xi_g \ll 1$ denotes storage-dominated emergence, $\Xi_g \approx 1$ a mixed boundary layer, and $\Xi_g \gg 1$ a rapid-relaxation regime in which a friction-like reduction may become appropriate. The failed gate supplies no value for $\hat{\Gamma}_{\text{cg}}$ or Ξ_g . Likewise, the familiar post-emergent Bianchi-I dilution $\sigma \propto a^{-3}$ and $\sigma^2 \propto a^{-6}$ describes geometric evolution after E^* , not a premetric thermodynamic sink [10].

Clock rule: N_E is defined only on the E^*+ side. Lower-order proper time, Hubble rate and ADM curvature are not extrapolated backward through R or P . Premetric comparisons use τ -response quantities or ratios invariant under a constant reparametrization of τ .

7.3 N0.6: separating GR normalization from the arbitrary τ scale

A direct reconstruction of λ_g initially mixed post-emergent gravity, patch-energy normalization and the arbitrary scale of τ . N0.6 separates these ingredients. Before specializing to GR, write the geometry coefficient

$$A_E^{(\text{gen})} = C_g V_f / (E^* N_E^2), \quad C_g|_{\text{GR}} = 1/(16\pi G). \quad (54)$$

MOH/W1 supplies the relative sign and quadratic shear structure; standard GR supplies $C_g = 1/(16\pi G)$ only after E^* . Let ε_E be the dimensionless T1.1 common energy at the accepted E^* crossing and introduce an explicit energy-completeness factor f_E :

$$E^* \varepsilon_E = f_E \rho_E V_f. \quad (55)$$

The statement $f_E = 1$ would mean that the modeled T1.1 sector exhausts the energy density sourcing the newborn homogeneous GR patch. That is an additional matching assumption, not a default identity. The factor f_E is therefore not merely a small normalization uncertainty; it marks the unresolved cross-sector identification between the finite toy-model energy account and the stress-energy density that sources the post-emergent GR patch. Nor can the premetric finite-work ledger be promoted directly to a generic globally conserved cosmological energy after E^* . For a closed universe, general relativity has no meaningful notion of the total energy of the universe [21]; the present matching must instead be made through a declared local stress-energy and patch relation [8,9]. With $\hat{H}_E \equiv N_E H_E$ and $S_E \equiv \dot{s}_E^2 \text{Tr}(B_E^2)$, the spatially flat homogeneous GR constraint used here is

$$6 \hat{H}_E^2 - S_E = 16\pi G \rho_E N_E^2. \quad (56)$$

Under a constant reparametrization $\tau' = a\tau$, the individual quantities N_E and $\dot{s}_E$ change, so they should not be fitted separately as physical constants. Useful dimensionless combinations are

$$R_H = \hat{H}_E / |\dot{s}_E|, \quad R_Y = \zeta_{Y,0} / |\dot{s}_E|, \quad \Xi_g = \hat{\Gamma}_{cg}(\tau) / |\dot{s}_E|. \quad (57)$$

The rapid-relaxation branch can reconstruct a geometry-resistance coefficient only conditionally after a sink law is supplied. The calibration problem is thereby reduced to explicit physical inputs; no new λ_g prediction follows.

7.4 N0.7-N0.8: three shortcuts that do not close the trace mode

First, continuity of the higher-order state q through E^* does not define q as the newborn logarithmic scale factor $\alpha = \ln a$. In the simplest direct canonical class the parent kinetic term has positive sign, $L_{H,\text{kin}} = (I_H/2)\dot{q}^2$, whereas the isotropic ADM kinetic term has the opposite sign. If $\alpha - \alpha_E = F(q) - F(q_E)$ and $F'(q_E) = -\beta_H$, equality of the two kinetic forms would require

$$\beta_H^2 = -4\pi G N_E I_H / (3V_E), \quad (58)$$

which has no real solution for positive I_H , V_E and N_E . The direct $q_H \rightarrow \alpha$ canonical continuation therefore FAILS. This sign obstruction is consistent with the known indefiniteness/conformal-factor sign structure of the gravitational action [18]; its role here is to reject this naive interface identification, not to claim a new GR result. A relation such as $\hat{H}_E = -\beta_H \dot{q}_E$ can survive only as a new interface-response ansatz whose Jacobian β_H must be supplied by additional physics; $\beta_H = 1$ is not licensed.

Second, the already-accounted T1.1 work cannot be spent again to create expansion. At E^* the exact work identity is

$$J_{(H \rightarrow \text{PR})} = \kappa q \dot{y} = d(\Phi_b + E_{\text{mem}})/d\tau + \dot{y}^2 + \dot{r}^2, \quad J_{\text{res}} = 0. \quad (59)$$

The archived crossing recomputation gives $|J_{\text{res}}|$ at numerical round-off. Appending a new expansion budget from the same $H \rightarrow \text{PR}$ transfer would therefore double count work. Any new post-emergent source must be part of a new common functional or an independently derived boundary/source law.

Third, the emergence event supplies newborn initial data rather than an impulsive 'kick from rest'. Before E^* , α , a , t'_L , H_L and K_{ij} are undefined. In the flat GR/Bianchi-I branch, positive newborn density requires

$$\hat{H}_E^2 = [S_E + 16\pi G \rho_E N_E^2]/6 > 0 \quad (\rho_E > 0). \quad (60)$$

This permits nonzero newborn extrinsic curvature without a pre-emergent lower-order rest state. Accelerated expansion remains a separate stress-closure question. The separately tested reversible storage coordinate z is therefore frozen outside the active minimum model and does not determine the ADM trace normalization.

7.5 N0.9: invariant reduction and structural underdetermination

The remaining question is whether the newborn isotropic trace rate can be fixed without reintroducing a hidden constant. Let

$$u_E \equiv |\dot{S}_E|, \quad B_2 \equiv \text{Tr}(B_E^2), \quad A_E \equiv V_f/(16\pi G E^* N_E^2). \quad (61)$$

Using (55)-(56), define the reparametrization-invariant combinations

$$\mathcal{G}_E \equiv A_E u_E^2, \quad \mathcal{M}_E \equiv f_E \mathcal{G}_E = f_E A_E u_E^2. \quad (62)$$

The homogeneous constraint reduces to

$$6R_H^2 - B_2 = \varepsilon_E / \mathcal{M}_E, \quad R_H^2 = [B_2 + \varepsilon_E / \mathcal{M}_E]/6. \quad (63)$$

Under $\tau' = \alpha\tau$, $u_E \rightarrow u_E/a$ and $A_E \rightarrow a^2 A_E$, so both $\mathcal{G}_E$ and $\mathcal{M}_E$ are invariant. The clock-normalization problem has therefore not merely been renamed as N_E . The difficulty is structural: current active dynamics supplies ε_E and u_E , while W_2 conditionally supplies B_2 , but no independent active equation fixes $\mathcal{M}_E$. For any $\mathcal{M}_E > 0$ there is a compatible R_H , and conversely for any $R_H^2 > B_2/6$ there is a positive $\mathcal{M}_E$.

Attempted shortcut	Audit result
$R_H = \beta_H R_q/s$	Not available: β_H remains OPEN and the direct canonical $q_H \rightarrow \alpha$ class failed.
Set $f_E = 1$	Not available: this assumes complete identification of the modeled energy with the newborn patch density.
Fit N_E or V_f/E^*	Not available: N_E alone is τ -normalization dependent and A_E contains an unresolved cross-sector scale.
Infer from the old λ_g scan	Forbidden: that scan is a frozen FAIL and λ_g was only a stress amplitude.
Use optional z storage	Not active: z is frozen as a side branch and did not determine ADM trace normalization.

Section 7 verdict: The failed friction-only gate is not rescued. Its coefficient is reinterpreted as a relative resistance, stored shear is separated from irreversible loss, and the clock dependence is reduced to invariant combinations. Direct $q_H \rightarrow \alpha$ continuation and residual-work reuse FAIL. The strongest surviving flat-GR statement is $R_H^2 > B_2/6$ if $\rho_E > 0$. A parameter-free value of R_H is not fixed by the current model; the trace-normalization bridge remains OPEN and is carried into the stress-closure audit of Section 8.

8. Post-Emergent Acceleration and Stress-Closure Audit

8.1 I0: acceleration sufficiency

Section 7 leaves the newborn isotropic trace normalization structurally underdetermined. I0 now asks a post-emergent question that can be answered independently of that absolute rate: given admissible homogeneous GR initial data, what instantaneous stress condition is sufficient for accelerated expansion?

After E^* , and only after E^* , we use the spatially flat, $\Lambda=0$ Bianchi-I Einstein equations as an external control class [8–10]. With $\Sigma \equiv \sigma_{ij}\sigma^{ij}$ and the convention of Section 5, the homogeneous constraint and mean-scale-factor acceleration equation are

$$6H^2 - \Sigma = 16\pi G\rho, \quad (64)$$

$$\ddot{a}/a = -(4\pi G/3)(\rho + 3p) - \Sigma/3. \quad (65)$$

Both equations are EXT. They require a newborn lower-order metric, proper time and stress-energy tensor; none is extrapolated backward through the premetric interval. For $\rho > 0$ define

$$w \equiv p/\rho, \quad r_\sigma \equiv \Sigma/(16\pi G\rho). \quad (66)$$

Equation (65) then gives the instantaneous sign criterion

$$\ddot{a}/a > 0 \Leftrightarrow 1+3w+4r_\sigma < 0. \quad (67)$$

At E^+ , equations (51), (55), (62) and (63) reduce the shear fraction to

$$r_\sigma, E = B_2 \mathcal{M}_E / \varepsilon_E = B_2 / (6R_H^2 - B_2). \quad (68)$$

Hence the same criterion may be written without choosing the unresolved trace normalization,

$$1+3w_E+4B_2 \mathcal{M}_E / \varepsilon_E < 0. \quad (69)$$

I0 receives PASS status as an EXT algebraic consistency check inside the declared flat-Bianchi-I/GR control class. After the homogeneous constraint is applied, R_H is not an independent quantity in the acceleration sign. The unresolved inputs are the invariant emergence normalization $\mathcal{M}_E$ and, most importantly, the newborn mean equation-of-state parameter w_E . Whether MOH satisfies the acceleration condition therefore remains a stress-closure problem.

8.2 I1: stress-energy derivative debt

The active premetric model supplies energy values and finite-work identities along its declared state-space trajectory. Post-emergent mean pressure requires a different datum: the response of newborn energy to isotropic volume or metric deformation. For a homogeneous post- E^* system, the standard work-conjugate relation is [12]

$$p_E = -(\partial E_{\text{post}} / \partial V)|_{(E^+)}, \quad (70)$$

with the derivative taken along a specified constitutive path. This is an EXT relation. A boundary energy value alone does not fix it. For example, the family

$$E_{\text{post}}(c)(V) = E_E - p_c(V - V_E) + O[(V - V_E)^2] \quad (71)$$

The family has the same value E_E at V_E for every p_c but an arbitrary boundary pressure $p_E = p_c$. Equation (55) can conditionally match a modeled energy value to a newborn density through f_E , while leaving the corresponding volume derivative unspecified. The exact T1.1 work identity constrains transfer and dissipation, not post-emergent constitutive stress. The current provenance therefore leaves p_E and w_E structurally underdetermined; their status is OPEN because the required derivative data are absent.

8.3 I2–I3: elastic and traction audits

W2 supplies a traceless intrinsic-shape variable B . I2 tests whether that shape sector can also determine the missing mean stress. After E^* , decompose the spatial stress into trace and traceless parts,

$$T^i_j = p \delta^i_j + \pi^i_j, \quad \pi^i_i = 0. \quad (72)$$

A volume-preserving metric deformation obeys

$$\delta \ln V = (1/2) h^{ij} \delta h_{ij} = 0. \quad (73)$$

The isotropic pressure contribution is orthogonal to such a variation, whereas a traceless stress π^i_j may still do work. W2 can therefore support a candidate deviatoric or shear-response channel after an additional constitutive bridge is supplied. If the W2 newborn shape is conditionally taken as a preferred stress-free configuration, direct matching gives $\pi_E = 0$ as a null rather than a derived constitutive law. I2 receives PASS status as an architecture consistency check for the constrained-elastic/isochoric separation, while the mean stress trace remains OPEN.

I3 expresses the missing bridge explicitly. Let $E_{\text{post}} = E^* e(X^A)$ for post-emergent constitutive variables X^A , define generalized forces $Q_A \equiv -\partial e / \partial X^A$, a logarithmic volume strain $\varepsilon_v \equiv \ln(V/V_E)$, and the boundary Jacobian

$$J_v^A \equiv (\partial X^A / \partial \varepsilon_v)|_{(E^+)}. \quad (74)$$

Then the work-conjugate boundary pressure and equation-of-state parameter are

$$p_E = (E_*/V_E)Q_{AJ_v^A}, \quad w_E = f_{EQ_{AJ_v^A}}/\varepsilon_E. \quad (75)$$

The active premetric dynamics supplies generalized forces with respect to its own state variables, but the boundary Jacobian J_v^A is absent. Before E^* , V , a , $\alpha = \ln a$ and lower-order metric strain are undefined, and the direct $q_H \rightarrow \alpha$ canonical continuation that could have supplied a volume direction already FAILED in Section 7. A nonzero J_v^A therefore requires a new interface constitutive law. I3 receives PASS status for the generalized-force/work-conjugate reduction. A parameter-free p_E/w_E map, its sign and the required Jacobian remain OPEN under the present provenance.

8.4 I4: generic constraint audit and optional tension-manifold side class

Before opening a new tension class, I4a tests whether a generic post-emergent junction constraint can close the trace using existing variables. For $C(X, \varepsilon_v) = 0$, the allowed volume direction obeys $C_A J_v^A + C_v = 0$. Here $U_{HY} \equiv U_{int}(q, y) = -\kappa q y$ is the active H-formation interaction potential of Section 4. The natural active level set $C = U_{HY} - \text{const}$ is normal to the existing interaction force but has $C_v = 0$, so it supplies no trace reaction; replacing it by $C = U_{HY} - \Psi(\varepsilon_v)$ merely introduces the missing constitutive derivative Ψ' under a new name. I4a therefore FAILS to close the trace debt.

I4-T identifies one post-emergent model class that closes the sign problem while remaining explicitly separate from the active MOH derivation. Consider, after E^* , a d -dimensional tension-bearing structure with constant effective tension T_d . If its physical d -measure scales as $A_d \propto a^d \propto V^{(d/3)}$, then

$$E_d = T_d A_d, \quad A_d \propto V^{(d/3)}, \quad (76)$$

and the standard volume derivative gives

$$w_d = p_d / \rho_d = -d/3. \quad (77)$$

For a pure component of this class, equation (67) becomes

$$1 - d + 4r_\sigma < 0. \quad (78)$$

Thus $d=1$ cannot produce strict acceleration for $r_\sigma \geq 0$; $d=2$ requires $r_\sigma < 1/4$; and $d=3$ requires $r_\sigma < 1/2$. These are exact consequences of the declared tension ansatz. I4-T is CONDITIONAL and remains a frozen optional post- E^* side class; its physical existence requires independent provenance, and it cannot repair an earlier failed gate.

8.5 I5: no-tension provenance null

The final audit asks whether any frozen result of the active model requires a negative-pressure or tension-bearing post-emergent sector. As a provenance null, take a newborn branch with no continuing $H \rightarrow L$ source, no anisotropic matter stress and pressureless matter,

$$Q_{HL} = 0, \quad \pi_j^i = 0, \quad p = 0. \quad (79)$$

The standard homogeneous conservation and shear equations then give [10]

$$\rho \propto a^{-3}, \quad \Sigma \propto a^{-6}, \quad r_\sigma \propto a^{-3}. \quad (80)$$

Equation (67) reduces to $1 + 4r_\sigma < 0$, which cannot be satisfied for $r_\sigma \geq 0$. The pressureless no-tension branch therefore decelerates while remaining compatible with finite-work renewal, history-sensitive accessibility and the conditional W2 intrinsic-shape map. I5 receives PASS status as a no-tension compatibility null. The active frozen core does not require a dedicated tension sector; accelerated expansion remains independent of the frozen MOH core results.

A continuing $H \rightarrow L$ source, a volume-coupled constitutive law, a tension sector or another negative-pressure mechanism may be investigated only as additional physical structure with its own energy and provenance closure. None may be inserted retroactively into T1.1, the failed integrated geometry gate or the Section 7 normalization audit.

Section 8 verdict: I0 is PASS as an EXT algebraic consistency check in the spatially flat $\Lambda=0$ Bianchi-I/GR control class. I1 is OPEN because boundary energy does not determine p_E/w_E without derivative data. I2 is PASS as a constrained-elastic architecture consistency check but leaves the mean trace OPEN. I3 is PASS for the generalized-force/work-conjugate reduction, while the parameter-free pressure map, its sign and boundary Jacobian remain OPEN. I4a FAILS to close the trace with a generic constraint, while I4-T is CONDITIONAL and frozen as a new optional post- E^* tension side class. I5 is PASS as a no-tension compatibility null. Gate I therefore remains BLOCKED, not failed, and no I6 numerical acceleration scan is opened without independently justified post- E^* constitutive physics.

9. Current Claim Set and Open Physical Debts

The completed gates define the current publication claim set. The ledger below is cumulative: later retuning or optional side branches do not alter earlier FAIL or BLOCKED labels, and external physics remains distinct from quantities derived inside the active toy model.

Status	Current claim	Publication meaning
PASS	Exact common-energy and work identities for T0/T1/T1.1 and the active orientation minimum; reciprocal backreaction is required for closure. W1 and I0 pass as EXT consistency checks, I2 and I3 pass their stated analytic reductions, and I5 passes as a pressureless no-tension compatibility null.	May be stated as results or consistency checks of the declared equations and control classes. PASS does not establish a microscopic carrier, an absolute physical normalization, predictive superiority of R/H, or a cosmological realization.
CONDITIONAL	History-correlated residue changes accessibility relative to matched controls inside the declared readout ansatz; W2 supplies a scale-free intrinsic-shape map after E^* . I4-T gives $w=-d/3$ only for an explicitly new frozen tension-manifold side class.	State only together with the unresolved carrier, sign, dimensionality, coframe, matching and constitutive assumptions. Existence inside an ansatz is not evidence of physical necessity.
FAIL	The A2 robustness gate; the original frozen T1 thresholds after dynamic memory is charged; the integrated positive geometry-load gate at every predeclared λ_g ; direct canonical $q_H \rightarrow \alpha$ continuation; reuse of already-accounted $H \rightarrow PR$ work; and generic-constraint closure of the trace.	Retain as frozen negative results. Diagnostic rescans, reinterpretation or later side branches cannot convert these outcomes into PASS.
OPEN	Microscopic identity of H and the physical carrier/readout law of R; dimensional calibration of q , κ and mobilities; physical dimensionality/coframe and E^* microphysics; f_E , $\mathcal{M}_E$ and the parameter-free trace normalization R_H ; newborn $T_{\{\mu\nu,E\}}$, p_E/w_E , the boundary Jacobian J_v^A , anisotropic stress π_{ij} and any continuing $H \rightarrow L$ source Q_{HL} .	Requires an independent physical relation, measurement or derivation. Structural underdetermination and missing derivative data are recorded here rather than promoted to additional status categories.
BLOCKED	W3 general inhomogeneous/low-Weyl extension, and any numerical accelerated-expansion gate or post-emergent prediction that requires w_E or Q_{HL} .	Do not run or report as failed until the prerequisite homogeneous coupling/normalization and stress-energy closure are independently supplied.

The active chain reaches $R+H \rightarrow P \rightarrow E^* \rightarrow$ a conditional newborn intrinsic geometry. The remaining physical debts are $T_{\{\mu\nu,E\}}$, p_E , π_{ij} , Q_{HL} , a general low-Weyl initial condition, and an accelerated-expansion mechanism. These boundaries define the next physical problems rather than parameters available for retuning inside the existing toy model.

Section 9 verdict: The present paper supports a finite-work reciprocal renewal model with explicit common-energy bookkeeping, history-sensitive accessibility inside a declared ansatz, and a conditional scale-free route to newborn homogeneous intrinsic shape. It must equally retain the frozen geometry failures, structural trace/stress underdetermination and blocked W3/acceleration extensions. Further progress requires an independently motivated physical bridge, not reinterpretation of the present negative results.

10. Reproducibility and Provenance

10.1 Claim-level reproducibility boundary

Reproducibility is defined here claim by claim, not as preservation of the entire exploratory development history. A public artifact is evidentiary only if it supports a statement retained in Sections 3–9 or a frozen negative result required to interpret that statement. Each numerical or algebraic claim must be traceable through four links: declared model equations or EXT input; frozen protocol and parameter set; executable calculation or explicit derivation; and the reported output and status. If one of those links is absent, the material may remain in the private development archive but is not part of the evidentiary package.

The public release therefore does not promote discarded analogies, exploratory plots, conversational notes or unsuccessful intermediate mechanisms into evidence. Such material may document how a question was found, but it does not determine why a published claim is retained.

10.2 Minimal public package

The release package is intentionally minimal. It should contain only the artifacts needed to reproduce the retained quantitative statements, frozen failures and provenance assignments. The required structure is:

Artifact	Required contents	Role in the evidence chain
Claim manifest	Claim/gate identifier; manuscript section and equation/table location; current PASS, CONDITIONAL, FAIL, OPEN or BLOCKED status; pointer to the supporting source and output.	Provides a one-to-one map from a published statement to the artifact that supports it.
Executable source	Minimal source code required for the reported scans, controls, work/energy checks, crossing recomputations and normalization/stress audits, together with the runtime/dependency specification.	Reproduces calculations without importing exploratory mechanisms that are not part of the retained model.
Frozen protocol files	Branch parameters, initial-condition or phase sampling, mobilities, gate criteria, frozen κ_{50} and λ_g values where applicable, stopping rules, tolerances, and seeds or explicit permutations for stochastic controls.	Separates predeclared or inherited inputs from later diagnostic rescans and prevents silent retuning.
Headline machine-readable outputs	CSV or equivalent machine-readable rows underlying the reported persistence fractions, thresholds, work statistics, closure residuals and shuffle/control outcomes.	Allows the manuscript summaries to be recomputed from retained numerical output rather than from formatted tables alone.
Provenance and status ledger	For each retained quantity or bridge: D/I/P/A/N/F/EXT provenance, freeze point, status, and any explicit no-retuning dependency.	Keeps external physics, assumptions, inherited values, normalizations and derived results auditable and distinct.
Checksum manifest	SHA-256 checksums for every public artifact and the complete release archive, identified by manuscript/release version.	Makes the evidentiary snapshot immutable and permits later releases to be compared without overwriting the earlier record.

10.3 Frozen protocols, numerical tolerance and determinism

Numerical PASS/FAIL labels are properties of a declared protocol rather than movable conclusions. The public record must therefore preserve the exact gate definition used for every frozen result and distinguish it from later diagnostic rescans. In particular, the Section 6 positive-load FAIL must remain tied to the frozen T1.1 κ_{50} values and the predeclared λ_g scan; later κ rescans are diagnostic only. The same rule applies to the T1→T1.1 frozen-threshold failures and the A2 robustness FAIL. BLOCKED branches are recorded as blocked prerequisites, not converted into numerical failures.

Where phase sampling, random ensembles or shuffle/permutation controls are used, the package must provide either the exact seed set or the explicit sample/permutation indices, together with the sample count and aggregation rule. Integrator step size, stopping conditions, numerical tolerances and closure-residual criteria must likewise be explicit. A rerun need not reproduce the last floating-point digit on every platform, but it must reproduce the reported gate classification and the stated numerical precision within the declared tolerance.

10.4 Provenance, versioning and preservation of negative results

Every quantity entering a retained claim is recorded with the provenance vocabulary of Section 1.1: D, I, P, A, N, F and EXT. Outcome-dependent fitting F remains inadmissible for a main claim. A diagnostic rescan may extend the record, but it cannot overwrite the parameter set, code snapshot or status of the original frozen gate.

Negative results are therefore versioned objects. The integrated geometry FAIL, the failed direct $q_H \rightarrow \alpha$ continuation, the residual-work reuse failure and other frozen outcomes remain linked to the exact protocol that generated them. Optional side classes, including the reversible z-storage branch and the I4 tension-manifold construction, are archived separately from the active

minimum model so that they cannot silently enter its bookkeeping. Each public release receives an immutable manifest and checksums; a correction or extension creates a new release rather than replacing the evidentiary snapshot.

Section 10 verdict: The reproducible object is a minimal, versioned chain from declared equations and frozen protocols to executable calculations, machine-readable outputs, provenance/status records and checksums. Exploratory development material is excluded unless it is required to reproduce a retained claim. Frozen negative results remain attached to the exact protocol that produced them; later diagnostics may extend the record but cannot replace it.

11. Discussion

11.1 Deliberate reduction to a minimum-sufficient model

MOH is a multilevel architecture. The present paper instantiates the minimum H+R/P renewal unit needed for an auditable calculation. In the broader architecture, multiple levels may coexist and exchange influence through more than adjacent pairs; schematic channels such as $H1 \leftrightarrow R1$, $H2 \leftrightarrow R1$, $H2 \leftrightarrow R2$ and $H2 \leftrightarrow H1$ are conceptually admissible, with selection, suppression, reorganization, collapse and renewal potentially occurring at several levels. Those additional channels remain outside the calculations reported here.

This reduction is methodological. A full hierarchy would require explicit state variables for every retained level, declared carriers for each cross-level interaction, a common work and energy account for every active channel, compatible clock or parameter maps, collapse and renewal criteria, and matched controls able to distinguish genuine mechanism from flexibility introduced by the enlarged model. With several levels and simultaneous couplings, the number of possible interaction paths grows rapidly before their physical normalization is specified. The minimum system keeps causal attribution and falsification visible.

We use a minimum-sufficient-model rule. New reservoirs, couplings, phases or degrees of freedom enter only after a specific deficit has been demonstrated, and then in the smallest form needed to test that deficit with explicit provenance, work closure, controls and a kill condition. The active model treats H as an already existing finite continuing sector. The origin of H, the genesis of still higher orders, and any law determining the number of levels remain explicit OPEN physical debts.

11.2 What the minimum model establishes

This reduction makes one renewal interface auditable without hidden support from unmodelled levels. The T branch establishes an explicit finite-work reciprocal formation mechanism with backreaction, dynamical memory cost and positive dissipation. History-correlated structure is operationally distinguishable from matched controls and provides the model-level realization of inherited sensitivity described in Sections 3 and 4. W1/W2 then supply a conditional homogeneous geometry bridge while keeping dimensionality, coframe promotion and normalization assumptions visible.

Several ingredients of this behavior have established quantitative analogues outside MOH. Dynamic bifurcation memory, phase tipping, material memory, Kibble–Zurek state selection and driven adaptive resonance each show, in different settings, that prior trajectory, phase or formation protocol can condition later response [13–17]. These literatures constrain the novelty claim: MOH does not present history-sensitive response as a newly discovered physical phenomenon. Its remaining conceptual contribution is the particular stage-separated R/H renewal architecture and the attempt to audit whether that architecture yields calculable consequences beyond a generic expanded-state model. The present paper has not yet established such predictive superiority.

The negative results are equally informative. The integrated positive geometry-load gate fails at every predeclared positive load at the frozen formation thresholds; direct canonical $q_H \rightarrow \alpha$ continuation fails; already-accounted $H \rightarrow PR$ work cannot be reused; the newborn trace rate is structurally underdetermined; and the post-emergent mean pressure remains open. Together these outcomes define the present boundary of the architecture without absorbing failed gates into additional freedom.

These obstacles do not all have the same epistemic status. The ADM sign/quadratic structure is an established GR consistency constraint [8,9], the Bianchi-I shear/Weyl relations belong to standard homogeneous cosmology [10,20], and the sign obstruction encountered by the direct $q_H \rightarrow \alpha$ continuation is consistent with the known conformal-factor indefiniteness of the gravitational action [18]. By contrast, the frozen T1.1 threshold losses and the failure of the friction-like homogeneous-geometry bridge are model-specific negative results of the declared protocols. The absence of a physical R carrier, a cross-sector normalization and a post-emergent stress closure are OPEN interface debts rather than failed tests. This separation is intended to show a later reader which walls are already known physics, which were produced by the present toy construction, and which remain untested.

11.3 Why the blocked branches are not rescued by the full hierarchy

The broader multilevel architecture cannot serve as an unseen reservoir when the active minimum model encounters a deficit. Adding an unmodelled higher level, cross-level coupling or external source after a failed gate would erase the evidentiary meaning of that gate. The same rule applies to the frozen optional z-storage branch and the post-E* tension side class: each can motivate a new model, but neither enters an earlier account retroactively.

W3 remains BLOCKED until a homogeneous coupling/normalization is independently justified, while the accelerated-expansion branch remains BLOCKED until a constitutive stress-energy bridge is supplied. These statuses identify separate missing prerequisites; they make no claim that a fuller MOH hierarchy must fail at either task. Any later higher-level sector must enter as a new declared physical structure with its own source identity, coupling law, energy bookkeeping, null controls and failure criterion.

11.4 Route toward a fuller multilevel model

A fuller MOH model can be built outward from the validated and failed boundaries of the minimum system. The immediate priority is an independently motivated interface law that closes the newborn trace/stress sector without retuning T1.1 or the failed geometry gate. W3 can be reopened when its own homogeneous coupling/normalization prerequisite is independently justified. A subsequent multilevel extension can then study how several continuing and residual sectors coexist, compete, suppress or reinforce one another, and how collapse and renewal propagate through a network of levels.

The origin of higher orders is a separate and harder problem. A future model must explain how a higher sector forms, what makes it dynamically persistent, how its resources are bounded, how it couples to lower and neighboring orders, and how its own renewal or termination is defined. Until such relations are derived, the multilevel hierarchy remains architectural context rather than extra dynamical machinery in the present calculation.

Section 11 verdict: The narrow scope is deliberate. The present paper tests the minimum H+R/P renewal unit needed to expose finite-work, memory, geometry and stress-closure constraints. It does not explain the origin of H or higher levels and does not activate the broader many-channel hierarchy. Those omissions are explicit OPEN scope debts. They may motivate later models, but they cannot be used to repair the frozen failures or blocked branches reported here.

12. Conclusion

This work reports a controlled attempt to turn the R/H renewal architecture into a minimum finite-work toy model. The attempt does not produce a physically closed or predictive cosmological renewal theory. Within the declared model class, formation work can be generated reciprocally, memory can be carried inside the same energy account, history-dependent accessibility can operationalize inherited sensitivity, and a scale-free relational map can provide a conditional route to newborn homogeneous intrinsic shape. These results define a calculable toy renewal interface and a reproducible record of where the construction succeeds, fails or stops. They do not establish a new universal law of inherited sensitivity, predictive superiority over generic expanded-state dynamics, a generic low-Weyl mechanism, or a complete cosmological model.

The current boundary is equally explicit. The integrated positive geometry-load gate fails at the frozen formation thresholds; direct $q_H \rightarrow \alpha$ continuation and reuse of already-accounted $H \rightarrow PR$ work fail; the homogeneous trace normalization and newborn mean pressure remain structurally open; and W3 together with the numerical accelerated-expansion branch remains blocked. The origin of H and the genesis of higher orders are separate OPEN problems.

Further progress requires independently motivated interface physics for the trace/stress sector, an independently justified homogeneous coupling/normalization before W3, and later a controlled extension toward the broader multilevel hierarchy. Each extension must enter as a declared mechanism with its own energy closure, provenance, controls and falsification conditions.

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Data and code availability: A reproducibility package containing the retained source code, frozen protocols, machine-readable outputs, provenance ledger, README and checksum manifest is available in the companion data and code archive identified by the DOI on the title page.

Author contributions: The author originated the MOH hypothesis and its multilevel architecture, conceived and directed the research program, specified the modelling questions and acceptance/failure criteria, reviewed the calculations and interpretations, and prepared the manuscript.

Use of generative AI: OpenAI's ChatGPT was used as a research and modelling assistant for mathematical derivation checks, numerical experiments, adversarial review, documentation, literature support, language editing and preparation of reproducibility materials. Anthropic's Claude was used as an independent critical reviewer of the manuscript; its comments informed revisions to claim strength, literature positioning, status consistency and presentation of negative results. The author reviewed all outputs, determined the modelling assumptions and status labels, and assumes responsibility for the manuscript.

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