

Must an Ordered Cosmological Beginning Be History-Free?

A Multilevel Oscillatory Hierarchy and Penrose's Low-Gravitational-Entropy Problem

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Preprint DOI:
<https://doi.org/10.5281/zenodo.21757636>

Abstract

Roger Penrose's low-gravitational-entropy problem asks why the early universe was extraordinarily smooth and why its gravitational degrees of freedom, represented in his account by Weyl curvature, were so strongly restricted. This article addresses a narrower question within that problem: must an ordered cosmological beginning be imposed as a history-free initial condition? Conformal cyclic cosmology supplies one reference case in which a new aeon belongs to a wider history. Eternal inflation and bubble-universe models provide another, because local cosmological domains can arise inside a continuing background. Against this backdrop, the article develops the conceptual possibility of a multilevel oscillatory hierarchy. A lower cosmological order may destabilize, collapse, and renew while a higher order continues through its own phase. Renewal is conditioned through two analytically separable channels: the fluctuation-dominated residue of the preceding lower order and the current state of the continuing higher order. Their joint effect is described as inherited sensitivity, a historically formed disposition expressed in realized response, stability, thresholds, and accessible trajectories. The proposal does not explain why a renewed beginning should possess low Weyl curvature. Its conceptual contribution is to historicize the beginning and to specify the dynamical burden that a genuine explanation must carry. Penrose's mass-clock argument also constrains oscillatory language: absolute frequencies cannot simply be preserved across a scale-free transition, and candidate relational descriptors must first be physically definable and comparable before their transformation properties can be assessed. The article concludes with a discriminating model program designed to test whether the two-channel classification has predictive value beyond ordinary hidden-state path dependence, followed by a separate thermodynamic extension.

1. A Personal Return to a Physical Problem

Ideas do not reveal all their implications when they first arise. Some become more precise only after a later encounter places them beside a question formulated by someone else with greater physical clarity. When I listened again to Sir Roger Penrose discussing conformal cyclic cosmology [29], I recognized a possible connection between his problem of the extraordinarily ordered Big Bang and my earlier reflections on multilevel oscillatory orders [14].

The connection is not an identification of the two cosmological pictures. Penrose asks why the Big Bang had such an exceptional gravitational character. The hierarchy raises a related but narrower question. Could a genuine cosmological beginning possess a wider dynamical history, and could the conditions of its formation shape the responses and trajectories later available to it?

That question must now be separated from a stronger claim that the earlier versions of this article left insufficiently explicit. A history for an ordered beginning is not yet an explanation of its gravitational smoothness. The present revision is organized around that distinction.

2. Penrose's Low-Gravitational-Entropy Problem—and Its Contested Framing

The physical setting begins with the singularity theorems. Penrose's analysis of gravitational collapse showed that singularity formation could not be dismissed as an artifact of exact spherical symmetry. Hawking extended related geometrical methods to cosmology, and their joint theorem established geodesic incompleteness under broad conditions in gravitational collapse and in the backward extension of cosmological history [9–11]. The theorems do not supply a complete physical model of a singularity and do not by themselves identify it with an ordinary spacetime point of infinite density. They establish that classical spacetime cannot be geodesically extended indefinitely under the stated assumptions.

The mathematical kinship between black-hole and cosmological singularities exposes a physical asymmetry. Black holes arise through gravitational clustering and are associated with extremely high gravitational entropy. The early universe was instead strikingly smooth on large scales. Gravitational degrees of freedom capable of producing strong tidal fields, inhomogeneity, and collapsed structure were severely restricted [1,2]. Matter and radiation may have been near thermal equilibrium while the gravitational field occupied an extraordinarily special state.

Penrose expresses the distinction through Weyl curvature, the free, tidal, and radiative part of the gravitational field. His Weyl curvature hypothesis proposes that these degrees of freedom were strongly suppressed at the initial cosmological singularity, whereas singularities produced by gravitational collapse may contain highly developed Weyl curvature [1,2]. The hypothesis is not a consequence of the singularity theorems. It is a proposed physical account of the time-asymmetric difference between the two ends of gravitational evolution.

Inflation can enlarge a sufficiently smooth region and suppress some pre-existing inhomogeneities, but Penrose's objection reaches the conditions required for inflation itself. In his framing, inflation does not explain why the gravitational state permitting it was already so special or why low gravitational entropy belongs to the past boundary rather than to both temporal ends [1,2]. The explanatory problem is therefore not only how smoothness develops. It is why the admissible initial gravitational state occupied such a restricted part of the available state space.

The term gravitational entropy does not, however, denote a single universally accepted quantity. Penrose's Weyl-curvature proposal is one influential framing. Clifton, Ellis, and Tavakol develop a different thermodynamically motivated construction based on the Bel–Robinson tensor for selected classes of spacetimes [25]. Philosophical analyses by Earman and Callender also question how a Boltzmannian Past Hypothesis should be formulated in cosmology, whether a sufficiently well-defined measure is available, and what kind of explanation a special initial condition requires [26–28].

The present article therefore adopts Penrose's problem conditionally and explicitly. It accepts the suppression of gravitational degrees of freedom as the physical question to which Penrose directs attention, while making no claim that Weyl curvature supplies the only accepted measure of gravitational entropy or that the foundational debate over the low-entropy past has been settled. Within that conditional framing, four issues must remain distinct: the specific low-Weyl condition, the historicity of the beginning, the loss and recovery of physical scale, and the thermodynamic admissibility of any renewal process.

3. What CCC Actually Proposes

Conformal cyclic cosmology places an ordered beginning within a wider cosmological history. An aeon in CCC is not a conventional expansion–contraction cycle followed by a physical bounce. The remote future of one aeon is conformally joined to the initial boundary of the next [1,2,4,8]. Conformal geometry preserves light cones, angular relations, and causal structure while discarding a fixed assignment of absolute lengths and durations.

For a cosmology with a positive cosmological constant, an infinitely remote expanding future can be represented by a finite spacelike conformal boundary. Conversely, a cosmological origin may be conformally expanded into a spacelike initial boundary. The two boundaries do not acquire the same physical character merely through rescaling. A smooth future boundary can arise from continued expansion under suitable conditions, whereas a smooth initial boundary imposes a severe restriction on the admissible gravitational states [1,2,4,12].

Penrose draws on Tod’s proposal that a smooth conformal initial boundary can encode the suppression of gravitational degrees of freedom at the Big Bang [12]. CCC identifies the future conformal infinity of one aeon with a crossover surface that also serves as the initial conformal boundary of the next. Each aeon contains a complete cosmological history, and the sequence gives the new beginning a wider history without preserving the preceding universe in its original metric form.

The loss of a physically fixed scale is central to the crossover. Penrose combines the mass–energy relation and the Planck relation [1,2]:

$$E = mc^2$$

$$E = h\nu$$

A stable particle of rest mass m can therefore be assigned the characteristic frequency

$$\nu = mc^2/h$$

Such a periodic scale can function as a primitive physical clock. Its period fixes a time scale and, through the speed of light, a corresponding length scale. Light cones determine conformal and causal structure; rest-mass-based clocks provide the extra information needed to select a particular metric within a conformal class [1,2].

Massless fields do not provide an intrinsic rest-mass clock of that kind. Penrose emphasizes the conformal properties of Maxwell theory and, when masses are neglected, the classical Yang–Mills fields [1,2]. In the remote future, black holes are expected to evaporate through Hawking radiation [13]. CCC further assumes that remaining rest masses ultimately cease to have physical significance. That assumption is speculative, but its role is precise: it removes the clocks that would continue to anchor an absolute metric scale.

Loss of scale does not erase all structure. Causal and conformal geometry remain, and CCC permits transformed physical influences from a previous aeon to affect its successor. Proposed observational signatures include Hawking points in the cosmic microwave background. Their empirical status remains disputed because independent reanalyses have not found statistically compelling confirmation [5–7]. A 2025 preprint by Meissner and Penrose introduces a gravitational-wave-dominated epoch around the crossover [3]. It is a current development of CCC, not evidence for the hierarchy proposed below.

Important technical questions remain open, including the choice of conformal factor and the matching of physical quantities across the crossover [3,4]. The present argument does not require CCC to be empirically correct. CCC functions as a sharply defined case in which an ordered

beginning is historically embedded and in which the disappearance of rest-mass clocks imposes a nontrivial constraint on the language used to describe continuity.

CCC nevertheless differs from the proposed hierarchy. It provides an ordered succession of aeons linked by conformal continuation. It does not posit a wider dynamical order that remains active with its own phase and state while a lower cosmological order is renewed. That distinction is real, but it does not make CCC the only relevant neighbor.

4. Wider Histories of Local Beginnings: CCC, Eternal Inflation, and Bubble Universes

The idea of a local cosmological beginning inside a continuing background is already well developed in inflationary cosmology. In eternal-inflation scenarios, an inflating false-vacuum region can continue while pocket or bubble universes form within it [24]. The interior of a nucleated bubble may possess its own cosmological time and developmental history even though the surrounding inflating background has not ended. The general thesis that a local time-zero can coexist with a wider ongoing process is therefore not distinctive to an oscillatory hierarchy.

The literature also contains stronger forms of historical conditioning. Garriga, Guth, and Vilenkin analyze a “persistence of memory” in the distribution of bubble collisions: the observable pattern can retain an asymmetry connected with the initial conditions imposed on the parent inflating spacetime [22]. Later work incorporating more realistic cosmological evolution inside the bubble and domain-wall dynamics found that the late-time collision distribution can become nearly isotropic, so the persistence effect is model-dependent rather than universal [31]. That memory is not the inherited sensitivity defined here, but the terminology is close enough to make a direct distinction necessary. McInnes likewise argues that low-entropy conditions in a bubble universe may be inherited from the ambient spacetime [23]. A surrounding state that conditions a new cosmological domain is thus an occupied conceptual territory.

CCC, eternal inflation, and bubble cosmology share a structural motif: a cosmological beginning can be local to a domain or aeon while belonging to a wider history. Their physical implementations differ. CCC uses conformal matching between complete aeons. Eternal inflation generates multiple domains within a persisting inflating background. Neither framework, in its standard form, supplies the particular combination proposed by the multilevel oscillatory picture.

After those neighbors are subtracted, the remaining proposal has five connected elements. The continuing background is itself an oscillatory order with a phase and unfinished history. The architecture permits more than two nested levels. Renewal occurs at a lower hierarchical level from a residue rather than through the proliferation of spatially separate bubbles. Influence between levels may be reciprocal, so formation of the lower order can modify the wider order that conditions it. Finally, the inherited quantity is intended as a disposition to respond, expressed through stability and thresholds, not primarily as a selected vacuum, a parameter set, or a collision imprint [14].

These distinctions establish conceptual identity, not scientific success. They matter only if the two-channel organization introduced below yields consequences that ordinary bubble initial conditions, a single hidden state, or a generic path-dependent model do not capture equally well. The burden of distinctiveness is therefore transferred from vocabulary to model comparison.

5. The Multilevel Oscillatory Proposal

The proposal treats the observable universe as a possible lower oscillatory order embedded in a wider order with a longer characteristic time scale. “Oscillatory” currently names a dynamical architecture of buildup, destabilization, collapse, and renewal. It does not yet identify the physical variables that oscillate, the field content of the orders, or a universal resonance mechanism [14].

A collapse of the lower order would not preserve the previous universe in a latent form. Its organized regime would break down or undergo a fundamental redistribution, leaving a fluctuation-dominated residue. The residue is neither empty nor a miniature copy of the vanished structure. Its possible statistical, spectral, or correlational organization may reflect the preceding development in transformed form without retaining directly recoverable content [14].

The higher order is assumed to continue through this event. Its phase, coupling state, fluctuation background, and available drive change along an unfinished trajectory while the lower regime disappears and becomes established anew. Renewal is consequently conditioned by two sources: the residual state of the lower order and the current state of the higher order. The two sources can vary independently and therefore define analytically distinct channels.

Formation of the new lower regime constitutes a genuine local time-zero because that organized structure did not exist in the same form before the transition. The same event does not have to begin all temporality. Higher-order temporality denotes the continuing evolution of a wider level with a different time scale, not a second independent time dimension. A lower order may complete a full cycle during an unfinished phase of the slower order.

The term renewal is preferable to restart. A restart resumes a preserved system after interruption. Renewal produces a new organized regime from a residue under conditions formed by a wider history. The local beginning remains genuine even though it is not metaphysically isolated.

Influence may also be reciprocal. As the lower order forms, it can alter the coupling, amplitude, phase, or available energy of the higher order. Pump depletion and backreaction are possible dynamical forms of that reciprocity, but they remain working hypotheses until the transferred quantity and governing law are defined. The positive conceptual claim is limited to an architecture in which wider history, local renewal, and reciprocal conditioning can be stated together. In a genuinely multilevel extension, analogous exchanges could link successive levels into a cascade of conditioning and backreaction, although the present article analyzes only one lower–higher pair.

6. Inherited Sensitivity and the Burden of Distinctiveness

Inherited sensitivity does not add a mysterious variable outside the complete physical state of a system. It classifies a historically formed dispositional profile whose carrier variables may be omitted by a chosen macroscopic description. In the present cosmological application, the profile is attributed to two sources: channel R, the organization of the residue, and channel H, the current state of the continuing higher order.

Channel R may include statistical distributions, correlations, relative mode weights, or other features that survive collapse in transformed form. Channel H includes phase, coupling state, fluctuation background, available excitation, and the higher order’s own history. Their interaction can condition the regime that forms, the states it can sustain, its transition thresholds, and its later responses.

The PDS terminology separates sensitivity from realized response. Sensitivity denotes a disposition that may remain latent. Realized response is the operationally identifiable effect produced under a specified environmental influence. A threshold marks the level at which a response becomes

detectable, effective, persistent, or structurally consequential; it does not mark the first existence of sensitivity [15–18].

Path dependence and hysteresis are close neighbors. A complete extended state can encode the effects of history, and many ordinary physical systems display different responses because hidden variables differ. The two-channel proposal is analytically useful only if classifying the origins of those variables into R and H improves explanation or prediction. Merely renaming hidden-state dependence would add no physical content.

The decisive comparison therefore holds the selected macroscopic state of the lower order and the subsequent forcing fixed while varying R and H. Support for inherited sensitivity would require systematic differences in transition time, realized response, persistence, stability, or threshold that are predicted more effectively by the two-channel structure than by a simpler model. The distinction must also allow the contributions of R, H, and their interaction to be separated.

Failure is informative. If an ordinary expanded state description predicts all outcomes equally well, or if R and H cannot be operationally distinguished, inherited sensitivity remains a useful interpretive phrase but not an independently productive analytical instrument. The concept earns its stronger status only through a discriminating model.

7. Historical Differentiation and Evolution of Accessible Trajectories

Non-identical cosmological cycles are not new. Tolman's early relativistic-thermodynamic analysis examined the conditions under which periodic or quasiperiodic behavior could occur [20,30]. Modern models of cosmological hysteresis show that a nonzero pressure–volume loop can alter successive cycles even without entropy production [21]. The present proposal therefore claims no priority for the general idea that cycles differ.

Its narrower question concerns the origin and consequence of that difference. A new lower regime forms from a residue R at a particular state H of the wider order. A changed residue can supply a different mixture of available fluctuations. A changed higher-order phase can modify which components are amplified or suppressed, how long a coupling window remains open, and which transition is reached first. The same later influence can then produce a different realized response because the renewed regime occupies a different region of dynamical state space.

Evolution is used here in a deliberately restricted sense. It denotes a historically conditioned change in accessible trajectories: shifted thresholds, altered stability, entry into a previously unavailable regime, or continuation beyond a boundary at which an earlier cycle failed. It does not imply linear progress, increasing complexity, or automatic improvement. A later trajectory may be wider, narrower, or simply organized differently.

Reciprocal coupling can make the history cumulative. A lower cycle with a different course leaves a different residue and may modify the higher order in another way. The next renewal then occurs inside an environment partly altered by the preceding lower-order development. This possibility differs from Smolin's cosmological natural selection, which links black holes to the production of new universes and variation in physical parameters [19]. No reproduction through black holes or selection of constants is proposed here.

The evolutionary claim remains conditional. A model must show whether phase-conditioned renewal actually shifts thresholds or opens states under neutral and alternative couplings.

8. What the Hierarchy Does—and Does Not Explain About Low Gravitational Entropy

The hierarchy does not yet explain why a renewed cosmological beginning should have low Weyl curvature. Historical embedding and gravitational smoothness are different achievements. The former answers whether an ordered beginning can belong to a wider history. The latter requires a physical mechanism that restricts the admissible gravitational degrees of freedom.

A fluctuation-dominated residue is not automatically smooth. Until its ontology is specified, it is not known whether the relevant fluctuations are geometrical, material, radiative, statistical, or some combination. Nor does continuing higher-order excitation naturally guarantee smoothness. Generic driving could amplify inhomogeneity as readily as it suppresses it.

A future model must therefore establish whether a gravitationally smooth regime is selected, projected, damped, or stabilized by independently motivated couplings or emerges from the model's own dynamics. Selective removal of gravitationally analogous modes may be examined as a class of tests, but not as a mechanism assumed in advance. Introducing a designated “Weyl-like” sector and damping it by construction would merely encode the desired conclusion. Neutral couplings, alternative couplings, and negative controls are required.

The gravitational-wave-dominated crossover proposed by Meissner and Penrose confirms only that the gravitational sector remains central to current technical development of CCC [3]. It does not supply a higher oscillatory order, a selective drain, or a derivation of the present hierarchy. Any connection beyond that limited observation would be an unsupported inference.

One open ontological possibility is that a metric becomes physically established only with the renewed organized regime. Even then, the problem is not removed by definition. A complete account would have to show what pre-metric or boundary data constrain the emergent metric and why the resulting gravitational state is exceptionally regular. “The metric emerges later” is a question for the model, not an escape from Penrose's challenge.

The conceptual response can now be stated precisely. The hierarchy relocates the explanatory task; it does not discharge it. A renewed beginning may be historically conditioned instead of imposed as an isolated initial condition, but the model must still explain why its gravitational state is smooth rather than generically inhomogeneous. If no independently motivated route from the two conditioning channels to a low-Weyl regime can be found, the framework contributes to the historicity of the beginning and no further to the physical solution of Penrose's problem.

9. Mass, Frequency, and the Definability of Relational Descriptors

Penrose's mass-clock argument imposes a fundamental constraint on oscillatory language. A numerical frequency is defined relative to a time unit. When rest-mass clocks cease to anchor a metric scale, an absolute frequency cannot pass through a scale-free boundary as an invariant by itself [1,2]. It is therefore illegitimate to say that a mode enters a new cycle with the same numerical frequency unless a physical clock and a cross-boundary mapping have been specified on both sides.

This restriction does not imply that time, causality, or dynamics disappear. Frequencies can become physically meaningful again after a local metric and suitable clocks emerge in the new order. The problem is the direct identification of absolute values across a transition during which the metric scale is not fixed.

Relational candidates include relative phase, dimensionless ratios of characteristic scales, normalized spectral shape, correlation structure, ordering of modes, and coupling topology. Their

lack of dimensions does not make them automatically well defined across a conformal transition. Three logically prior tests must be passed.

The first test is definability. Phase and spectral modes presuppose physical degrees of freedom, a field content, an observable, a mode decomposition, or another structure from which they can be constructed. A conformal class alone does not provide every decomposition used in ordinary oscillator language. Without the relevant physical structure, a “phase” or “spectrum” remains metaphorical.

The second test is comparability. Quantities assigned on the two sides of a transition require a rule that relates events or boundary data. Such a rule may involve a foliation, transport prescription, matching condition, causal relation, or explicit boundary map. Because a conformal factor can vary locally, even dimensionless ratios evaluated at different events cannot be assumed to correspond automatically.

Only the third test concerns transformation or invariance. Once a quantity is physically defined and the objects being compared are related, its transformation law can be derived and any preserved relation can be identified. No candidate descriptor in the present hierarchy has yet passed all three stages. They form a research list, not a set of established cross-boundary observables.

The same caution applies to the residue and the continuing higher order. A “spectral structure” carried through renewal cannot mean an unchanged list of absolute frequencies. At most, a relational organization may condition the concrete frequencies, amplitudes, couplings, and thresholds that become measurable after a new scale is established. A physical model must identify the carrier and the mapping before it can calculate such conditioning.

10. Black Holes as Internal High-Entropy Structures

Black holes sharpen the contrast at the center of Penrose’s argument. They are highly clustered gravitational structures associated with large gravitational entropy, whereas the cosmological beginning was exceptionally smooth. Their mergers, gravitational radiation, and eventual Hawking evaporation also play a role in CCC, where transformed effects from the preceding aeon may influence the next [1–3,13].

The multilevel hierarchy assigns black holes no separate reproductive or hierarchical status. They remain internal structures of the lower cosmological order. Their formation and evaporation can alter the energy, entropy, and residual state of that order, but a local event horizon or singularity does not by itself define a higher level.

The distinction from cosmological natural selection is therefore explicit. Smolin’s proposal gives black holes a generative role in the production of new universes whose parameters vary [19]. The present framework contains no such reproduction, mutation of constants, or selection process. Black holes matter as internal high-entropy structures and possible contributors to the lower order’s later residue.

11. Objections, Higher-Order Identity, Motivation, and Failure Conditions

The first objection concerns the higher order itself. No empirical evidence presented here establishes a cosmological level beyond the observable universe. The higher order is introduced as a structural hypothesis. PDS and analogies with nested nonequilibrium systems supply a language

and a heuristic motive, not evidence for a new cosmological entity [14–18]. Its scientific value depends on whether the architecture yields distinguishable models or tests.

A second objection concerns identity. The argument repeatedly describes the higher order as continuing while its phase, energy, amplitude, and coupling change. A model must specify what makes it the same order through those changes. Possible criteria include continuity of a state trajectory in a defined phase space, persistence of the governing variables and equations, continuity of coupling topology, or a geometrically defined causal relation. Without such a criterion, “the same higher order in another phase” cannot be distinguished from the replacement of one system by another.

A third objection targets the residue. Negative descriptions are insufficient. Saying that the residue is not a preserved universe and not recoverable information does not establish what it is. A physical model must identify fields, correlations, boundary data, probability distributions, geometrical degrees of freedom, or another carrier capable of coupling to the renewed lower order.

Calling the hierarchy oscillatory also remains provisional. The relevant variables, normal modes, dissipation, resonance conditions, and coupling terms have not been specified. Oscillatory terminology is legitimate as an architectural hypothesis only while the article makes clear that no new force or completed cosmological dynamics has been derived.

Thermodynamics provides a further boundary. Local self-organization does not reduce total entropy without cost. Renewal requires available free energy, defined system boundaries, dissipation, and an account of entropy production or export. Tolman’s wider treatment of relativistic thermodynamics and cyclic cosmology remains a classical warning that periodic language cannot bypass thermal bookkeeping [20,30]. A simple oscillator model cannot be relabeled as a computation of cosmological gravitational entropy.

The framework must also survive reduction to ordinary state description. If the two channels provide no predictive or explanatory gain after all relevant hidden variables are included, inherited sensitivity adds interpretation but no independent analytical leverage. Likewise, failure follows if the relational descriptors cannot be defined and compared, if higher-order identity cannot be operationalized, if every renewal is energetically inconsistent, or if no physical coupling can produce the proposed conditioning.

None of those outcomes is excluded in advance. A research program becomes stronger, not weaker, when its terms of failure are explicit. The hierarchy remains a philosophically coherent possibility only so long as it is presented as a structural hypothesis. It becomes a physical proposal only through models that can reveal both success and failure.

12. Outlook: A Discriminating Model and Its Thermodynamic Extension

12.1 Model A: a discriminating dynamical test

The first modeling stage should test the analytical value of the two conditioning channels without claiming a cosmological entropy calculation. Let x denote the state variables of the lower order L , r the variables representing the residue R , and h the state of the higher order H . A generic model skeleton can be written as

$$\begin{aligned} dx/dt &= F(x) + G_R(x,r) + G_H(x,h) + G_RH(x,r,h) + u(t) \\ dh/dt &= Q(h) + B(x,h) \end{aligned}$$

Here $u(t)$ is a controlled subsequent influence, G_R and G_H represent the separate channels, G_{RH} their interaction, and B the backreaction of the lower order on the higher. The symbols do not define a physical cosmology. They state the minimum structure required for a discriminating test.

The design should compare systems with the same selected macroscopic description $M(x)=m_0$ and the same forcing $u(t)$, while varying r and h . At least five cases are required: a null model, R only, H only, additive $R+H$ without interaction, and a model containing an $R \times H$ interaction. Outcomes should include renewal time, transition threshold, realized response, stability, persistence, spectral organization, dissipation, energy extraction, and backreaction.

Model comparison is essential. The two-channel formulation should be evaluated against an ordinary expanded state-space model using predictive accuracy, parameter economy, out-of-sample behavior, or another declared criterion. If the expanded state model performs equally well and the R/H classification adds no stable inference, inherited sensitivity is reduced to a descriptive partition of hidden-state path dependence.

A possible low-Weyl analogue belongs only to a later branch of Model A. Relevant classes of modes must be defined independently, and any selective effect must either follow from physically motivated coupling or emerge from the model's own dynamics rather than be prescribed to suppress the designated sector. Neutral couplings, reversed selectivity, and alternative damping structures should serve as controls. The desired smooth state counts as a result only if it emerges robustly rather than being encoded in the equations.

The model must specify negative outcomes before calculation. The concept is weakened if R and H cannot be separated, if their interaction is negligible, if thresholds do not change under controlled conditions, or if the same results follow from a simpler model. A failure of the cosmological analogy would not invalidate the operational PDS language in other domains, but it would block the stronger application proposed here.

12.2 Model B: thermodynamic extension

A second modeling stage can ask whether renewal is thermodynamically admissible. It requires more structure than Model A: a defined state space or coarse-graining, subsystem boundaries for L , H , and the environment, and a declared entropy functional appropriate to the chosen dynamics. Only then can entropy production, transfer, and export be calculated.

The energetic account must distinguish total energy from available free energy, coherent organized energy, and energy dispersed into thermalized degrees of freedom. Backreaction must appear in the balance rather than allowing the higher order to function as an unlimited source. The test is whether a renewed organized regime can form as a nonequilibrium process while the combined energy and entropy accounting closes.

Model B would still be a toy model unless its variables were connected to a physical cosmological ontology. Its value is methodological: it can show whether the architecture hides an entropy reset, whether finite drive and dissipation permit repeated renewal, and which assumptions would have to be replaced before any gravitational interpretation becomes defensible.

13. Conclusion

The question posed in the title admits a limited answer. An ordered cosmological beginning does not have to be history-free. CCC embeds a new aeon in a conformal succession, and eternal inflation embeds local domains in a continuing inflating background. A multilevel oscillatory

hierarchy offers another conceptual architecture in which a lower order acquires a genuine local time-zero while a wider order continues through its own dynamical history.

The proposal adds two analytically distinct channels of conditioning: the residue of the preceding lower order and the current state of the higher order. Their joint influence is described as inherited sensitivity, a disposition expressed through realized response, stability, thresholds, and accessible trajectories. Whether that classification has value beyond hidden-state path dependence is not settled by the conceptual argument. Model A is intended to decide it, and Model B is required before renewal can be called thermodynamically admissible.

Penrose's physical problem remains open. Historical embedding does not explain the suppression of gravitational degrees of freedom, and no low-Weyl mechanism has been derived. The contribution of the article is therefore threefold: it distinguishes local origin from absolute origin, identifies a two-channel form of historical conditioning, and specifies the tests and failure conditions required for that architecture to become physically meaningful. Its unresolved core is equally explicit: a future model must still show why a historically conditioned beginning would be gravitationally smooth.

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