Cyclical, Nested Cosmology with Persistent Gravitational Topology

Dark matter as gravitational memory; black holes as temporal archives; cosmic structure as inherited constraint geometry

David Lones

February 2026

Abstract

We propose a speculative framework in which the universe is a *nested, cyclical* system whose large-scale structure is governed by **persistent gravitational topology** rather than continuously novel initial conditions.

Topology is encoded at an early epoch, preserved and amplified by a collisionless metric component interpreted here as dark-matter geometry, and revealed by baryonic matter as a late-arriving tracer. Black holes are reinterpreted as **temporal mirror inversions**: surface-bound archives encoding the past worldlines of absorbed matter as horizon data.

1 Introduction

Standard cosmology explains structure growth but leaves unresolved the origin of large-scale topology, the nature of dark matter, and the fate of information. This thesis reallocates explanatory roles rather than introducing new entities.

> The universe does not invent structure every morning; it unfolds it.

2 Early Encoding of Topology

Inflationary perturbations encode a constraint graph of peaks, filaments, saddles, and voids. This is not a blueprint for galaxies, but a topological skeleton limiting later evolution.

We model the progression as:

$$\text{Topology} \longrightarrow \text{Metric scaffold} \longrightarrow \text{Tracer dynamics} \longrightarrow \text{Archive saturation} \longrightarrow \text{Conformal recursion}$$

3 Dark Matter as Persistent Metric Geometry

Dark matter is treated here not as exotic particles nor cross-universe gravity, but as long-lived curvature modes: **gravitational memory** inherited across cosmic epochs.

- Explains smooth halos and filaments
- Explains robustness of the cosmic web
- Requires no new interactions

We decompose the metric as

$$g_{\mu\nu} = \bar{g}_{\mu\nu} + h^{(b)}_{\mu\nu} + h^{(p)}_{\mu\nu}$$

where $h^{(p)}$ represents persistent curvature modes (the dark matter candidate) that satisfy

$$\frac{d}{dt} h^{(p)} \approx 0$$

4 Baryons as Tracers

Baryonic matter is dissipative and late-arriving. It statistically settles into pre-existing attractors, revealing rather than creating structure.

Geodesic motion holds:

$$\frac{Du^{\mu}}{D\tau} = 0$$

with entropy production $\dot{S} > 0$.

5 Nested Branching and Degeneracy

Fine-scale histories may branch into near-identical realizations. These branches do not interact; they become indistinguishable as entropy compresses degrees of freedom.

Microhistories form equivalence classes under coarse-graining:

$$\Gamma_i \sim \Gamma_j \quad \text{if} \quad D(\Gamma_i, \Gamma_j) < \epsilon$$

6 Black Holes as Temporal Mirror Archives

A black hole is not a container in space but a **mirror in time**. The event horizon functions as an index surface encoding absorbed worldlines. The interior represents compressed, inverted orderingnot a forward narrative.

Horizon entropy remains

$$S = \frac{A}{4G\hbar}$$

interpreted as archive capacity. Worldlines map to horizon state:

$$\mathcal{W} \to \mathcal{H}$$

A black hole is a surface-written archive of everything that fell into it.

7 Horizon Merging and Convergence

As black holes merge and expansion isolates regions, micro-historical differences collapse into equivalence classes. Convergence occurs through loss of distinguishability, not interaction.

Archive merging:

$$\mathcal{H}_{12} = \mathcal{H}_1 \oplus \mathcal{H}_2$$

Differences compress via entropy increase.

8 Conformal Inversion and Cosmic Recursion

The far-future horizon-dominated state becomes conformally equivalent to an inverted initial condition, allowing topological inheritance across cycles.

As $T \to 0$, scale becomes irrelevant. We apply the conformal mapping

$$g_{\mu\nu} \to \Omega^2 g_{\mu\nu}$$

so the late state can serve as an effective new initial condition.

9 Topology Persistence Dynamics

We formalize persistent curvature modes as slow variables in cosmological evolution.

Let $\mathcal{T}$ denote the topological constraint field derived from primordial curvature. We model its evolution as

$$\frac{\partial \mathcal{T}}{\partial t} = -\lambda \mathcal{D}[\mathcal{T}] + \eta$$

where

- $\mathcal{D}$ represents dissipative baryonic backreaction

- $\lambda \ll 1$ expresses persistence
- η encodes stochastic quantum fluctuations

In the persistence limit $\lambda \to 0$, topology behaves as an effective conserved quantity across cosmic epochs.

10 Horizon Archive Formalism

We treat the event horizon as a boundary encoding operator.

Define a projection

$$\Pi_H : \mathcal{W} \to \mathcal{H}$$

mapping worldline data $\mathcal{W}$ to horizon microstates $\mathcal{H}$.

Archive density scales with area:

$$\rho_A = \frac{dS}{dA}$$

Black hole mergers then act as information coarse-graining operations:

$$\Pi_{H_{12}} = \mathcal{C}(\Pi_{H_1}, \Pi_{H_2})$$

where $\mathcal{C}$ represents entropy-increasing compression.

This reframes gravitational collapse as boundary accumulation rather than interior storage.

11 Cycle Phase Space and Renormalization

Cosmic cycles can be interpreted as scale transformations in configuration space.

Let Λ denote characteristic scale. We consider flow:

$$\frac{d\mathcal{T}}{d \ln \Lambda} = \beta(\mathcal{T})$$

where β is a topology flow function.

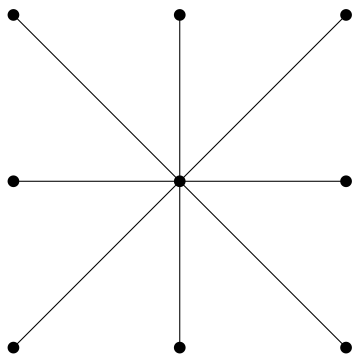
A fixed point

$$\beta(\mathcal{T}_*) = 0$$

represents a persistent cosmological skeleton inherited across cycles.

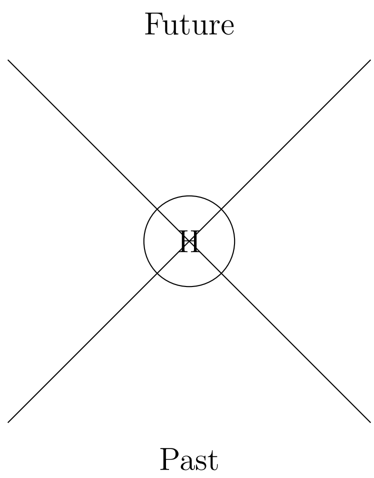
This suggests cosmic recursion behaves analogously to renormalization group flow.

12 Standing Cosmic Web Geometry



Filament network as standing topology

13 Causal Archive Geometry



The horizon H acts as a causal boundary where worldlines terminate and archive encoding occurs.

14 Implications

- Dark matter as gravitational memory
- Cosmic web as standing topology
- Black holes as archival endpoints
- Cycles as re-expression, not replay

15 Falsifiability

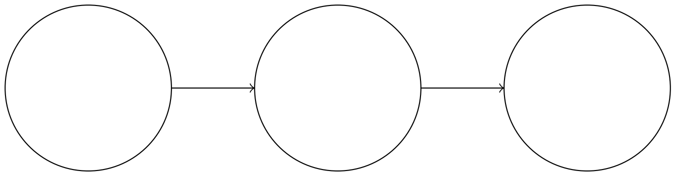
The framework fails if early-epoch topology does not statistically correlate with late-time lensing structure, or if large-scale coherence contradicts inheritance of curvature modes.

Prediction: correlation between early curvature and late lensing

$$\rho = \mathrm{corr}(\Phi_{\mathrm{early}}, \kappa_{\mathrm{lensing}})$$

Framework falsified if $\rho \approx 0$.

16 Visual Model of Recursion



Cycle A Archive Cycle B

17 Conclusion

The universe is framed as a memory-bearing geometric system: it explores difference locally, compresses it globally, and re-expresses inherited constraints across cycles.