The Seam–Fold–Bulk Conjecture

A Framework for Informational Cosmology and Emergent Spacetime

Author: David Kocher
August 2025

Abstract

This paper presents a new framework in cosmology called the Seam–Fold–Bulk Conjecture. The central idea is that the universe—its matter, energy, space, and time—emerges not from fixed laws or constants, but through the recursive organization of information. Rather than relying on a singularity at the Big Bang or assuming the universe began from nothing, this model proposes that what we call "spacetime" unfolds in three functional phases: the **Seam**, a kind of boundary between eras of the universe; the **Fold**, a stage of recursive transformation where raw information becomes structured; and the **Bulk**, the large-scale, familiar reality of space, time, and matter.

This framework is inspired by developments in loop quantum cosmology, holographic theories like AdS/CFT, and tensor network models from quantum information theory. It treats time not as a built-in dimension of the universe, but as something that emerges from change—specifically, from the way information is transformed and organized. Similarly, dark energy is reframed as a temporary condition rather than a permanent cosmological constant. This model is testable through cosmological observations and is intended as a serious alternative to models like ΛCDM and inflationary multiverse theories.

---

1. Introduction

Current cosmological models, especially ΛCDM, do an excellent job describing the structure and behavior of the observable universe. They predict the cosmic microwave background, the formation of galaxies, and the accelerating expansion of space. But they also leave fundamental questions unanswered. Chief among these are: What happened before the Big Bang? What is the true nature of dark energy? And is time something that exists fundamentally, or does it emerge from something deeper?

Recent advances in physics have opened the door to alternative answers. Loop quantum cosmology, for example, suggests that the universe didn't begin with a singularity but instead

underwent a "bounce" from a previous phase. Meanwhile, theories like the holographic principle and the AdS/CFT correspondence show that the full content of a volume of space may be encoded on its boundary—implying that space itself could be a derived concept. Additionally, research into tensor networks and quantum error-correcting codes suggests that the very structure of space could arise from how information is organized and preserved.

In this context, the Seam–Fold–Bulk Conjecture proposes a new framework. It suggests that the universe isn't built on a fixed background of space and time, but rather arises from a recursive process of informational transformation. This process is structured in three stages—the Seam, the Fold, and the Bulk—that correspond to different ways information behaves and manifests. These stages help explain how the universe evolves, why time seems to flow, and why dark energy might not be constant after all.

---

2. The Seam–Fold–Bulk Framework

The Seam

The Seam represents a boundary between two cosmic epochs. It is not a physical object, but a transition surface where the usual rules of classical physics no longer apply. In traditional models, the beginning of the universe is described as a singularity—an infinitely small and dense point. But in loop quantum cosmology, that singularity is replaced by a smooth transition known as a "bounce." The Seam is the informational counterpart to this idea. It's a boundary where the previous phase of the universe ends and a new one begins—not through destruction or creation from nothing, but through transformation of informational structure.

At this boundary, information exists in a disordered or unstructured state. Rather than being organized into particles or spacetime, it is something more primitive—like raw data before it is processed.

The Fold

After the Seam, information undergoes a process of recursive transformation called folding. This stage is where patterns emerge from disorder. The Fold takes disorganized information from the boundary and compresses it into structured forms that give rise to things like space, energy, and causality.

The idea of folding comes from theories like the AdS/CFT correspondence in string theory, where a lower-dimensional surface encodes the geometry of a higher-dimensional space. It also connects with work in quantum information science, especially tensor networks and quantum

error-correcting codes. These tools show how complex systems can be built from simple, repeated operations that preserve information even when individual parts fail or change.

In this framework, the Fold is a dynamic, recursive process. It doesn't happen just once—it continues as the universe evolves, building complexity layer by layer.

The Bulk

The Bulk is the emergent domain we recognize as the universe. It's the space where galaxies, black holes, and physical laws play out. But according to the Seam–Fold–Bulk model, this large-scale structure is not fundamental. Instead, it is the result of deep, ongoing transformations happening at the informational level during the Fold stage.

Importantly, the structure of the Bulk depends on how much information has been folded and how that information is organized. The geometry of space, the flow of time, and even the presence of dark energy arise from this process. What we think of as constants—like the cosmological constant (Lambda)—may in fact change slowly over time as the folding continues and saturates.

Time as Emergent

One of the most radical features of this model is its treatment of time. Instead of being a built-in axis of reality, time is viewed as something that arises from change. Specifically, time is defined by how informational states evolve relative to each other. If nothing changes, time doesn't flow. When information transforms—such as during folding—time appears to move forward.

This idea resonates with "thermal time" proposals and relational models of physics, where time is not an independent background but a way to describe motion between states.

---

3. Implications for Cosmology

Dark Energy Is Not Constant

The Seam–Fold–Bulk model predicts that dark energy—the mysterious force accelerating the expansion of the universe—is not constant. Instead, it is seen as a kind of "entropic tension" that results from folding. As the Fold process progresses and complexity saturates, this tension weakens and begins to decay. This could explain emerging data suggesting that cosmic acceleration may be slowing down at certain redshifts.

Gravity Makes a Comeback

As dark energy fades, gravity can once again dominate cosmic dynamics. This leads to a reorganization of matter and structure formation. Rather than expanding forever into emptiness, the universe could enter a new phase where gravitational attraction shapes its fate—perhaps even leading to another contraction and bounce.

The Universe May Be Cyclic

When folding reaches its informational limit, the system resets: a new Seam emerges, and the process begins again. Each cycle inherits some features from the last but remains distinct. This avoids problems seen in other cyclic models, such as infinite entropy buildup. In this framework, entropy is bounded, and the universe evolves through lawful, non-destructive cycles.

Geometry is a Form of Computation

Another consequence of this model is that the structure of the universe may be understood as a kind of computation. The recursive nature of folding resembles quantum circuits or tensor networks, where each operation builds on the last and encodes meaningful geometry. This connects the universe's large-scale structure with the logic of information processing.

The Arrow of Time Comes from Information Flow

The directionality of time—why the past is different from the future—emerges from the recursive nature of folding. Each new Fold state builds on the last but is not simply reversible. This asymmetry creates the experience of time flowing forward, even though the system as a whole remains unitary and reversible at a fundamental level.

---

4. Theoretical Constraints and Predictions

This model is consistent with several existing theories:

- **Loop quantum cosmology** supports the bounce and Seam concept.

- **Holographic principles** support the idea of folding information from boundaries into higher-dimensional space.
- **Tensor networks and quantum error correction** align with how Fold recursion could build up the Bulk.

It also stands apart from other models:

- It does **not** require a fixed cosmological constant.
- It avoids invoking a multiverse or eternal inflation.
- It treats time and entropy as emergent, not imposed.

The model makes testable predictions, including:

- A slow decay in dark energy rather than a constant value.
- Possible signatures in the cosmic microwave background from past Folds.
- Gravitational waves leftover from previous cosmic cycles.
- Slight differences in how matter clusters in space due to entropy gradients in folding.

---

5. Conclusion

The Seam–Fold–Bulk Conjecture offers a bold reimagining of the cosmos. Rather than starting from a singular point or relying on untestable metaphysical ideas, it builds a universe out of information and recursion. Time, space, matter, and energy emerge from this recursive process. Dark energy is temporary. The universe is not a one-time event but a cycling pattern of informational reorganization.

This framework draws strength from quantum gravity, holography, and information theory. It provides a unified model with clear predictions and avenues for falsification. If supported by future observations, it could represent a major shift in how we understand the origin, structure, and fate of the universe—not as a static thing, but as a recursive unfolding of structured information.