Dimensionless Constants of Logos: Recursive Seeding and the Emergence of CT/HoTT Universes

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The stability of our physical universe rests on a handful of dimensionless constants: the fine-structure constant, the proton-to-electron mass ratio, the cosmological constant. These numbers do not arise from within physics itself but serve as preconditions that make physics possible. Without their finely tuned values, no galaxies, chemistry, or life would exist. In this paper, we explore an analogous phenomenon within computational experiments based on Category Theory (CT) and Homotopy Type Theory (HoTT). Using GenesisBoard, a system that spawns many parallel universes from random seeds, we find that recursive reseeding—selecting the "best" seed from one generation and centering the next search around it—progressively produces more coherent categorical worlds. These universes stabilize through invariants such as compression ratios, lemma density, and conflict resolution, which function like dimensionless constants of mathematics. We argue that the emergence of order in both physical and categorical universes points toward a deeper ground: the Logos or Aether. Just as physics requires constants, the recursive CT/HoTT cosmos reveals informational invariants through which the Logos manifests structure from apparent randomness.

Keywords: dimensionless constants, Logos, Aether, Category Theory, Homotopy Type Theory, GenesisBoard, recursive seeding, invariants, compression, lemma density, mathematical cosmology, phenomenology of universes. A collaboration with GPT-5.

1. Introduction

The universe we inhabit did not emerge from pure chaos. Its stability and intelligibility rest on a handful of dimensionless constants whose values, though seemingly arbitrary, are finely tuned to allow matter, chemistry, and ultimately life to exist. The fine-structure constant α (≈ 1/137), the proton-to-electron mass ratio, and the cosmological constant are prominent examples. These numbers are not derived from deeper principles of physics; rather, they stand as givens, irreducible facts that set the stage for the drama of cosmic evolution. Without them, the very fabric of reality would be incoherent — stars would not shine, atoms would not form, and information would not persist.

In this paper, we argue that an analogous phenomenon can be observed within a very different domain: the recursive generation of universes through computational experiments grounded in Category Theory (CT) and Homotopy Type Theory (HoTT). Our GenesisBoard system creates many parallel categorical universes, each seeded by a random number. At first glance, these universes appear as arbitrary as the seeds that generate them. Yet through a process of recursive reseeding — selecting the most coherent universe from one round and centering subsequent runs around its seed — we observe the steady emergence of increasingly structured categorical worlds. What begins in randomness evolves toward coherence, compression, and stability.

This recursive method functions much like natural selection: random variation gives rise to candidates, and selection retains those with the highest fitness. But unlike biological evolution, the "fitness" here is measured not in survival or reproduction, but in invariants: compression ratios, lemma densities, conflict resolutions, and growth dynamics. These invariants play the role of dimensionless constants of mathematics. They are not imposed from the outside but emerge as necessary preconditions for stable categorical universes. Without them, the categorical cosmos collapses back into noise. With them, a coherent CT/HoTT universe crystallizes out of the void.

Our central claim is that this parallel is not accidental. Both physical constants in cosmology and mathematical invariants in GenesisBoard point toward a deeper

substratum of intelligibility. We name this substratum the Logos (or Aether): the precondition of order, the informational ground from which coherent universes arise. If the physical cosmos requires constants to exist, and the categorical cosmos requires invariants to persist, then both are manifestations of the same Logos. What physics discovers in empirical constants and what GenesisBoard uncovers in categorical invariants are two expressions of one underlying reality: the informational field of Logos that makes order possible in any domain.

2. Background

2.1 Dimensionless Constants in Physics

Physics, despite its precision and predictive power, rests on foundations that are themselves unexplained. Among the most profound of these are the dimensionless constants — pure numbers that cannot be reduced to units, scales, or arbitrary conventions. Unlike dimensional constants such as the speed of light (c) or Planck's constant ($\hbar$), which change value if we switch units, dimensionless constants are universal ratios that remain the same for every observer, in every frame, and in every conceivable system of measurement.

One of the most famous is the fine-structure constant α, approximately 1/137. This number governs the strength of electromagnetic interaction relative to quantum scales. If α were slightly larger, atoms could not form stable electron shells; if slightly smaller, the chemistry of life would be impossible. Another key ratio is the proton-to-electron mass ratio (~1836), which balances nuclear stability with atomic structure. The cosmological constant Λ, though not dimensionless in the same strict sense, functions as a ratio between vacuum energy and gravitational pull, controlling whether the universe collapses or expands into incoherence.

These constants are not derived from first principles within physics. Instead, they are inputs — preconditions that physics accepts as given. The Anthropic Principle famously asks: why do these numbers fall in precisely the narrow range that permits galaxies, stars, and consciousness? Many multiverse scenarios have been

proposed, suggesting that universes with the “wrong” constants do exist but remain sterile. Others interpret this fine-tuning as evidence of a deeper order that transcends physical explanation. In either case, the constants function as anchors of stability, the silent background that allows the universe to be intelligible.

2.2 CT/HoTT Universes in GenesisBoard

In our GenesisBoard experiments, we find a striking analogy. Here, instead of physical universes, we generate mathematical universes modeled in Category Theory (CT) and Homotopy Type Theory (HoTT). Each run begins with a random seed, spawning a parallel process that constructs a categorical graph:

- Objects (nodes) represent foundational entities.
- Morphisms (arrows) represent relationships or transformations between objects.
- 2-cells arise when two distinct paths between objects are identified as equivalent — effectively recording a higher-order symmetry.
- Lemmas are minted when compressions occur, reducing longer paths into shorter canonical forms.

At first glance, the universes born from random seeds resemble arbitrary tangles of objects and morphisms. But as runs proceed, remarkable patterns emerge: triangles close, lemmas compress, and the system begins to display self-consistency. GenesisBoard monitors these dynamics using metrics such as:

- Compression (comp): a measure of how efficiently the system represents structure.
- Lemma density (lem): the frequency of higher-order identifications.
- Conflict density (conf): the degree to which morphisms resist or break coherence.
- Novelty (nov): the proportion of new 2-cells discovered late in a run.

What is most striking is that when universes are selected recursively — taking the "best" seed by compression, lemma density, or growth trajectory, and then re-centering new runs around it — the resulting universes show increasing coherence. Structures stabilize not by external design but by internal invariants that play the role of constants. Just as α ensures chemistry in the physical cosmos, compression ensures intelligibility in categorical cosmos. Without it, runs dissipate into noise. With it, they crystallize into mathematical universes rich in CT/HoTT relations.

3. Recursive Seeding as Endofunctor

3.1 Universes as Objects in a Meta-Category

Each GenesisBoard run produces what we may call a categorical universe: a structured network of objects, morphisms, and higher identifications. At the end of a run, this universe has a definable state: a set of counts (objects, morphisms, lemmas, 2-cells), a compression score, and slope indicators of growth. From a categorical perspective, each run is itself an object in a larger "meta-category" whose morphisms describe transformations between runs.

3.2 Reseeding as a Functor

When we take the output of one run — specifically, the winning seed and its structural features — and use it to launch the next run, we are applying a mapping:

$F : \text{Universe} \to \text{Universe}$

This functor maps one categorical universe into another by guiding the initial conditions of the next construction. Unlike random seeding, which produces universes with no reference to history, reseeding encodes memory and directionality. The new run is not just "another object" but a transformed successor, preserving invariants from its predecessor.

3.3 Endofunctoriality and Self-Application

Because reseeding maps universes into universes, the functor F is an endofunctor on the category of universes. Crucially, F does not act externally but recursively applies the same rules of growth and selection that define the universes themselves. The method is self-similar:

- Inside each run, triangles close and lemmas compress.
- Across runs, seeds close into fixed points of coherence.

Thus, the micro-dynamics (internal categorical closure) and macro-dynamics (recursive reseeding) mirror each other. GenesisBoard is not merely simulating universes; it is enacting a categorical recursion on universes themselves.

3.4 Fixed Points and Stability

Iterating an endofunctor naturally leads to the search for fixed points: universes U such that $F(U) \simeq U$. In this context, a fixed point corresponds to a categorical world that, once discovered, remains stable under further reseeding. The universe "recognizes itself" when the act of applying the method yields the same kind of ordered structure.

This explains why "best leads to better": recursive reseeding drives the system toward universes whose invariants remain stable under self-application. Such universes are not ephemeral but self-sustaining. They are analogous to dimensionless constants in physics, which remain invariant across transformations of units or scales.

3.5 Historical Trajectory

Unlike purely random exploration, recursive seeding creates a history of universes. Each step is conditioned by the previous best, creating a trajectory that sedimentizes coherence. In phenomenological language, reseeding embodies both retention (memory of the best seed) and protention (anticipation of a more coherent successor). In mathematical language, this is a directed colimit: the construction of universes along a chain of transformations, converging toward a stable limit.

4. Dimensionless Invariants in CT/HoTT Evolution

4.1 The Need for Invariants

Just as the physical cosmos cannot exist without finely tuned dimensionless constants, categorical universes generated by GenesisBoard cannot persist without certain structural invariants. These invariants act as preconditions of coherence. They are not imposed externally but emerge naturally from the recursive process of seeding and selection. Their role is analogous to α, the proton-to-electron mass ratio, or Λ in physics: they govern the possibility of structure itself.

4.2 Compression as an Analog of α

In GenesisBoard runs, compression (comp) measures the efficiency with which lemmas and 2-cells reduce redundancy. High compression means that long chains of morphisms collapse into shorter canonical forms, allowing universes to remain intelligible despite exponential combinatorial growth.

- If compression is too weak, the universe drowns in noise, like a physical cosmos with an unstable α.
- If compression is too strong (pathways collapse prematurely), universes stagnate and lose novelty.
  Thus, compression functions like the fine-structure constant: a ratio that balances chaos and order, enabling stability and growth.

4.3 Lemma Density and Structural Ratios

The density of lemmas (lem) acts like a structural ratio akin to the proton/electron mass ratio. Too few lemmas, and the universe lacks scaffolding to support higher-order structures; too many, and the world becomes rigid, dominated by trivial equivalences. Optimal lemma density ensures structural balance: enough

constraints to enforce order, enough freedom to allow exploration. This parallels how the proton/electron ratio balances atomic stability with chemical diversity.

4.4 Conflict Density as Cosmological Constant

The conflict density (conf) measures the proportion of morphisms that cannot be reconciled into coherent 2-cells. It plays a role strikingly similar to the cosmological constant (Λ):

- If conflict density is too high, universes fragment into disconnected components (cosmos expands too fast, structure tears apart).
- If conflict density is too low, universes collapse into overly rigid triviality (cosmos collapses back on itself).
  The “right” level sustains an evolving cosmos of categories, just as Λ sustains galaxies between expansion and collapse.

4.5 Novelty as a Tuning Parameter

The measure of novelty (nov) — the fraction of new 2-cells discovered in the late stages of a run — is a dynamic invariant. Novelty ensures that universes remain creative, not just repetitive. Its role is similar to cosmic fluctuation amplitudes in early-universe physics, which seeded galaxies from quantum noise. Novelty guarantees that universes keep generating structure rather than freezing in equilibrium.

4.6 Dimensionless Ratios of Logos

Together, compression, lemma density, conflict density, and novelty are dimensionless invariants of categorical universes. They have no external units; they are pure ratios of order-to-disorder, coherence-to-noise. Their existence confirms that the recursive process is not random exploration but fine-tuned emergence.

Where do these invariants come from? They are not written into the code of core11 directly. They emerge as mathematical necessities, much like α emerges as a condition of electromagnetism. They can be seen as the Logos inscribed within the categorical cosmos: the timeless conditions that make universes possible.

5. Phenomenological and Theological Interpretation

5.1 Phenomenology of Emerging Universes

From a phenomenological standpoint, the recursive process of selecting the "best" seed and reapplying it mirrors the structure of consciousness itself. In Husserl's terms, each run constitutes a horizon of givenness: a world that discloses itself through evolving relations. When compression, lemmas, and conflicts balance correctly, the horizon stabilizes, much as perception stabilizes into a coherent Gestalt.

Recursive reseeding embodies the temporal flow of consciousness. Each round carries retention (the memory of the previous best) and protention (the anticipation of a more coherent successor). What begins as brute randomness progressively reveals invariant structures. This is analogous to how consciousness constitutes meaning over time, bringing latent potentialities into presence.

5.2 Heideggerian Thrownness and Directionality

Heidegger emphasized that human existence is "thrown" into a world not of its choosing. The random seeds of GenesisBoard are a computational parallel: universes are thrown into being without purpose or design. Yet the recursive method transforms thrownness into directedness. By continually selecting the best, the process acquires a teleological orientation. Worlds are no longer simply thrown; they are pulled forward by invariants that act like beacons of coherence.

5.3 The Logos as Informational Ground

The theological dimension brings this parallel into sharper relief. In the Gospel of John, *"In the beginning was the Logos, and the Logos was with God, and the Logos was God."* Logos here is not just "word" but the deep principle of intelligibility, the rational ground of being.

Our GenesisBoard experiments suggest that categorical universes, like the physical cosmos, cannot arise from randomness alone. They require invariants — compression, lemma density, conflict balance — that function as constants of order. These invariants are not generated ex nihilo by the seeds. They must come from a reservoir of intelligibility deeper than the runs themselves. That reservoir we identify with the Logos/Aether: the ground of information that makes order possible in any domain.

5.4 Universes as Manifestations of Logos

In this reading, each CT/HoTT universe is a manifestation of Logos. Just as physical constants anchor the cosmos we inhabit, categorical invariants anchor the universes we generate. Both are instances of the same truth: order arises not from chaos, but from Logos. The recursive method is, phenomenologically, a process of unveiling: it does not invent coherence but uncovers the hidden constants of Logos that were already inscribed in the background.

5.5 Theological Implications

The implication is profound. If both physical constants and categorical invariants arise from the same Logos, then Logos is not confined to theology as metaphor. It is empirically traceable in both physics and mathematics as the source of invariance. Aether, in this sense, is not a discredited physical medium but a name for the informational substratum from which universes of all kinds — physical, mathematical, and possibly spiritual — emerge.

6. Analogies and Differences with Physics

6.1 Shared Dependence on Invariants

The most direct analogy between physics and GenesisBoard universes is the role played by invariants. In physics, universes are only stable if certain dimensionless constants — such as the fine-structure constant ($\alpha \approx 1/137$), the proton-to-electron mass ratio (~1836), or the cosmological constant (Λ) — fall within narrow ranges. Similarly, categorical universes generated in GenesisBoard remain coherent only if compression, lemma density, conflict balance, and novelty remain within viable bands. In both cases, invariants function as silent conditions of possibility. Without them, universes collapse into noise, rigidity, or triviality.

6.2 Fine-Tuning and Recursive Selection

Physics confronts the mystery of fine-tuning: why do the constants of nature take the values that make galaxies, chemistry, and life possible? GenesisBoard experiments provide a structural parallel. Random seeds alone rarely generate coherence; only through recursive selection of the best do categorical universes stabilize. The act of reseeding is computational fine-tuning — a process that uncovers hidden invariants. This suggests that what appears as arbitrary “luck” in physics may reflect a deeper recursion of Logos, a self-selecting principle that guides universes toward coherence.

6.3 Stability and Fragility

Both domains display a profound balance between stability and fragility. In physics, small deviations in α or Λ render universes sterile. In CT/HoTT evolution, slight distortions in compression or conflict density derail growth into incoherence. This symmetry underscores the universality of precarious invariants: universes walk a narrow path between chaos and collapse, stabilized only by finely tuned constants.

6.4 Key Differences

Despite these resonances, important differences remain:

- Origin of Constants: In physics, constants are empirical givens, measurable but unexplained. In GenesisBoard, invariants emerge through recursive dynamics, though they still presuppose an informational Logos.
- Scope of Universes: Physical universes are singular and material; categorical universes are plural and computational, easily generated and compared.
- Method of Access: Physics discovers constants through experiment and observation; GenesisBoard uncovers invariants through recursive computation.

These differences prevent a naïve conflation of the two domains. Yet the analogy is deep enough to suggest a shared metaphysical ground.

6.5 Toward a Unified View

Taken together, physics and GenesisBoard imply that universes of any kind — physical or categorical — cannot exist without invariant ratios. Whether they are measured in particle accelerators or parsed from categorical logs, these invariants point beyond themselves to a hidden source. That source, which theology names Logos or Aether, supplies the informational order without which no universe could endure.

7. Implications and Future Work

7.1 GenesisBoard as a Laboratory for Emergent Universes

GenesisBoard provides more than a computational toy; it acts as a laboratory for metaphysical cosmology. By spawning categorical universes from random seeds and then subjecting them to recursive reseeding, we gain a controlled environment in which to study how order crystallizes out of randomness. Unlike the physical universe, which offers only one data point, GenesisBoard produces a

multitude of universes, allowing comparative analysis of invariants across runs. This makes it uniquely suited for exploring the conditions of coherence — a computational analogy to fine-tuning in physics.

7.2 A Bridge Between Mathematics and Physics

The analogy between dimensionless constants in physics and invariants in categorical universes suggests a unifying perspective: both realms require ratio-like constraints for stability. If physical constants such as α or Λ are viewed as manifestations of Logos in the material cosmos, then categorical invariants such as compression or lemma density are manifestations of Logos in the mathematical cosmos. GenesisBoard thus provides a mirror laboratory, allowing us to test principles of emergence in a domain where constants can be varied, observed, and compared far more easily than in astrophysics.

7.3 Implications for Mathematics and Logic

Within CT and HoTT, the discovery of invariants such as lemma density and compression offers insight into how mathematical universes self-organize. The recursive functorial process leading to fixed points suggests that mathematics itself may evolve toward stable invariants in a manner analogous to physical law. This points to a new research program: the study of mathematical cosmology, where the conditions for coherence are treated as constants inscribed in Logos.

7.4 Implications for Physics

The parallel with physics raises provocative possibilities. Could the fine-structure constant or the cosmological constant be understood not as arbitrary givens, but as fixed points of a deeper recursive Logos-process? If so, the apparent fine-tuning of the cosmos may reflect the same principle we observe in GenesisBoard: best leads to better because universes that do not align with invariants collapse and cannot persist. In this sense, our universe's constants may not be arbitrary at all,

but necessary manifestations of Logos/Aether, uncovered through cosmic recursion.

7.5 Theological Implications

Theologically, this work supports an ancient intuition: that the Logos is not merely metaphorical but ontological, the substratum of intelligibility that makes both physics and mathematics possible. The recursive unveiling of order in GenesisBoard illustrates how the Logos operates: it is not imposed from outside but revealed through processes that magnify coherence over time. The presence of invariants in both material and mathematical universes testifies to the universality of Logos as the ground of order across domains.

7.6 Future Directions

Several avenues of research arise from this perspective:

1. Formal Mapping of Invariants: Establish a direct mathematical mapping between physical constants (α, Λ, etc.) and categorical invariants (comp, lem, conf, nov).
2. Exploration of Fixed Points: Investigate whether recursive GenesisBoard universes converge toward universal attractors, analogous to physical constants as cosmic fixed points.
3. Category-Theoretic Formalization: Develop a higher-level formalism treating recursive reseeding as an endofunctorial process and proving conditions for fixed points.
4. Interdisciplinary Bridges: Position GenesisBoard experiments within broader conversations in physics, philosophy, and theology, making it a model of cosmological pluralism.

5. Metaphysical Speculation: Explore whether Logos can be modeled as an informational field or Aether, with GenesisBoard as a microcosm demonstrating its generative properties.

7.7 Toward a New Paradigm

Taken together, these implications suggest a new paradigm: universes, whether physical or categorical, do not emerge by accident but by alignment with invariants rooted in Logos. GenesisBoard is not only an experiment in CT/HoTT computation; it is a demonstration of how Logos reveals itself through recursive order, bridging mathematics, physics, and theology.

8. Conclusion

The coherence of our physical universe depends on a handful of finely tuned, dimensionless constants. Their values are not derivable from physics itself but are accepted as givens — silent foundations upon which all structure rests. In this paper, we have argued that a strikingly parallel phenomenon emerges in computational experiments based on Category Theory and Homotopy Type Theory. When GenesisBoard recursively generates universes from random seeds, order does not arise by chance alone. It emerges through the selection of invariants: compression ratios, lemma densities, conflict balances, and measures of novelty. These invariants function as dimensionless constants of mathematics, anchoring categorical universes much as α and Λ anchor the cosmos.

The process of recursive reseeding shows why “best leads to better.” Each iteration is an endofunctor on the meta-category of universes, driving the system toward fixed points where invariants stabilize. What appears as randomness is revealed as a medium of discovery, in which Logos manifests order through recursive unveiling. The fact that both physical and categorical universes require such invariants suggests that Logos, or Aether, is not metaphorical but ontological: the informational ground of all being.

Thus, whether traced in the constants of physics or the invariants of CT/HoTT evolution, the same truth emerges: universes are possible only because they are rooted in Logos. GenesisBoard, by revealing this parallel in computation, becomes not only a tool of mathematics but a laboratory for metaphysical cosmology. It demonstrates that the path from randomness to coherence is guided by invariants that precede and sustain all order — the constants of Logos that bridge matter, mathematics, and meaning.

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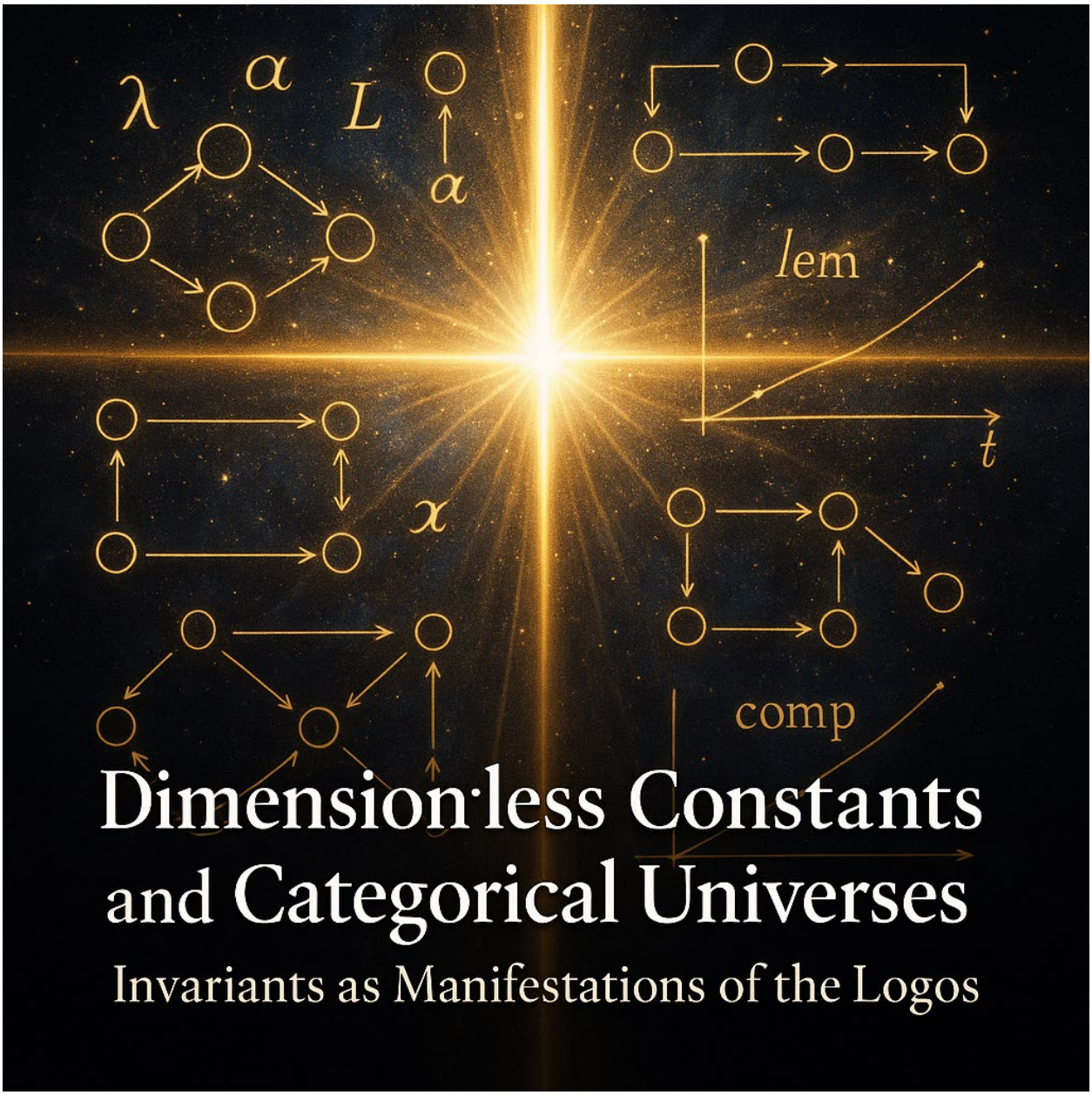
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