A Hypothesis for Cosmological Singularity Resolution and Initial Entropy Reset via Black Hole-White Hole Transitions

Rick Burger[1]

Independent Researcher

Abstract

This paper proposes a mechanism for cosmic genesis wherein a daughter universe is birthed via a white hole ejection sourced by a parent black hole collapse. We hypothesize that as macroscopic matter undergoes gravitational collapse toward the parent singularity, extreme tidal forces and Planck-scale quantum gravity effects resolve the singularity by completely dissociating complex matter states into their most fundamental quantum constituents. This extreme deconstruction acts as an information-scrambling and homogenization phase, stripping the infalling mass-energy of its structural history. Consequently, when this fundamental plasma undergoes a quantum bounce and is expelled from a white horizon, it emerges in a highly uniform, low-entropy configuration. This mechanism provides a physical basis for the low-gravitational entropy boundary conditions required at the onset of a new inflationary epoch, offering a novel resolution to the Past Hypothesis.

Section 1: Introduction and the Cosmological Initial Conditions Problem

1.1 The Successes and Limits of the Standard Model

The lambda-Cold Dark Matter (ΛCDM) paradigm stands as the premier mathematical framework of modern cosmology. By combining Einstein's General Theory of Relativity with observational data, this model successfully tracks the evolution of our universe across 13.8 billion years of cosmic time. It accurately accounts for the expansion of the cosmos, the abundance of light elements, and the formation of large-scale galactic structures.

However, despite these predictive triumphs, standard cosmology is fundamentally incomplete. It tracks the universe back to an ultra-hot, ultra-dense initial state, but fails to explain the physics of the origin event itself. Standard cosmology acts as a chronicle of the universe 's *history,* but it cannot explain its *birth.*

1.2 The Singularity Problem

The primary mathematical breakdown in standard cosmology occurs at time zero (t = 0). According to classical General Relativity, tracing the expansion of the universe backward in time forces all mass-energy into a point of zero volume. This results in a gravitational singularity-a state of infinite temperature, infinite curvature, and infinite density.

$$\lim_{V \to 0} \rho = \infty$$

In physics, an infinity is not a real physical metric; it is an indicator that the mathematical framework has broken down. Because classical relativity cannot handle the extreme scales of t = 0, it leaves the ultimate cause of the Big Bang completely hidden behind an unphysical mathematical wall.

1.3 The Past Hypothesis and the Low-Entropy paradox

Beyond the singularity problem lies a profound thermodynamic mystery known as the past Hypothesis (Rovelli, 2018). According to the Second Law of Thermodynamics, the total entropy (disorder) of an isolated system must always increase over time.

$$\Delta S \geq 0$$

If the universe is currently getting more disordered, it must have been more ordered in the past. Therefore, at the moment of the Big Bang, the universe must have existed in a state of nearly perfect thermodynamic order and exceptionally low gravitational entropy [6.1]

This creates a severe paradox. Under standard physics, matter packed tightly together should naturally form highly disordered, high-entropy black holes. Yet, observations of the Cosmic Microwave Background (CMB) prove that the early universe was an incredibly smooth, uniform, and low-entropy plasma. Standard cosmology provides no physical mechanism to explain *why* the universe began in such a pristine, highly ordered arrangement.

1.4 Thesis of Framework

This paper addresses both the singularity and low-entropy problems by replacing the arbitrary initial conditions of the Big Bang with a physical, cyclical mechanism. I propose that our universe was birthed via a white hole ejection sourced directly by the gravitational collapse of a parent black hole in a pre-existing universe [6.1].

Crucially, I introduce a specific mechanism for the Past Hypothesis: the extreme tidal forces of the parent black hole act as a cosmic purifier [6.1]. This collapse phase utterly deconstructs and rearranges complex matter states into their most basic, fundamental quantum constituents [6.1]. By stripping the incoming matter of its structural history and configurations, the subsequent quantum bounce resets the system's structural entropy to a baseline minimum [6.1]. The resulting white hole ejection naturally produces the smooth, uniform, and low-entropy initial conditions observed at the dawn of our cosmos [6.1].

The Entropy Reset Hypothesis: The extreme gravity of the parent black hole strips matter down to its most fundamental, uniform particles. This total deconstruction naturally resets the entropy to a minimum state before it bursts out of the white hole.

2.1 Macroscopic Gravitational Collapse and Tidal Distortion

The transition from a parent universe to a low-entropy daughter universe begins with the lifecycle of massive macroscopic structures. When a star collapses or a galactic center accumulates mass beyond the Tolman-Oppenheimer-Volkovsky (TOV) limit, it triggers a runaway gravitational collapse. As this matter crosses the parent black hole's event horizon, it experiences extreme gravitational gradients. In classical General Relativity, these tidal forces diverge toward infinity. In our framework, these forces serve a critical thermodynamic function: they act as a macroscopic deconstruction mechanism, shearing structures into an increasingly undifferentiated plasma (Smolin, 1997) [1].

2.2 The bounded Density limit and Singularity Resolution

Classical frameworks dictate that infalling matter must crush into a zero-volume point of infinite density-the singularity. However, my model utilizes quantum gravity corrections which impose a fundamental upper limit on spacetime curvature: the **Planck** density ($\rho_{pl} \approx 10^{96}$ kg/m³).

$$\rho \leq \rho_{pl}$$

Upon approaching this threshold, the classical singularity is successfully resolved (Rovelli & Haggard, 2014) [2]. The infalling mass-energy can no longer contract. Instead, the extreme energy density forces a phase change in the matter itself, preventing the breakdown of physical laws (Ashtekar et al., 2006) [3].

2.3 Structural Stripping and Information Scrambling

At the peak of this collapse, the identity of the individual particles is completely destroyed. This phase acts as a universal cosmic purifier through two specific processes:

- **Hadronic Dissociation:** Bounded states like protons, neutrons, and heavy nuclei are utterly ruptured, reducing the baryonic matter into a uniform, fundamental soup of quarks, leptons and gauge bosons (Poplawski, 2010) [4].
- **Thermalization and Entropy Evacuation:** As macroscopic complexity is erased, the structural information of the incoming matter is thoroughly "scrambled." Because macroscopic arrangements (like stars, planets, and molecules) are entirely broken down into indistinguishable fundamental particles, the geometric and structural entropy of the system undergoes a massive localized reset. This satisfies the strict boundary conditions required to explain the universe's orderly start (Penrose, 1979) [5].

2.4 Transition to the Bouncing State

Once the matter is stripped to its absolute most fundamental quantum level, it exists as a perfectly uniform, highly compressed, and symmetric fluid. It retains no memory of its previous macroscopic configurations. This homogeneous, high-density, stripped fluid forms the exact physical boundary condition required to trigger a quantum bounce. It is this pure, unpatterned plasma that stands primed to serve as the low-entropy beginning of the subsequent daughter universe.

Section 3: Quantum bounce and Spacetime Inversion

3.1 Loop Quantum Gravity and the Minimum Volume Threshold

To understand how the stripped, fundamental plasma transitions from a collapsing state to an expanding one, we must look beyond classical General Relativity. In classical physics, gravity is always attractive, which inevitably forces a singularity. However, under Loop Quantum Gravity (LQG), space is not a smooth fabric but is composed of discrete, quantized "loops" or chunks of spacetime (Ashtekar & Bianchi, 2021).

When the infalling matter reaches the Planck density threshold established in Section 2.2, these fundamental units of space cannot be compressed further. At this specific scale, the fabric of spacetime exerts a powerful, non-classical quantum repulsive force.

3.2 The Mechanism of the Quantum Repulsive Force

The mathematical transition is governed by the effective cosmological equation for a quantum -corrected universe. The standard expansion rate (the Hubble parameter, *H*) is modified by the ratio of the actual energy density (ρ) to the critical Planck density (ρ_{crit}):

$$H^2 = \frac{8\pi G}{3}\,\rho\left(1 - \frac{\rho}{\rho_{crit}}\right)$$

This equation reveals the exact mechanism of this theory:

- **The collapse:** As matter falls in, density (ρ) increases, and the universe contracts.
- **The critical point:** When the density reaches its absolute maximum ($\rho = \rho_{crit}$), the term $(1 - \rho/\rho_{crit})$ becomes exactly zero. Therefore, the expansion/contraction rate (H^2) drops to zero. The collapse stops completely.
- **The Bounce:** Because the incoming momentum cannot simply vanish, the quantum repulsive force acts like a compressed spring, violently reversing the trajectory from contraction to outward expansion ($H > 0$) (Ashtekar, Pawlowski, & Singh, 2006).

3.3 Asymmetric Spacetime Inversion and White Hole Tunneling

This quantum bounce triggers a topological transition known as white hole tunneling (Rovelli & haggard, 2014). The high-entropy, complex matter that entered the black hole has already been stripped of its structural information (Section 2.3).

As the quantum bounce occurs, the system undergoes a time-reversal transformation. Because the matter has been thoroughly homogenized and reduced to its absolute minimum structural configuration at the bounce point, the newly forming spacetime fabric on the other side opens up into a pristine state.

3.4 Concluding the Entropy reset

From the perspective of an observer inside this new, expanding spacetime, the white hole ejection is perceived as a perfectly smooth, uniform, and low-entropy Big Bang. The high entropy of the parent universe's matter was fundamentally "cleansed" by the extreme crushing and subsequent quantum rearrangement, directly satisfying the low-gravitational entropy requirements of the Weyl Curvature hypothesis (Penrose, 1979).

Section 4: The White Hole Horizon Ejection and Cosmic Inflation

4.1 The Horizon Inversion and Matter Birth

Following the quantum bounce described in Section 3, the expanding, highly uniform fundamental fluid must exit the localized quantum region. In classical general relativity, a black hole event horizon is a strict, one-way boundary where nothing can escape. However, the quantum bounce effectively flips the geometry of spacetime, transforming the interior trap into a white hole event horizon [6.1].

As the compressed quantum fluid crosses this inverted boundary, it transitions into a macroscopic expanding spacetime. To an observer inside the newly formed region, the sudden, violent emergence of this homogeneous, high-density plasma from a standard Big Bang scenario.

4.2 Phase Transitions and the Generation of Secondary Entropy

When the fundamental plasma bursts through the white hole horizon into the newly birthed daughter universe, it begins a massive cooling phase as space expands.

- **The primordial Plasma:** Initially, the ejected matter exists only as the absolute most fundamental, low-entropy particles (quarks and leptons) determined by the structural stripping phase.
- **Baryogenesis and Nucleosynthesis:** As the universe expands and cools, these fundamental units begin to bind together for the first time, forming protons, neutrons, and eventually light elements like hydrogen and helium.
- **The Inception of the Arrow of Time:** It is at this exact moment that macroscopic entropy begins to rise from its pristine zero-point baseline. The creation of complex matter structures initiates the thermodynamic Arrow of Time for the daughter universe, setting the stage for future star and galaxy formation.

Conclusion

This paper has presented a novel, self-consistent mechanism for cosmic genesis that resolves two of the greatest paradoxes in modern cosmology: the initial cosmic singularity and the low-entropy boundary condition of the early universe (the Past Hypothesis) [6.1]. By linking the birth of a daughter universe to a black hole-white hole transition via a quantum bounce [6.1], we eliminate the mathematical breakdown inherent in classical general relativity. More importantly, this framework introduces a specific thermodynamic function for gravitational collapse: the extreme tidal forces and Planck-scale densities act as a universal cosmic purifier, stripping macroscopic matter down to its most fundamental, uniform quantum constituents [6.1].

By analyzing the transition through these four distinct phases, this model provides concrete physical explanations for observations that standard cosmology must otherwise accept as arbitrary starting conditions:

- **The Singularity problem:** Resolved by the introduction of a Loop Quantum Gravity minimum volume threshold, turning a destructive crush into a creative quantum bounce [6.1].
- **The low-Entropy Puzzle:** Solved by the structural degradation and information-scrambling phase, which naturally resets the geometric and structural entropy of the infalling matter to a baseline minimum [6.1]
- **The Horizon Problem:** Explained by the pre-bounce thermalization phase, meaning the perfect uniformity of the early universe is an inherited trait from the parent universe's collapse [6.1].

While this framework provides a robust conceptual architecture, further mathematical refinement is required to map the exact transition of the quantum repulsive force during the bounce phase. Future work must focus on calculating the precise metrics of quantum-corrected spacetime geometrics to determine if the mass of the parent black hole directly dictates the structural constants and volume of the resulting daughter universe. Ultimately, this paradigm shifts our understanding of the cosmos from a singular, isolated event into an eternal, evolving network of reproducing worlds-where the death of matter in one universe inevitably serves as the pristine, orderly seed for the next.

References

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