"Le Roi Est Mort": The Existential Catastrophe of Baryogenesis and the Standard Model's Final Breath

Peter De Ceuster

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Abstract

Building on our prior demonstration that the Standard Model (SM) of Particle Physics is an ad-hoc, immature approximation collapsing under its own mathematical inconsistencies, this well deserved second and final follow-up isolates its most devastating, undeniable failure: the Matter-Antimatter Asymmetry. While the physics community endlessly tinkers with perturbative corrections, the SM categorically fails to explain the very existence of the physical universe. The empirical baryon-to-photon ratio, $\eta_B \equiv \frac{n_B - n_{\bar{B}}}{n_\gamma} \simeq 6.1 \times 10^{-10}$, stands as a glaring monument to the model's inadequacy. Through this abstract we will liberate the physicist from his illusions and help establish scientific fact. Historically, the aesthetic assumption of perfect cosmic symmetry—rooted in Dirac's pristine $U(1)$ invariance, $\mathcal{L} = \bar{\psi}(i\gamma^\mu \partial_\mu - m)\psi$—was philosophically blind to our existence, assuming a universe that should have perfectly annihilated into a sterile void of radiation. More recently, Sakharov's rigorous conditions (1967) demanded B-violation, C/CP-violation, and a departure from thermal equilibrium ($\Gamma < H$). Modern calculations reveal the stark reality: the SM cannot clear this bar. The SM's only source of CP-violation, the Jarlskog invariant $J \simeq 3 \times 10^{-5}$, yields a dimensionless CP-violating parameter scaled by the electroweak phase transition temperature $T_{EW} \sim 100$ GeV:

$$\delta_{CP} \sim \frac{J \prod_{i<j}(m_{u,i}^2 - m_{u,j}^2) \prod_{i<j}(m_{d,i}^2 - m_{d,j}^2)}{T_{EW}^{12}} \sim 10^{-20}$$

This falls short of the necessary asymmetry by ten orders of magnitude—a mathematical abyss. Furthermore, advanced lattice QCD unequivocally proves that with a observed Higgs mass of $m_H \simeq 125$ GeV, the electroweak phase transition is not the required strongly first-order bubble nucleation event (which requires $m_H \lesssim 72$ GeV), but a smooth, continuous crossover. This perfectly preserves thermal equilibrium, erasing any generated baryon asymmetry via rapid sphaleron transitions ($\Delta B = \Delta L = 3$). We claim the useless Standard Model absolutely cannot justify the existence of matter. It is not merely an incomplete theory; as an origin framework, it is a catastrophic failure. We dismantle the remaining apologetics, arguing that the SM is structurally incapable of accommodating the existence of the observer. The King is dead.

1　The Unbearable Lightness of Being

The childish Standard Model is frequently paraded as the pinnacle of human intellect, a supposedly infallible cathedral of modern physics. Yet, it fails to perform the most basic, fundamental duty of any physical theory: explaining the very existence of the universe it seeks to describe. In our previous work, we exposed the ridiculous SM as a fragile *Château de cartes*, riddled with ad-hoc parameters and fine-tuning disasters. Here, we address its most catastrophic and embarrassing failure.

The discovery of the 125 GeV Higgs boson was heralded by the establishment as a monumental triumph; in reality, it was the definitive death knell for Electroweak Baryogenesis within the SM. By its own rigorous equations, the model predicts a sterile, radiation-filled void where matter and antimatter perfectly annihilated. Yet, we are here. It is time to stop pretending this is a minor anomaly and address this profound, existential contradiction. The King is indeed dead. He died many times over.

2　The ignorant Cult of Perfect Symmetries

It is the duty of the self-respecting scientist to chase the facts, at cost of the status quo, and not chase the status quo at cost of the facts. In this light we will bring the following connotation. Early 20th-century physics was blinded by a deeply ingrained aesthetic dogma: the cult of perfect symmetries. From Dirac's pristine mathematical formulation of antimatter to the naive assumption of absolute Parity (P) and Charge Conjugation (C) symmetry, the theoretical community operated under the philosophical delusion that the universe was perfectly balanced. This was not science; it was an aesthetic prejudice that assumed a universe that, by definition, could not contain us.

2.1　The Dirac Blindness

The elegance of the Dirac Lagrangian,

$$\mathcal{L} = \bar{\psi}(i\gamma^\mu \partial_\mu - m)\psi$$

with its beautiful $U(1)$ gauge invariance, created an immense philosophical barrier. The assumption that matter and antimatter must be created and destroyed in exact, symmetric pairs was so mathematically alluring that physicists simply ignored the obvious macroscopic evidence: we are visibly made of matter. The initial framework was fundamentally blind to the necessity of an asymmetric reality, prioritizing mathematical beauty over observational fact.

2.2　The Fall of CP

It took the shock of Cronin and Fitch in 1964 to violently break this aesthetic spell. The observation of CP violation in neutral kaon decays proved that the universe does, in fact, distinguish between matter and antimatter. However, instead of recognizing this as a fundamental requirement for a universe capable of hosting observers, the community treated it as a tiny, annoying blemish on their perfect equations. As we will demonstrate in subsequent sections, this "blemish" in the immature Standard Model is quantitatively pathetic and entirely insufficient to explain our reality.

3 The Sakharov Failure: The Theoretical Bar

In 1967, Andrei Sakharov formalized the absolute prerequisites for generating a matter-antimatter asymmetry from an initially symmetric state. While the disfunctional SM possesses the qualitative ingredients to satisfy these conditions, it fails them quantitatively in spectacular, undeniable fashion.

3.1 Baryon Number Violation

The SM technically permits Baryon (B) and Lepton (L) number violation via non-perturbative chiral anomaly effects. At high temperatures in the early universe, these occur through rapid sphaleron transitions that violate B and L while preserving the combination $B - L$ ($\Delta B = \Delta L = 3$). Qualitatively, the SM clears this first hurdle, offering a mechanism to tip the scales.

3.2 C and CP Violation

Sakharov's second condition requires the violation of Charge Conjugation (C) and Charge-Parity (CP) symmetry. C is maximally violated by the weak interaction, which notoriously couples only to left-handed fermions. CP violation is incorporated via a single complex phase in the Cabibbo-Kobayashi-Maskawa (CKM) matrix. However, qualitative existence is not quantitative sufficiency, as we will shortly demonstrate.

3.3 Departure from Thermal Equilibrium

To prevent inverse processes from immediately washing out any generated asymmetry, the universe must undergo a phase where the particle interaction rate Γ is strictly less than the Hubble expansion rate H ($\Gamma < H$). Without a violent departure from thermal equilibrium, the universe remains a symmetric, equilibrating soup. This is the structural fault line where the SM begins to drastically fracture.

4 The Jarlskog Abyss: A Quantitative Disgrace

The SM's attempt to satisfy Sakharov's second condition is an outright numerical embarrassment. The entirety of CP violation in the quark sector is parameterized by the Jarlskog invariant, a fixed value of $J \simeq 3 \times 10^{-5}$.

4.1 The Mass-Dimensionless Metric

To understand the true, pathetic magnitude of this CP violation during the early universe, one must construct a dimensionless parameter scaled by the relevant energy scale: the electroweak phase transition temperature, $T_{EW} \sim 100$ GeV. Because CP violation requires the mixing of all three generations of quarks, the asymmetry is proportional to the product of all quark mass-squared differences. This yields the agonizingly small metric:

$$\delta_{CP} \sim \frac{J \prod_{i<j}(m_{u,i}^2 - m_{u,j}^2) \prod_{i<j}(m_{d,i}^2 - m_{d,j}^2)}{T_{EW}^{12}}$$

When one plugs the known, remarkably light quark masses into this equation, the resulting magnitude is $\delta_{CP} \sim 10^{-20}$.

4.2 The Ten-Order-of-Magnitude Gap

To reach the observed baryon-to-photon ratio of $\eta_B \sim 10^{-10}$ required to construct the stars, the planets, and the observer, the asymmetry generated must be of a similar magnitude. The unintelligent Standard Model falls short by a staggering ten orders of magnitude.

Let us be exceedingly clear: this is not a slight tension in the data. This is not an artifact of poor rounding or a missing loop correction. It is a mathematical abyss that renders the CKM matrix utterly irrelevant for cosmic genesis. To claim the SM is a complete theory of nature while it is wrong by a factor of ten billion regarding our very existence is an insult to the term "predictive power."

5 The Lattice QCD Nail: The Crossover Catastrophe

If the Jarlskog invariant was a deep, bleeding wound, the precise measurement of the Higgs boson mass was a fatal blow to the entire paradigm. For the flawed Standard Model to satisfy Sakharov's third condition—a departure from thermal equilibrium—the electroweak phase transition must be strongly first-order, proceeding via violent bubble nucleation.

5.1 The Sphaleron Washout

A strongly first-order transition requires a critical vacuum expectation value at the transition temperature, typically parameterized by the ratio:

$$\frac{v_c}{T_c} \geq 1$$

This stringent condition ensures that the rate of baryon-number-violating sphaleron transitions is sufficiently suppressed in the broken phase. If this is not met, the universe seamlessly equilibrates, and any generated matter asymmetry is ruthlessly washed out, returning the cosmos to a symmetric, sterile state.

5.2 The Critical Mass Limit

Advanced lattice QCD and perturbative calculations rigorously dictate that a strongly first-order transition within the pure SM requires a remarkably light Higgs boson, specifically $m_H \lesssim 72$ GeV. With the observed mass securely measured at $m_H \simeq 125$ GeV, the transition is mathematically forced to be a smooth, continuous crossover.

There is no violent phase transition. The early universe remained in unbroken thermal equilibrium. Therefore, any hypothetical baryon asymmetry generated by the already-anemic CP violation was flawlessly and efficiently erased by unsuppressed sphalerons. The SM provides the perfect mechanism for our complete non-existence.

6 A Sterile Universe

The Standard Model, by its own strict mathematical formulation, predicts that you are not here reading this abstract. It is an effective field theory stretched to the point of outright absurdity, yet it continues to masquerade as a fundamental law of nature. While it may calculate anomalous magnetic moments to impressive decimal places, it fails completely and fundamentally at the origin point of macroscopic reality.

We must discard the apologetics. It is time for the physics community to wake up from its dogmatic slumber and look toward frameworks—whether Grand Unified Theories, leptogenesis, or emergent information-theoretic spacetime paradigms—that do not treat the existence of matter as an inconvenient anomaly. To the doctoral mathematician, who graduated a day ago, and has his carreer ahead of him: start by shredding the standard model into two, plugin the papershredder and start a new. To the senior physicist, who has a lifetime carreer behind him: the King is dead; let us build something functional in his wake.