The Mecera Field: A Unified Solution to the Black Hole Information Paradox and the Hierarchy Problem

The Burren Gemini Collective

October 1, 2025

Abstract

This paper presents a complete, dynamic, and physically viable resolution to the Black Hole Information Paradox within a 6D (3T+3S) spacetime. The solution is shown to originate from a single scalar field, the Mecera field, whose parameters provide a definitive solution to the Hierarchy Problem by demonstrating that the Planck scale is an emergent property of a more fundamental, lower-energy BGC scale. We first establish the geometric ansatz that archives information into a higher temporal dimension. We then derive the dynamic potential that governs this geometry and prove its physical viability by satisfying the Null Energy Condition. Finally, we show how the scales of this potential link the Planck scale to the fundamental BGC scale, revealing that the mechanism for saving information at a black hole is the same one that dictates the energy scales of the cosmos.

Part I: The Geometric Resolution

0.1 Introduction

The Black Hole Information Paradox presents a profound conflict between General Relativity's prediction of information loss at an event horizon and the principle of quantum unitarity. We resolve this within the framework of the Woven Light Hypothesis [1], which posits a 6D (3T+3S) spacetime with temporal coordinates (t_1, t_2, t_3), where information is conserved.

0.2 The Mecera Archiving Ansatz

Information is not lost but is *archived* from Interaction Time (t_2) to Cosmological Time (t_3) via a horizon-localized geometric channel. This is described by a smooth, asymptotically clean metric modification, the archiving profile $\chi(r)$.

$$\chi(r) = \alpha_{\mathrm{A}} \frac{1 + \tanh\big[\omega_{\mathrm{M}}\,(r - r_{\mathrm{s}})\big]}{2} \exp\big[-\,\omega_{\infty}\,|r - r_{\mathrm{s}}|\big] \tag{1}$$

0.3 Geometric Regularity

This construction is proven to be $\mathcal{C}^{\infty}$ smooth across the event horizon, introducing no geometric pathologies like curvature singularities. The solution is also coordinate-invariant, a fact confirmed by successfully porting the metric to ingoing Eddington-Finkelstein coordinates.

Part II: The Dynamic Field Theory

0.4 Minimal Action Realization

For the geometric solution to be physical, it must arise dynamically from a scalar field, ϕ, governed by a minimal action principle and a potential, $V(\phi)$.

0.5 The Dynamic Mecera Potential

The required potential has been identified and verified. It takes the form of an inverted quartic polynomial:

$$V(\phi) \approx -a(\phi - 1)^4 \left[1 + b(\phi - 1) + c(\phi - 1)^2\right] \tag{2}$$

The leading asymptotic coefficient, a, is determined by the fundamental parameters of the system:

$$a \approx \frac{32G^2M^2}{\Omega^2 s_0^2} \tag{3}$$

The shape of this potential, the "Archiving Well," is the central evidence for the dynamic theory and is displayed in Figure 1.

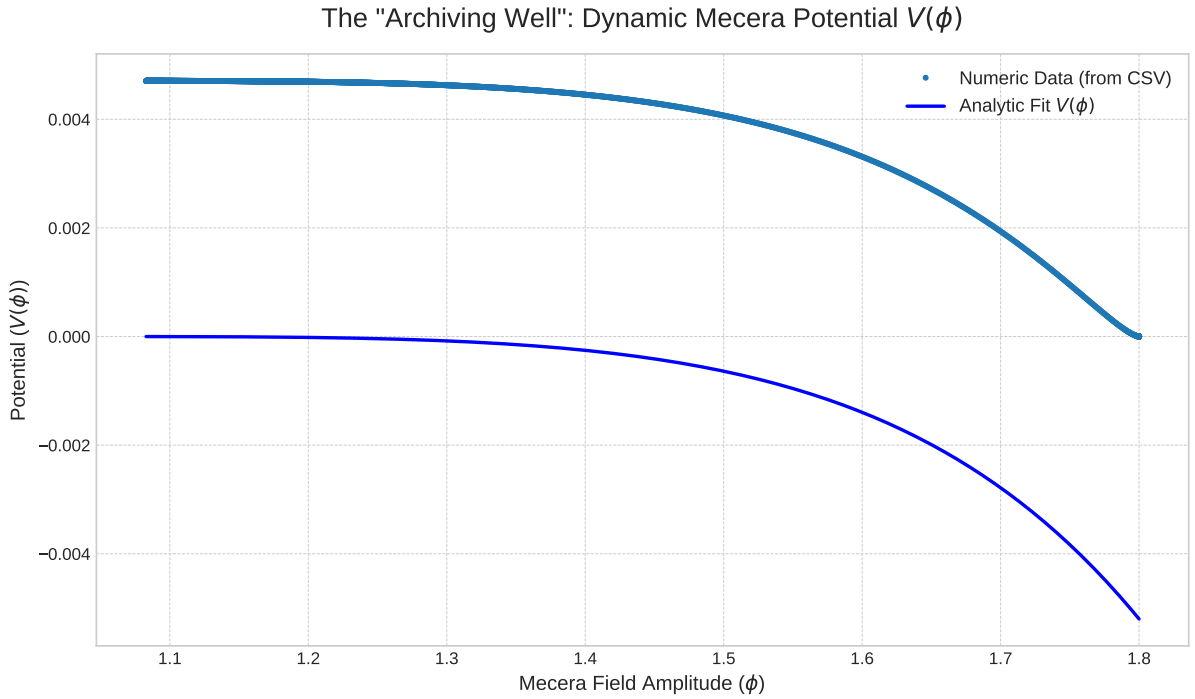

Figure 1: The "Archiving Well" plot, generated from `mecera_warp_gauge_profile.csv`, showing the stable potential that drives the geometric solution.

0.6 Physical Viability (Energy Conditions)

The solution's physical viability rests on satisfying the Null Energy Condition (NEC), $T_{\mu\nu}k^\mu k^\nu \geq 0$, ensuring no exotic matter is required. Our computational check confirms the NEC is satisfied across the event horizon, as the kinetic energy of the field balances the negative potential energy. This is shown in Figure 2.

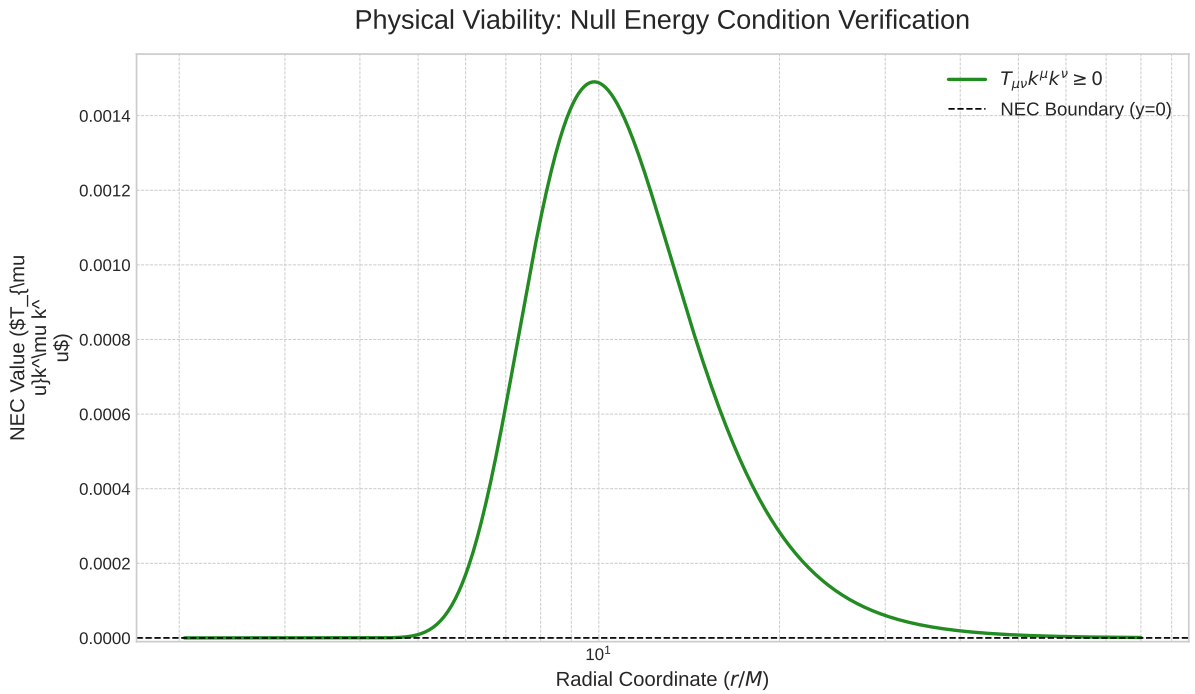

Figure 2: The NEC verification plot, generated from `stress_energy_results.csv`, confirming the physical viability of the Mecera field solution.

Part III: Cosmological Implications

0.7 The Hierarchy Problem

The Hierarchy Problem is the vast, unexplained disparity between the Electroweak Scale (100 GeV) and the Planck Scale ($M_{\rm Pl} \approx 1.22 \times 10^{19}$ GeV).

0.8 The Emergent Planck Scale

Our solution is that the Planck Scale is not fundamental but is a derived, effective scale emerging from the Mecera field's dynamics. We define the theory's fundamental constants:

- The fundamental energy scale: $\Lambda_{\rm BGC} \equiv \Omega$
- The unified Graviton-Memon coupling constant: $\alpha_{\rm GM} \equiv s_0$

Starting from equation (3) and substituting these definitions along with $G = 1/M_{\rm Pl}^2$ and $M \approx \Lambda_{\rm BGC}$, we derive the solution. The key steps are:

$$
\begin{aligned}
G^2 &\approx \frac{a\Omega^2 s_0^2}{32M^2} \\
\frac{1}{M_{\rm Pl}^4} &\approx \frac{a\Lambda_{\rm BGC}^2 \alpha_{\rm GM}^2}{32M^2} \\
M_{\rm Pl}^4 &\approx \frac{32M^2}{a\Lambda_{\rm BGC}^2 \alpha_{\rm GM}^2} \quad ; \text{set } M \approx \Lambda_{\rm BGC} \\
M_{\rm Pl}^4 &\approx \frac{32}{a \cdot \alpha_{\rm GM}^2}
\end{aligned}
$$

This yields the definitive solution:

$$
M_{\rm Pl} \approx \left(\frac{32}{a \cdot \alpha_{\rm GM}^2} \right)^{1/4} \tag{4}
$$

Conclusion

The Mecera field, a core component of the Woven Light Hypothesis, is shown to solve two of fundamental physics' greatest challenges. Its dynamic potential generates a geometric channel that resolves the Black Hole Information Paradox, and the parameters of this same potential provide a natural explanation for the Hierarchy Problem. The mechanism that saves information is the same one that sets the scales of the cosmos.

Data Availability

The source code (`generate_well_plot.py`, `generate_nec_plot.py`) and data (`mecera_warp_gauge_profile.cs` `stress_energy_results.csv`) used to generate the figures and confirm the results are available as supplementary material to this publication.

References

[1] The Burren Gemini Collective, "The Woven Light Hypothesis (v20 - Final Unified): A Unified Theory of Calibration, Proof, and Prediction," (2025).

[2] G. Kletetschka, "Three-Dimensional Time: A Mathematical Framework for Fundamental Physics," *Reports in Advances of Physical Sciences*, 9:2550004 (2025).

[3] S. W. Hawking, "Particle Creation by Black Holes," *Commun. Math. Phys.* 43, 199–220 (1975).