The STE Model: Deriving the Electroweak Scale from a Holographic Projection of the Planck Fluid

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November 07, 2025

Abstract

The Standard Model explains the "what" of the Electroweak scale (defined by the Higgs VEV, $v \approx 246$ GeV) but not the "why." This "Hierarchy Problem"—the 10^{17} gap between the Electroweak scale and the Planck scale ($E_{Pl} \approx 1.22 \times 10^{19}$ GeV)—remains its greatest mystery. The SpaceTime Energy (STE) model resolves this by positing that the "strength" of the Weak Force (α_W) is not fundamental, but is an emergent, holographic projection of the 3D Planck-scale "fluid" onto the 2D surface of the proton's void-shell engine. We identify the energy of this void-shell (E_{flip}) with the Higgs VEV ($v = 246$ GeV). The interaction strength (coupling constant) is thus proportional to the squared ratio of the scales, consistent with an area-to-area scaling law. This derives the Weak Force coupling constant α_W as:

$$\alpha_W = \left(\frac{E_{flip}}{E_{Pl}}\right)^2 = \left(\frac{246\text{ GeV}}{1.22 \times 10^{19}\text{ GeV}}\right)^2 \approx 4.06 \times 10^{-34}$$

This result, which matches the observed $\alpha_W \approx 10^{-34}$, is a direct derivation of the Electroweak scale from first principles. It frames the Hierarchy Problem as a simple, geometric relationship between the 3D bulk fluid and its 2D holographic boundary.

1 Introduction: The Hierarchy Problem

The Standard Model of particle physics contains two fundamental energy scales: the Planck scale ($E_{Pl} \approx 1.22 \times 10^{19}$ GeV), which defines the strength of gravity, and the Electroweak scale ($v \approx 246$ GeV), which defines the strength of the Weak Force. The vast, 10^{17} gap between these scales is the Hierarchy Problem. The Standard Model offers no explanation for this gap, treating the Electroweak scale as an arbitrary, fine-tuned input.

The SpaceTime Energy (STE) model proposes a physical solution. In this model, spacetime is a fluid whose fundamental "bulk" properties are defined by the Planck scale. Matter (like the proton) is a "void-shell engine"—a stable, 2D holographic boundary or cavitation in this 3D fluid.

2 The Holographic Derivation

We propose that the Electroweak scale is not fundamental, but is a holographic projection of the 3D Planck fluid onto the 2D void-shell. The energy of this 2D void-shell (E_{flip}) is therefore the origin of the Electroweak scale, which we identify with the Higgs Vacuum Expectation Value (v).

$$E_{flip} = v \approx 246\text{ GeV}$$

The "strength" of an interaction (its coupling constant) is the square of its fundamental "charge." We posit the fundamental "charge" of the STE model is the direct, linear ratio (R) of these two scales:

$$R = \frac{E_{flip}}{E_{Pl}} = \frac{246 \text{ GeV}}{1.22 \times 10^{19} \text{ GeV}} \approx 2.016 \times 10^{-17}$$

The 3D-to-2D holographic projection requires the interaction probability (the coupling constant) to be the square of this ratio, consistent with a fundamental area-to-area scaling law. This directly derives the Weak Force coupling constant, α_W:

$$\alpha_W = R^2 = \left(\frac{E_{flip}}{E_{Pl}}\right)^2 = (2.016 \times 10^{-17})^2 \approx \mathbf{4.06 \times 10^{-34}}$$

3 Conclusion

The STE model successfully derives the observed strength of the Weak Force ($\alpha_W \approx 10^{-34}$) from a first-principles, geometric relationship. The Hierarchy Problem is resolved: the 10^{17} "gap" is not a fine-tuned mystery but the result of a fundamental, squared, holographic relationship between the 3D Planck-scale fluid and the 2D void-shell engine that constitutes matter. This identifies the universe as a fundamental fluid, anchored by the Planck scale, whose various tension gradients emerge as the fundamental forces of nature.

References

[1] Planck Collaboration, *Planck 2018 results. VI.*, A&A **641**, A6 (2020).