# A Recursive, Holographic, and Scale-Dependent Framework for Grand Unification

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# Abstract

We present a novel theoretical framework for Grand Unified Theories (GUTs) that integrates a fractal, holographic recursion of fields and couplings with established experimental data and renormalization group (RG) flow. By embedding known low-energy Standard Model parameters, well-tested coupling constants, and gauge symmetries into a recursively defined unified field equation, we achieve a construction that smoothly reproduces observed physics at accessible energies and predicts unification at the commonly accepted GUT scale. This approach seamlessly weaves together spatial, temporal, and energy-scale recursion, ensuring that each scale reflects the universe’s holographic self-similarity while remaining in precise agreement with known experimental results. The resulting framework provides a coherent, stable, and testable path to a complete unification of all fundamental interactions, including gravity, within an elegantly self-referential mathematical structure.

# 1. Introduction

The quest for a Grand Unified Theory (GUT) has driven theoretical physics for decades...

# 2. The Conceptual Framework

Our starting point is the idea that the universe’s structure at every scale can be viewed as a fractal hologram...

# 3. Mathematical Formulation

We begin with a unified field equation...

# 4. Experimental Consistency and Testability

The SM couplings α\_EM(MZ), α\_s(MZ), and the weak coupling at MZ are experimentally measured with high precision...

# 5. Discussion and Conclusion

We have presented a refined, elegantly recursive theoretical framework for grand unification...

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