Abstract

We explore a 4D effective field theory inspired by Lisa Randall's 1999 RS1 model. While RS1 demonstrated that the hierarchy problem could be solved via 5D geometric warping, we investigate whether a scale-dependent phase transition in strictly 4D spacetime could produce observationally equivalent phenomenology. We define the "Modified Randall-Sundrum" (MRS) framework, where gravitational suppression is a function of a local state-variable (the Gravitational Reynolds Number, Re_G) rather than travel through an extra-dimensional bulk.

Building on Randall: The Transition from Warped to Phase Geometry

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1 Introduction

Lisa Randall's foundational insight in warped geometry was that gravitational suppression is *structural*. By introducing an exponential warp factor $e^{-2krc\pi}$ in a 5D bulk, she showed that the observed weakness of gravity could emerge naturally. In this investigation, we ask whether this structural suppression could manifest as a 4D phase transition.

2 The Concept of Phase suppression

In our "Phase Geometry" model, gravity enters a high-α (Dark Matter-like) state when the spacetime kernel is in a "Laminar" phase (low Re_G). As the system scales or gains velocity dispersion, it transitions into a "Turbulent" (Newtonian) phase.

3 Mathematical Translation

Randall's warp factor is defined by geometric distance:

$$S \propto e^{-2k|y|} \quad (geometric) \tag{1}$$

Our phase transition is defined by system state:

$$\alpha(Re_G) = \frac{\alpha_{max}}{1 + (Re_G/Re_c)^{\gamma}} \quad (phase) \tag{2}$$

4 Effective Description vs. Fundamental Theory

We frame MRS as an *effective description*. Just as thermodynamics describes the aggregate behavior of particles, Phase Geometry describes the aggregate gravitational coupling of a 4D kernel. This does not refute the existence of 5D bulk physics but explores its projection onto our observable 4D slice.

5 Conclusion

This first paper establishes the lineage. By honoring Randall's structural intuition, we operationalize it for 4D computational exploration.