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EFT breakdown of varying coupling constants

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QFT shows that fundamental constants are not fixed but vary with energy scales. This opens the possibility that in the early universe, gauge couplings may differ from those predicted by the Standard Model, potentially leading to observable non-standard phases. The low-energy spectrum of generic models that aim to archive this usually has a light singlet that couples through higher-dimensional operators to gauge bosons originating from a Dark Sector. In this work, we explore these scenarios in detail and show that in renormalizable QFT UV descriptions, drastic changes in the gauge coupling cannot occur at low energies, and given the nontrivial dynamics of the singlet field, the changes are entirely described by a dynamical RG equation with changing thresholds.

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