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Grand Unified origin of gauge interactions and families replication in the Standard Model

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The tremendous phenomenological success of the Standard Model (SM) suggests that its flavor structure and gauge interactions may not be arbitrary but should have a fundamental first-principle explanation. In this work, we explore how the basic distinctive properties of the SM dynamically emerge from a unified New Physics framework tying together both flavour physics and Grand Unified Theory (GUT) concepts. This framework is suggested by the gauge Left-Right-Color-Family Grand Unification under the exceptional E8 symmetry that, via an orbifolding mechanism, yields a supersymmetric chiral GUT containing the SM. Among the most appealing emergent properties of this theory is the Higgs-matter unification with a highly-constrained massless chiral sector featuring two universal Yukawa couplings close to the GUT scale. At the electroweak scale, the minimal SM-like effective field theory limit of this GUT represents a specific flavored three-Higgs doublet model consistent with the observed large hierarchies in the quark mass spectra and mixing already at tree level.

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