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Title: Fermion Mass Hierarchies and Modulus Stabilization in Modular-Invariant Theories of Flavor

In modular-invariant models of flavor, hierarchical fermion mass matrices may arise solely due to the proximity of the modulus $\tau$ to a point of residual symmetry. We show that in this approach the hierarchies depend on the decomposition of field representations under the residual symmetry group. Investigating systematically the possible fermion field representation choices which may yield hierarchical structures in the vicinity of symmetric points for the smallest finite modular groups, isomorphic to $S_3$, $A_4$, $S_4$, and $A_5$ and their double covers, we find a restricted set of pairs of representations for which the discussed mechanism may produce viable fermion (charged-lepton and quark) mass hierarchies. We construct a lepton flavor model in which both the charged-lepton mass hierarchies and the neutrino mixing arise naturally without fine-tuning. We study further the problem of modulus stabilization in the framework of the modular symmetry approach to the flavor problem.

By analyzing simple UV-motivated CP-invariant potentials for the modulus $\tau$ we find that a class of these potentials has (non-fine-tuned) CP-breaking minima in the vicinity of the point of $Z_3^{ST}$ residual symmetry, $\tau \simeq e^{2\pi i/3}$. Stabilizing the modulus at these novel minima breaks spontaneously the CP symmetry and can naturally explain the mass hierarchies of charged leptons and possibly of quarks.