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Yukawa Couplings in 3HDM

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We study a three-Higgs-doublet extension of the Standard Model invariant under a generalized CP (GCP) transformation and focus on the specific GCP-realization labelled by $(\theta, \alpha, \beta, \gamma) = (\pi/3, \pi/3, \pi/3, \pi/3)$. This model—a natural 3HDM continuation of a previously identified non-trivial GCP-invariant 2HDM—belongs to the CPc class of scalar potentials and yields a total of 22 free parameters (four from the scalar-field parametrization and eighteen from the Yukawa matrices). We classify the allowed Yukawa textures for this choice of GCP, construct the full Lagrangian, and perform a global numerical fit to the quark-sector data (quark masses and CKM matrix elements, including CP violation as measured by the Jarlskog invariant). We find that the $\pi/3$ 3HDM provides an excellent fit to the measured quark masses and CKM observables while maintaining non-degenerate, non-zero masses and a non-vanishing Jarlskog invariant. The fit reduces the effective parameter freedom and leads to characteristic correlations among Yukawa entries and between fermion and scalar sector observables; these give rise to concrete, testable predictions for the scalar spectrum and for flavor-changing observables. We discuss the phenomenological implications and avenues for experimental discrimination in future flavor and collider studies.

Field of Research/Work

Particles and Fields

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