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New Mass Matrix Ansatz and Enhanced Di-Higgs Production in the Two Higgs Doublet Model

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We show that the rate for di-Higgs production at the LHC can be enhanced by a factor as large as 25 compared to the Standard Model value in the two Higgs doublet model, while being consistent with the known properties of the observed Higgs boson h. There are correlated modifications in $t\bar{t}h$ and resonant Zh production rates, which can serve as tests of this model. Our framework treats both Higgs doublets on equal footing, each with comparable Yukawa couplings to fermions. {\color{blue} The Cheng-Sher ansatz for multi-Higgs doublet model is shown to be strongly disfavored by current experiments.} We propose a new ansatz for the Yukawa couplings of the Higgs doublets Φ_a is proposed, where $Y_{ij}^{(a)} = C_{ij}^{(a)} \cdot \min\{m_i,\, m_j\}/v$, with $C_{ij}^{(a)}$ being order one coefficients, m_i the mass of fermion i and v the electroweak vacuum expectation value. Such a pattern of couplings can explain the observed features of fermion masses and mixings and satisfies all flavor violation constraints arising from the exchange of neutral Higgs bosons. The rate for $\mu \to e\gamma$ decay and new contributions to CP violation in $B_s - \overline{B}_s$ mixing are predicted to be close to the experimental limits.

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