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Fermion mass hierarchies from vector-like families with an extended 2HDM and a possible explanation for the electron and muon anomalous magnetic moments

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We study an extended 2 Higgs doublet model (2HDM) in which the Standard Model (SM) Yukawa interactions are forbidden due to a global $U(1)'$ symmetry, but may arise via mixing with vector-like families. In this model, the hierarchical structure of Yukawa couplings of quarks and leptons in the SM arises from the heavy masses of the fourth and fifth vector-like families. Within this model, we consider various non-standard contributions to the electron and muon anomalous magnetic moments. We first consider the W exchange at one-loop level, consistent with the $\mu \to e\gamma$ constraint, and show that it yields a negligible contribution to both electron and muon anomalous magnetic moments. We then consider Higgs scalar exchange, together with vector-like leptons, at one-loop level and show that it is possible to have non-standard contributions to the electron and muon anomalous magnetic moments within the 1σ constraint of certain experiments. We present some benchmark points for both the muon and the electron anomalies, together with some numerical scans around these points, which indicate the mass regions of the Higgs scalars of the 2HDM in this scenario.

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Primary authors: CÁRCAMO HERNÁNDEZ, Antonio Enrique (Universidad Técnica Federico Santa María); LEE, Huchan (The university of Southampton); KING, Stephen F (University of Southampton)

Presenter: LEE, Huchan (The university of Southampton)

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