

The electroweak precision constraints of the 2HDM+S

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The 2HDM+S is the singlet extension of the Two-Higgs-Doublets Model (2HDM). The singlet field and its mixing with the 2HDM Higgs sector lead to new contributions to the electroweak precision observables, in particular, the oblique parameters. In this paper, we identify five benchmark cases, where at most one mixing angle is nonzero and analyze the 95% C.L. allowed parameter space by the oblique parameters. In the alignment limit of the 2HDM, we find that other than the usual mass relations of $m_H \sim m_{H^\pm}$ or $m_A \sim m_{H^\pm}$, electroweak precision measurements also impose an upper limit on the neutral Higgs masses. In the cases with nonzero singlet mixing with the 2HDM Higgses H or A , we find approximate mass relations of $c_{\alpha_{HS}}^2 m_H + s_{\alpha_{HS}}^2 m_{h_S} = m_{H^\pm}$ or $c_{\alpha_{AS}}^2 m_A + s_{\alpha_{AS}}^2 m_{A_S} = m_{H^\pm}$. Those relations are universal to the 2HDM+S models, with or without further symmetry assumption. We also study the non-alignment limit of the 2HDM+S, which typically has tighter constraints on the masses and mixing angles. At the end, we examine the complementarity between the electroweak precision analyses and the Higgs coupling precision measurements.

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