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125 GeV Scalar Bosons in 2 doublet models

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The current Higgs boson data at 125 GeV state appears to exhibit a substantial excess in the di-photon final state, whereas a more or less SM-like rate is observed in the ZZ decaying to four lepton channel. Beyond the SM, the two-Higgs-doublet model (2HDM) containing a second Higgs doublet is one of the simplest extensions. We examine the maximum Higgs signal enhancements that can be achieved in the 2HDM (when either a single Higgs or multiple Higgses have mass(es) near 125 GeV). In general, the constraints of vacuum stability, unitarity and perturbativity play the key role in restricting possibilities for signal enhancement. The Type II model allows for an enhancement in the di-photon rate (relative to the SM) of the order of 2-3 but associated with an even larger ZZ signal, a situation disfavored by the LHC observations. In contrast, the maximal value for the di-photon signal in the Type I model can reach the order of 1.3 for which the ZZ signal is of order 1, both being consistent with the current data.

Auteur principal: M. JIANG, Yun (UC Davis)

Orateur: M. JIANG, Yun (UC Davis)

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