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Higgs pair production at the HL-LHC in the 2HDM: insight into trilinear Higgs couplings

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The Standard Model (SM) of particle physics predicts a minimal Higgs sector and the existence of one Higgs boson that has already been discovered at the Large Hadron Collider (LHC). However, nothing prevents nature from having a non minimal Higgs sector. In particular, when a set of theoretical and experimental constraints are taken into account, it is possible to postulate theories beyond the SM that aim at solving some of its shortcomings. One simple example is the 2 Higgs Doublet Model (2HDM), which predicts a total of ve Higgs bosons.
In this context, trilinear Higgs self coupling is an important parameter to properly characterize the Higgs potential and determine the Higgs sector that is realized in nature. Moreover, the loose experimental constraints on it available so far allow for a reasonable deviation from the SM expectation. Access to this parameter can be provided by Higgs pair production processes. The small cross section of this process requires higher luminosity prospected at further runs of the LHC. Focusing on the High Luminosity LHC, we evaluate several observables in the framework of the 2HDM, namely, the total di-Higgs production cross section and the differential cross section distributions with respect to the invariant mass of two SM-like Higgses in the nal state. We explore dierent scenarios that were obtained to maximize the trilinear Higgs couplings and evaluate whether the corresponding eect on the aforementioned observables can be determined with sucient signicance. We furthermore analyze the eect of the contribution of the resonant diagram involving a heavy CP even Higgs exchange, its mass and total decay width. Finally, we point out the experimental challenges of setting an appropriate bin location and size for extracting these features of the model out of the invariant mass distributions.

Category

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