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Electroweak production of Higgs boson pairs in 2HDMs

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One of the main features of a two Higgs doublet model (2HDM) is the presence of two additional neutral Higgs states besides the one mimicking the recently observed ~ 125 GeV state. These additional Higgs bosons can be produced at the LHC either singly via gluon fusion or in pairs with each other and with the SM-like state. When studying the pair production of Higgs bosons, generally the emphasis is laid on gluon-initiated processes, while the electroweak (EW) production is overlooked assuming its contribution to be highly sub-leading. In order to quantify this contribution, we analyzed in detail the cross sections corresponding to various possible combinations of two Higgs states obtainable at the 13 TeV LHC in the Z2-symmetric 2HDM of types I and II. For this purpose we first performed thorough scans of the parameter spaces of these models to obtain points satisfying the most relevant constraints from EW precision data, b-physics and the LHC direct searches for the non-SM-like Higgs bosons. We found that for certain Higgs state combinations the EW pair production can compete with QCD production. In particular, where the sum of the masses of the lightest scalar and pseudoscalar Higgs bosons is smaller than the Z boson mass, the EW pair production can dominate over the gluon-initiated process, to which only the QCD box diagram contributes, by orders of magnitude in the type-I 2HDM.

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