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Two (or more) Higgs bosons near 125 GeV in the complex NMSSM

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The two additional singlet-like Higgs bosons, one scalar and one pseudoscalar, of the next-to-minimal supersymmetric standard model (NMSSM) can result in some unique signatures at the Large Hadron Collider (LHC), helping establish the non-minimal nature of supersymmetry. In particular, there exists the possibility of one, or even both, of these new Higgs bosons being almost degenerate with the 125 GeV SM-like Higgs boson. When, motivated by the baryon asymmetry of the universe, CP-violating phases are explicitly invoked in the Higgs sector of the model, all the Higgs interaction eigenstates mix to give five CP-indefinite physical states. In such a scenario, when the mass difference between two (or more) Higgs bosons near 125 GeV is comparable to their widths, the off-diagonal contributions to the propagator matrix ought to be taken into account. We perform a detailed analysis of the impact of these contributions on the di-photon production in gluon fusion via Higgs resonance near 125 GeV at the current LHC run. We find that these effect can become quite sizable, thereby invalidating both the narrow width approximation and the approach based solely on the tree-level interference, and thus considerably modifying the phenomenology of the observed Higgs boson.

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