

Title: Mass-degenerate Higgs bosons at 125 GeV in the two-Higgs-doublet model

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Abstract: The analysis of the Higgs boson data by the ATLAS and CMS Collaborations appears to exhibit an excess of $h \rightarrow \gamma\gamma$ events above the Standard Model (SM) expectations, whereas no significant excess is observed in $h \rightarrow ZZ^* \rightarrow$ four lepton events, albeit with large statistical uncertainty due to the small data sample. These results (assuming they persist with further data) could be explained by a pair of nearly mass-degenerate scalars, one of which is an SM-like Higgs boson and the other is a scalar with suppressed couplings to $W+W-$ and ZZ . In the two-Higgs-doublet model, the observed $\gamma\gamma$ and $ZZ^* \rightarrow$ four lepton data can be reproduced by an approximately degenerate CP-even (h) and CP-odd (A) Higgs boson for values of $\sin(\beta - \alpha)$ near unity and $0:70$ less than or similar to $\tan\beta$ less than or similar to 1 . An enhanced $\gamma\gamma$ signal can also arise in cases where $m(h)$ similar or equal to $m(H)$, $m(H)$ similar or equal to $m(A)$, or $m(h)$ similar or equal to $m(H)$ similar or equal to $m(A)$. Since the $ZZ^* \rightarrow 4$ leptons signal derives primarily from an SM-like Higgs boson whereas the $\gamma\gamma$ signal receives contributions from two (or more) nearly mass-degenerate states, one would expect a slightly different invariant mass peak in the $ZZ^* \rightarrow$ four lepton and $\gamma\gamma$ channels. The phenomenological consequences of such models can be tested with additional Higgs data that will be collected at the LHC in the near future. DOI: 10.1103/PhysRevD.87.055009.

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