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Interpreting the 95 GeV Higgs Boson within a 2-Higgs Doublet Model

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We suggest an explanation for and explore the consequences of the excess around 95 GeV in the di-photon and di-tau invariant mass distributions recently reported by the CMS collaboration at the Large Hadron Collider (LHC), together with the discrepancy that has long been observed at the Large Electron-Positron (LEP) collider in the $b\bar{b}$ invariant mass. Interestingly, the most recent findings announced by the ATLAS collaboration do not contradict, or even support, these intriguing observations. Their search in the di-photon final state similarly reveals an excess of events within the same mass range, albeit with a bit lower significance, thereby corroborating and somewhat reinforcing the observations made by CMS. We have found that all three signatures can be explained within the general 2-Higgs Doublet Model (2HDM) Type-III.
We demonstrate that the lightest CP-even Higgs boson in this scenario can explain the excess in all three channels simultaneously, i.e., in the di-photon, di-tau and $b\bar{b}$ mass spectra, while satisfying up-to-date theoretical and experimental constraints. Moreover, the 2HDM Type-III predicts an excess in the $pp \to t\bar{t}H_{\rm SM}$ production channel of the 125 GeV Higgs boson discovered in 2012, with properties (couplings, spin and CP quantum numbers) consistent with those predicted in the Standard Model (SM). This effect is caused by a up to 18\% enhancement of the Yukawa coupling to top
(anti)quarks in comparison to the SM value. Such an effect can be tested soon at the High Luminosity LHC (HL-LHC), which can either discover or exclude the scenario we suggest. This unique characteristic of the 2HDM Type-III makes this scenario with the 95 GeV resonance very attractive for further theoretical and experimental investigations at the (HL-)LHC and future colliders.

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