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The SM expected branching ratio for $h \to \gamma\gamma$ and an excess for $h \to Z\gamma$

The recent measurements of $h \to Z\gamma$ from ATLAS and CMS show an excess of the signal strength $\mu_Z = (\sigma \cdot calB)_{\rm obs}/(\sigma \cdot calB)_{\rm SM} = 2.2 \pm 0.7$, normalized as 1 in the standard model˜(SM). If confirmed, it would be a signal of new physics (NP) beyond the SM. We study NP explanation for this excess. In general, for a given model, it also affects the process $h \to \gamma\gamma$. Since the measured branching ratio for this process agrees well with the SM prediction, the model is severely constrained. We find that a minimally fermion singlets and doublet extended NP model can explain simultaneously the current data for $h \to Z\gamma$ and $h \to \gamma\gamma$. There are two solutions. Although both solutions enhance the amplitude of $h \to Z\gamma$ to the observed one, in one of the solutions the amplitude of $h \to \gamma\gamma$ flips sign to give the observed branching ratio. This seems to be a contrived solution although cannot be ruled out simply using branching ratio measurements alone. However, we find another solution that naturally enhances $h \to Z\gamma$ to the measured value, but keeps the amplitude of $h \to \gamma\gamma$ close to its SM prediction. We also comment on the phenomenology associated with these new fermions.

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