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Analysing h to Zy decay at the Large Hadron Collider using SMEFT

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The ATLAS and CMS collaborations have jointly reported the first evidence of the Higgs boson (h) decay into a Z boson and a photon, with a statistical significance of 3.4σ. The observed signal strength, 2.2 ± 0.7 times the Standard Model (SM) expectation, exceeds the SM prediction even when next-to-leading order (NLO) QCD corrections and signal-background interference are taken into account. This persistent deviation motivates an interpretation in the context of the Standard Model Effective Field Theory (SMEFT). In this study, we investigate the $h \to Z\gamma$ decay process at the LHC, focusing on gluon-gluon fusion (ggF) as the primary production mechanism. We aim to constrain the relevant dimension-six SMEFT operators by fitting model parameters to cross-section measurements and differential kinematic distributions that are sensitive to new physics. To improve the efficiency of this exploration, we employ kinematic interpolation methods across the SMEFT parameter space. Beyond the ggF channel, we also investigate additional Higgs production mechanisms including vector boson fusion (VBF), associated production with top quarks (ttH), and vector bosons (VH) to capture a broader range of dynamics and improve the robustness of the SMEFT interpretation. Multiple Z decay final states are considered, including leptonic ($Z \to \ell^+\ell^-$) and hadronic ($Z \to jj$) modes, to maximize signal acceptance and provide complementary constraints on new physics scenarios.

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