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One-loop scalar leptoquarks effects in Higgs pair production via gluon fusion

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Abstract

Higgs pair production via gluon fusion, $gg \to HH$, probes the Higgs trilinear self-coupling and is loop-induced already at leading order, which makes it sensitive to new colored states. We study the one-loop effects of the scalar leptoquark $S_1 \sim (\bar{3}, 1, 1/3)$, including its full yukawa sector and a Higgs portal coupling $\lambda_{S_1 H}|H|^2|S_1|^2$. We implement the model in FeynRules and use NLOCT to generate a UFO with UV counterterms and R_2 terms for MadGraph5_aMC@NLO; it reproduces the Standard Model cross section at 14TeV to 0.06% and yields a UV-finite renormalized HHH vertex. Independently, we compute the full one-loop amplitude (30 diagramas with tirangle, box and contact topologies) with FeynArts and FeynCalc, reduced to Passarino-Veltman functions;it is UV finite and satisfies the Ward identity for each class of diagrams. Both calculations agree for the partonic cross section between 260GeV and 1TeV. For $M_{S_1} = 1$TeV and $\lambda_{S_1 H} = 1$, the relative effect ranges from about -15% near threshold to $+2\%$ at 1TeV, and amounts to -1.0%in the hadronic cross section at 14TeV. The corrected trilinear vertex alone accounts for less than 10% of the effects, which is driven by S_1 loops coupled to the gluons. We discuss the extension to the Manohar-Wise color octet and the 4321 model at future collider energies.

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