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Radiative decays of a singlet scalar boson through vector-like quarks

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If the standard model Higgs boson were much heavier, it would appear as a broad resonance since its decay into a pair of longitudinally polarized gauge bosons is highly enhanced. We study whether the same enhancement happens at loop level in a simple extension of the standard model with a singlet scalar boson S . In order to focus on the loop effects, S is assumed to have no interaction at tree level with the standard model particles. The singlet scalar S is linked to the standard model world radiatively by vector-like quarks running in the loop. We introduce three vector-like quark multiplets, an $SU(2)_L$ doublet, an up-type singlet, and a down-type singlet. There are two kinds of loop effects in the S phenomenology, the mixing with the Higgs boson and the radiative decays into hh , WW , ZZ , gg , and through the triangle loops. We show that the crucial condition for enhancing loop effects including the longitudinal polarization enhancement is the large mass differences among vector-like quarks. The current LHC constraints on S from the heavy scalar searches and the Higgs precision data are shown to be very significant.

Summary

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