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# Keisho Hidaka ”Impact of quark flavor violating SUSY on h(125) decays at future lepton colliders,”

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We study the CP-even neutral Higgs boson decays $h \to c\bar{c}, b\bar{b}, b\bar{s}, \gamma\gamma, gg$ in the Minimal Supersymmetric Standard Model (MSSM) with general quark flavor violation (QFV) due to squark generation mixings, identifying the h as the Higgs boson with a mass of 125 GeV. We compute the widths of the h decays to $c\bar{c}, b\bar{b}, b\bar{s}(s\bar{b})$ at full one-loop level. For the h decays to photon photon and gluon gluon we compute the widths at NLO QCD level. {\it For the first time}, we perform a systematic MSSM parameter scan for these widths including Supersymmetric (SUSY) QFV parameters respecting all the relevant constraints, i.e. theoretical constraints from vacuum stability conditions and experimental constraints, such as those from K- and B-meson data, electroweak precision data, and the 125 GeV Higgs boson data from recent LHC experiments, as well as the limits on SUSY particle masses from the LHC experiment. We also take into account the expected SUSY particle mass limits from the future HL-LHC experiment in our analysis. {\it In strong contrast to} the usual studies in the MSSM with quark flavor conservation (i.e. the MSSM with MFV), from the parameter scan we find that the deviations of these MSSM decay widths from the Standard Model (SM) values can be quite sizable and that there are significant correlations among these deviations. From the parameter scan, actually we have found the followings: \item DEV(c) and DEV(b) can be very large simultaneously: DEV(c) can be as large as $\sim \pm 60\%$, and DEV(b) can be as large as $\sim \pm 20\%$. \item DEV(b/c) can exceed $\sim +100\%$. \item $B(h^0 \to bs)$ can be as sizable as $\sim 0.15\%$ exceeding the ILC250+500+1000 sensitivity of $\sim 0.1\%$ at $4\sigma$ signal significance. \item DEV($\gamma$) and DEV(g) can be sizable simultaneously: DEV($\gamma$) can be as sizable as $\sim \pm 1\%$, and DEV(g) can be as large as $\sim -7\%$ and $\sim +4\%$. \item DEV($\gamma$/g) can be as large as $\sim +8\%$ and $\sim -4\%$. \item There are significant correlations among these DEVs and BRbs: - There is a very strong correlation between DEV(b/c) and DEV(c). - There are significant correlations between $B(h^0 \to bs)$ and the deviations DEV(b), DEV(c), DEV(b/c). - There is a very strong correlation between DEV($\gamma$) and DEV(g). This correlation is due to the fact that the stop-scharm mixture loop contributions dominate the two DEVs. Here, DEV(X) = Gam(X)_MSSM/Gam(X)_SM - 1, DEV(X/Y) = [(Gam(X)/Gam(Y))_MSSM]/[(Gam(X)/Gam(Y))_SM] - 1 with Gam(X) = Gamma(h -> X X bar). All of these sizable deviations from the SM in the h decays are due to (i) large scharm-stop mixing and large scharm/stop involved trilinear couplings $T_{U23}, T_{U32}, T_{U33}$, (ii) large sstrange-sbottom mixing and large sstrange/sbottom involved trilinear couplings $T_{D23}, T_{D32}, T_{D33}$ and (iii) large bottom Yukawa coupling $Y_b$ for large $\tan\beta$ and large top Yukawa coupling $Y_t$. Such sizable deviations from the SM can be observed at high signal significance in future lepton colliders such as ILC, CLIC, CEPC, FCC-ee and MuC {\it even after} the failure of SUSY particle discovery at the HL-LHC. In case the deviation pattern shown here is really observed at the lepton colliders, then it would strongly suggest the discovery of QFV SUSY (the MSSM with general QFV). This work is based on collaboration with H. Eberl and E. Ginina (HEPHY, Vienna). This work is based on the following papers and contains substantial new findings: Phys. Rev. D 91 (2015) 015007 [arXiv:1411.2840 [hep-ph]], JHEP 1606 (2016) 143 [arXiv:1604.02366 [hep-ph]]], IJMP A34 (2019) 1950120 [arXiv:1812.08010 [hep-ph]], PoS(EPS-HEP2021) 594, 2021 [arXiv:2111.02713 [hep-ph], ILC White Paper for Snowmass 2021 [arXiv:2203.07622], PoS(ICHEP2022) 536, 2022 [arXiv:2211.07243 [hep-ph]].

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