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The $h(125)$ decays to $c\bar{c}$, $b\bar{b}$, $b\bar{s}$, photon photon and gluon gluon in the light of the MSSM with quark flavor violation

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We study the Higgs boson decays $h \rightarrow c\bar{c}$, $b\bar{b}$, $b\bar{s}$, photon photon and gluon gluon in the Minimal Supersymmetric Standard Model (MSSM) with general quark flavor violation (QFV), identifying the h with 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 in the MSSM with QFV. For the h decays to photon photon and gluon gluon we compute the widths at NLO QCD level. We perform a MSSM parameter scan respecting theoretical constraints from vacuum stability conditions and experimental constraints, such as those from K- and B-meson data and electroweak precision data, as well as recent limits on Supersymmetric (SUSY) particle masses and the 125 GeV Higgs boson data from LHC experiments.

From the parameter scan, we find the followings:

(1) $\text{DEV}(h \rightarrow c\bar{c})$ and $\text{DEV}(h \rightarrow b\bar{b})$ can be very large simultaneously:

$\text{DEV}(h \rightarrow c\bar{c})$ can be as large as $\sim \pm 60\%$ and

$\text{DEV}(h \rightarrow b\bar{b})$ can be as large as $\sim \pm 20\%$.

Here $\text{DEV}(h \rightarrow X Y)$ is the deviation of the decay width $\Gamma(h \rightarrow X Y)$ in the MSSM from the SM prediction:

$$\text{DEV}(h \rightarrow X Y) = \Gamma(h \rightarrow X Y)_{\text{MSSM}} / \Gamma(h \rightarrow X Y)_{\text{SM}} - 1.$$

(2) The QFV decay branching ratio $\text{BR}(h \rightarrow b\bar{s} / \bar{b}s)$ can be as large as about 0.17% in the MSSM. It is almost zero in the SM.

The sensitivity of ILC(250 + 500 + 1000) to this decay BR could be about 0.1% at 4 sigma signal significance.

(3) $\text{DEV}(h \rightarrow \text{photon photon})$ and $\text{DEV}(h \rightarrow \text{gluon gluon})$ can be large simultaneously: $\text{DEV}(h \rightarrow \text{photon photon})$ can be as large as about +4% and $\text{DEV}(h \rightarrow \text{gluon gluon})$ can be as large as about -15%.

(4) There is a very strong correlation between $\text{DEV}(h \rightarrow \text{photon photon})$ and $\text{DEV}(h \rightarrow \text{gluon gluon})$. This correlation is due to the fact that the stop-loop (stop-scharm mixture loop) contributions dominate the two DEVs.

(5) The deviation of the width ratio $\Gamma(h \rightarrow \text{photon photon}) / \Gamma(h \rightarrow \text{gluon gluon})$ in the MSSM from the SM value can be as large as about +20%.

(6) All of these large deviations in the h decays are due to large scharm-stop mixing and large stop/scharm involved trilinear couplings T_{U23} , T_{U32} , T_{U33} and large sstrange-sbottom mixing and large sstrange/sbottom involved trilinear couplings T_{D23} , T_{D32} , T_{D33} .

(7) ILC can observe such large deviations from SM at high signal significance.

(8) In case the deviation pattern shown here is really observed at ILC, then it would strongly suggest the discovery of QFV SUSY (MSSM with QFV).

Note: This work is based on collaboration with H. Eberl and E. Ginina (HEPHY Vienna).

References:

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