Higgs decays to charm and bottom pairs in the MSSM with quark-flavour violation

Elena Ginina
HEPHY, Vienna

in collaboration with H. Eberl,
A. Bartl, K. Hidaka and W. Majerotto

Sixth workshop on Theory, Phenomenology and Experiment in Flavour Physics - FPCapri2016
Anacapri, June 2016

Contents

- Intro
- General quark-flavour mixing in the MSSM
- Higgs decay into bottom and charm pairs at full one-loop level
- Mass insertion technique
- Numerical results
- Conclusions

Intro

- The Higgs properties measured at the LHC are by now consistent with the SM
- However, deviations are not yet excluded and could point to “New physics”
- In the MSSM the discovered Higgs may well be the lightest neutral Higgs, h^0
- Moreover, MSSM provides new sources of quark-flavour violation (QFV) that can affect considerably the phenomenology of the Higgs interactions
- We study two important decays of the Higgs boson: into a pair of charm quarks, and into a pair of bottom quarks, at one-loop level in the MSSM with QFV
- We consider mixing between the two heavier generations of squarks, $\tilde{c}_{L,R} - \tilde{t}_{L,R}$ mixing
- Taking into account all constraints from B-physics we present a numerical results on how the Higgs properties are affected but the MSSM QVF parameters

General quark-flavour mixing in the MSSM

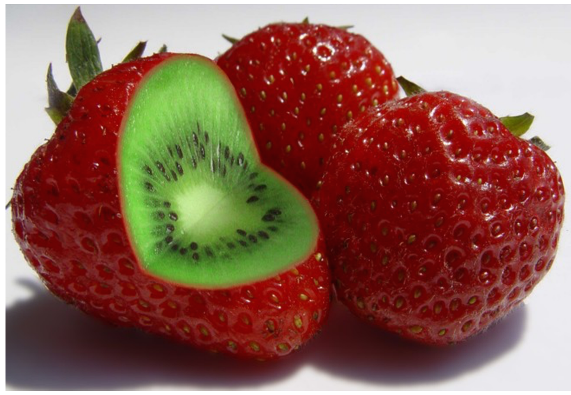
- In the SM all QFV terms are proportional to the CKM matrix

- In the general MSSM there are two concepts:

  * Minimal quark flavour violation - no new sources of QFV, in the super-CKM basis the squarks undergo the same rotations like the quarks, all flavour violating entries are related to the CKM matrix (e.g. $\tilde{\chi}_l^{\pm}\tilde{q}_i\tilde{q}_j \sim V_{q_i q'_j}$)

  * Non-minimal quark flavour violation - new sources of QFV, independent on the CKM, free (SUSY breaking) parameters in the theory

- In the following we assume non-minimal quark flavour violation



General quark-flavour mixing in the MSSM

- The flavour-violating terms are contained in the mass matrices of the squarks at the electroweak scale

$$\mathcal{M}^2_{\tilde{q}} = \begin{pmatrix} \mathcal{M}^2_{\tilde{q},LL} & \mathcal{M}^2_{\tilde{q},LR} \\ \mathcal{M}^2_{\tilde{q},RL} & \mathcal{M}^2_{\tilde{q},RR} \end{pmatrix}, \ q = u, d$$

- The 3x3 soft SUSY-breaking matrices can introduce QFV (off-diagonal) terms, e.g. in the up-squark sector

$$(\mathcal{M}^2_{\tilde{u},LL})_{\alpha\beta} = (M^2_Q)_{\alpha\beta} + \left[\left(\frac{1}{2} - \frac{2}{3}\sin^2\theta_W\right)\cos 2\beta m_Z^2 + (\hat{m}^2_u)_\alpha\right]\delta_{\alpha\beta},$$

$$(\mathcal{M}^2_{\tilde{u},RR})_{\alpha\beta} = (M^2_U)_{\alpha\beta} + \left[\left(\frac{2}{3}\sin^2\theta_W\right)\cos 2\beta m_Z^2 + (\hat{m}^2_u)_\alpha\right]\delta_{\alpha\beta},$$

$$(\mathcal{M}^2_{\tilde{u},RL})_{\alpha\beta} = \frac{v_2}{\sqrt{2}}(T_U)_{\beta\alpha} - (\hat{m}_u)_\alpha \mu^* \cot\beta\,\delta_{\alpha\beta}$$

- The mass eigenstates are obtained after diagonalization with a 6x6 rotation matrix

$$U^{\tilde{q}}\mathcal{M}^2_{\tilde{q}}(U^{\tilde{q}})^\dagger = \mathrm{diag}(m^2_{\tilde{q}_1}, \ldots, m^2_{\tilde{q}_6}) \text{ with } m_{\tilde{q}_1} < \cdots < m_{\tilde{q}_6}$$

General quark-flavour mixing in the MSSM

- Dimensionless QFV parameters are introduced in the up-type sector ($\alpha \neq \beta$)

$$\delta^{LL}_{\alpha\beta} \equiv M^2_{Q\alpha\beta}/\sqrt{M^2_{Q\alpha\alpha}M^2_{Q\beta\beta}} \; ,$$

$$\delta^{uRR}_{\alpha\beta} \equiv M^2_{U\alpha\beta}/\sqrt{M^2_{U\alpha\alpha}M^2_{U\beta\beta}} \; ,$$

$$\delta^{uRL}_{\alpha\beta} \equiv (v_2/\sqrt{2})T_{U\alpha\beta}/\sqrt{M^2_{U\alpha\alpha}M^2_{Q\beta\beta}}$$

- And in the down-type sector

$$\delta^{dRR}_{\alpha\beta} \equiv M^2_{D\alpha\beta}/\sqrt{M^2_{D\alpha\alpha}M^2_{D\beta\beta}}$$

$$\delta^{dRL}_{\alpha\beta} \equiv (v_1/\sqrt{2})T_{D\alpha\beta}/\sqrt{M^2_{D\alpha\alpha}M^2_{Q\beta\beta}}$$

The processes

- We study the decay of the lightest neutral Higgs boson $h^0 \to b\bar{b}$ at full 1-loop level in the MSSM with QFV

- The partial decay width including 1-loop contributions

$$\Gamma(h^0 \to b\bar{b}) = \Gamma^{\text{tree}}(h^0 \to b\bar{b}) + \delta\Gamma^{\text{1loop}}(h^0 \to b\bar{b})$$

with tree-level width

$$\Gamma^{\text{tree}}(h^0 \to b\bar{b}) = \frac{\mathrm{N_C}}{8\pi} m_{h^0} (s_1^b)^2 \left(1 - \frac{4m_b^2}{m_{h^0}^2}\right)^{3/2}$$

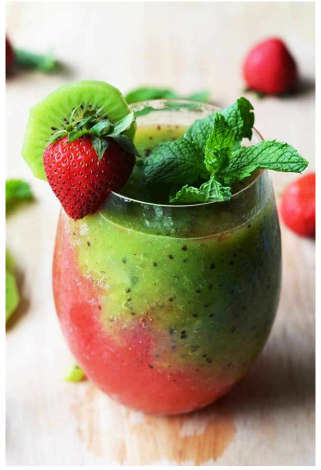
$$N_C = 3\,,\, s_1^b = g\frac{m_b}{2m_W}\frac{\sin\alpha}{\cos\beta} = \frac{h_b}{\sqrt{2}}\sin\alpha$$

- We compare it in detail (and recalculate in the MI approximation) with the process $h^0 \to c\bar{c}$, as previously studied by our group in Phys. Rev. D 91, 015007 (2015)

- In this context we often refer to the1-loop representation

$$\Gamma(h^0 \to b\bar{b}) = \Gamma^{g,\text{impr}} + \delta\Gamma^{\tilde{g}} + \delta\Gamma^{EW}$$

Mass insertion (MI) technique



- The perturbative interaction between the Higgs and the squarks is explicitly proportional to the Soft SUSY breaking trilinear coupling matrices T^U, T^D

- The dependence on the Soft SUSY breaking mass matrices $M_{Q,U,D}$ is, however, hidden in the squark mixing matrices $U^{\tilde{u},\tilde{d}}$

- An effective approach using the MI approximation technique can provide a good analytical description of this dependence

- In our calculations we exploit the Flavour Expansion Theorem (FET), suggested by A. Dedes et. al. JHEP 1506 (2015) 151 and use the numerical package MassToMI by J. Rosiek, CPC 201 (2016) 144.

MI approximation, general

- Given the structure $X = U^{\tilde{q}}_{iA} U^{\tilde{q}*}_{iB} B_0(0, m^2, m^2_{\tilde{q}_i})\,, \quad \text{with} \quad A \neq B.$

X given in terms of mass eigenstates, can be expanded into MIs,

$$
\begin{aligned}
X &= M^I_{AB}\, b_0\big(1, m^2, \{M_{AA}, M_{BB}\}\big) \\
&+ M^I_{Ai} M^I_{iB}\, b_0\big(2, m^2, \{M_{AA}, M_{ii}, M_{BB}\}\big) \\
&+ M^I_{Ai} M^I_{ij} M^I_{jB}\, b_0\big(3, m^2, \{M_{AA}, M_{ii}, M_{jj}, M_{BB}\}\big) \\
&+ M^I_{Ai} M^I_{ij} M^I_{jk} M^I_{kB}\, b_0\big(4, m^2, \{M_{AA}, M_{ii}, M_{jj}, M_{kk}, M_{BB}\}\big) + \ldots .
\end{aligned}
$$

The insertions are given by the elements of the matrix M^I (with $M^I_{ii} = 0$).

The generalized b_0 functions (first argument $\equiv$ number of insertions) can be written recursively as

$$
\begin{aligned}
b_0(1, a, \{b, c\}) &= \frac{b_0(a, b) - b_0(a, c)}{b - c}\,, \\
b_0(2, a, \{b, c, d\}) &= \frac{b_0(1, a, \{b, c\}) - b_0(1, a, \{b, d\})}{c - d}\,, \ldots \text{with} \\
b_0(a, b) \equiv B_0(0, a, b) &= \frac{b \log\left(\frac{b}{Q^2}\right) - a \log\left(\frac{a}{Q^2}\right)}{a - b} + \Delta + 1
\end{aligned}
$$

MI approximation in $h^0 \to c\bar{c}$

- We allow the squared $\tilde{u}$- mass matrix in the form:

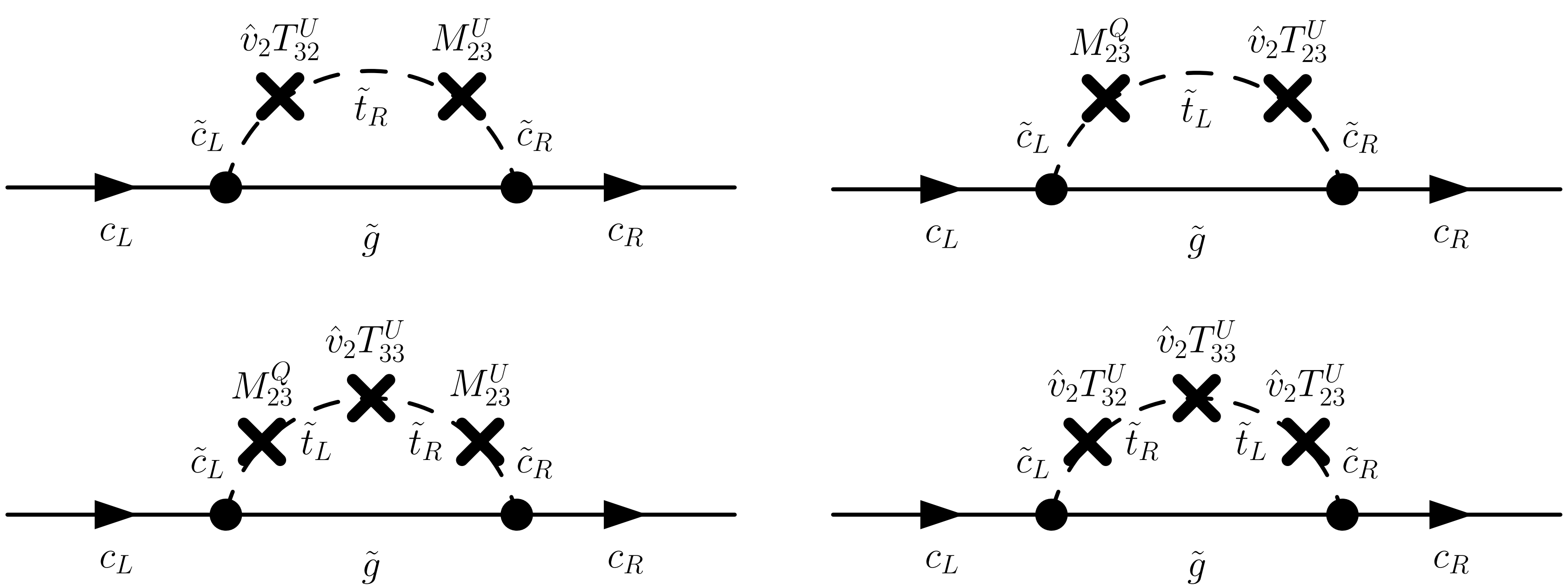
$$\mathcal{M}^2_{\tilde{u}} = \begin{pmatrix} \mathcal{M}^2_{\tilde{u},LL} & \mathcal{M}^2_{\tilde{u},LR} \\ \mathcal{M}^2_{\tilde{u},RL} & \mathcal{M}^2_{\tilde{u},RR} \end{pmatrix} \equiv M_{ij} = \begin{pmatrix} M^{LL}_{11} & 0 & 0 & 0 & 0 & 0 \\ 0 & M^{LL}_{22} & M^{Q}_{23} & 0 & 0 & \hat{v}_2 T^U_{32} \\ 0 & M^{Q}_{23} & M^{LL}_{33} & 0 & \hat{v}_2 T^U_{23} & \hat{v}_2 T^U_{33} \\ 0 & 0 & 0 & M^{RR}_{11} & 0 & 0 \\ 0 & 0 & \hat{v}_2 T^U_{23} & 0 & M^{RR}_{22} & M^{U}_{23} \\ 0 & \hat{v}_2 T^U_{32} & \hat{v}_2 T^U_{33} & 0 & M^{U}_{23} & M^{RR}_{33} \end{pmatrix}$$

gluino contribution to $h^0 \to c\bar{c}$

- The approximated result for the charm self-energy contribution with gluino

$$m_c \Sigma_c^{LR,\tilde{g}} = -\frac{2\alpha_s}{3\pi} m_{\tilde{g}} (T_2 + T_3 + T_4 + \ldots)$$

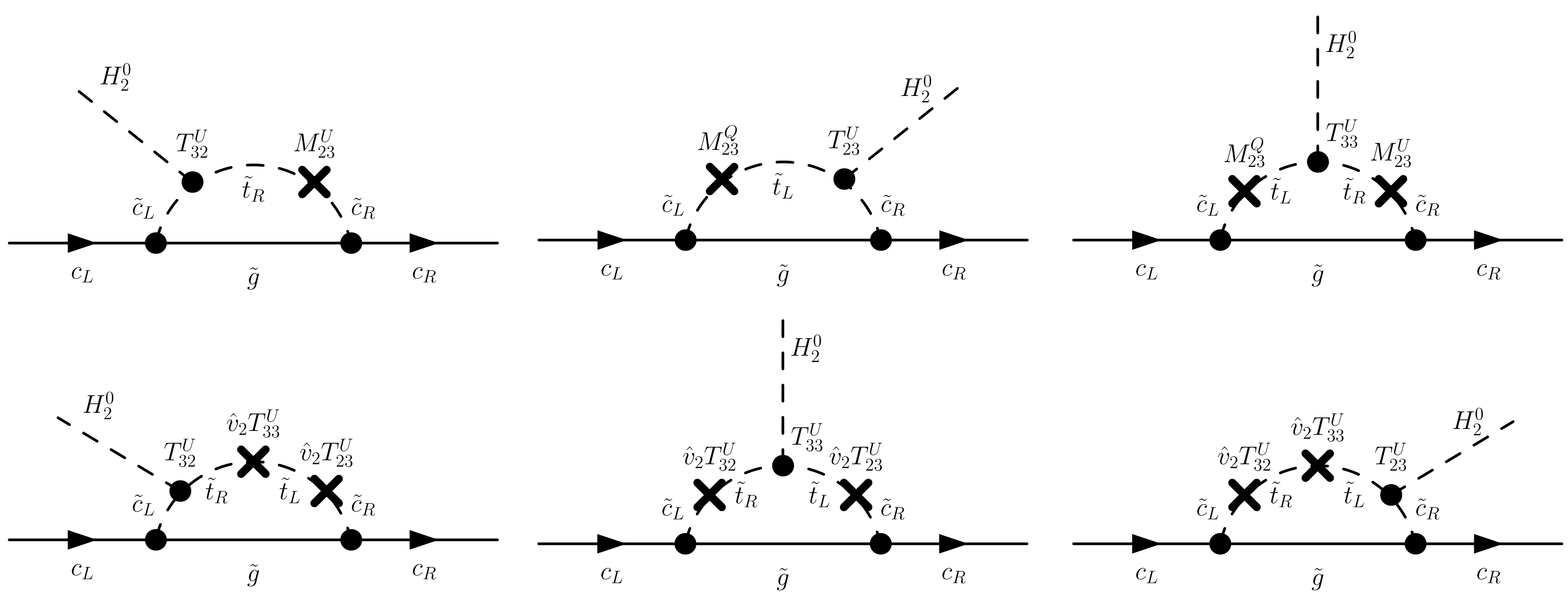
$$\begin{aligned} T_2 &= \hat{v}_2 \boxed{T^U_{32} M^U_{23}} b_0\left(2, m^2_{\tilde{g}}, \{M^{LL}_{22}, M^{RR}_{33}, M^{RR}_{22}\}\right) \\ &+ \hat{v}_2 T^U_{23} M^Q_{23}\, b_0\left(2, m^2_{\tilde{g}}, \{M^{LL}_{22}, M^{LL}_{33}, M^{RR}_{22}\}\right) \\ T_3 &= \hat{v}_2 T^U_{33} \left(M^Q_{23} M^U_{23} + 3^\rho\, \hat{v}_2^2 T^U_{23} T^U_{32}\right) b_0\left(3, m^2_{\tilde{g}}, \{M^{LL}_{22}, M^{LL}_{33}, M^{RR}_{33}, M^{RR}_{22}\}\right) \end{aligned}$$



gluino contribution to $h^0 \to c\bar{c}$

- The approximated result for the vertex correction with gluino

$$
\begin{aligned}
c^v &= -\frac{2\alpha_s}{3\pi} m_{\tilde{g}} \frac{\cos\alpha}{\sqrt{2}} \left(T_1^v + T_2^v + \ldots\right) \\
T_1^v &= \boxed{T_{32}^U M_{23}^U}\, b_0\big(2, m_{\tilde{g}}^2, \{M_{22}^{LL}, M_{33}^{RR}, M_{22}^{RR}\}\big) \\
&\quad + T_{23}^U M_{23}^Q\, b_0\big(2, m_{\tilde{g}}^2, \{M_{22}^{LL}, M_{33}^{LL}, M_{22}^{RR}\}\big) \;, \\
T_2^v &= T_{33}^U \left(M_{23}^Q M_{23}^U + 3\,\hat{v}_2^2\, T_{23}^U T_{32}^U\right) b_0\big(3, m_{\tilde{g}}^2, \{M_{22}^{LL}, M_{33}^{LL}, M_{33}^{RR}, M_{22}^{RR}\}\big)
\end{aligned}
$$



gluino contribution to $h^0 \to c\bar{c}$

- The SUSY $\overline{\mathrm{DR}}$ running charm mass

$$m_c \sim m_c\big|_{SM} + \Delta m_c^{\tilde{g}} \sim 0.6 \text{ GeV} + \Delta m_c^{\tilde{g}}$$

$$\Delta m_c^{\tilde{g}} \simeq -\frac{2\alpha_s}{3\pi} m_{\tilde{g}} \hat{v}_2 T_{32}^U M_{23}^U \, b_0\big(2, m_{\tilde{g}}^2, \{M_{22}^{LL}, M_{33}^{RR}, M_{22}^{RR}\}\big)$$

- To estimate, we take all arguments of the b_0 function equal $\sim M_S$

$$b_0\big(2, M_S^2, \{M_S^2, M_S^2, M_S^2\}\big) = \frac{1}{2M_S^4}\,, \hat{v}_2 = 170 \text{ GeV}\,, \alpha_s = 0.1$$

then $\Delta m_c^{\tilde{g}} \sim -1.8\,\mathrm{GeV}\, m_{\tilde{g}} \dfrac{T_{32}^U M_{23}^U}{M_S^4}$

- Furthermore, we take $m_{\tilde{g}} = \sqrt{M_{23}^U} = M_S$ and $T_{32}^U > M_S/3$

then the $\overline{\mathrm{DR}}$ running charm mass $m_c < 0$

and since there are no constraints on $M_{23}^U T_{32}^U$
this can lead to not positive definite width and break the perturbativity of the theory

MI approximation in $h^0 \to b\bar{b}$

- We allow the squared $\tilde{d}$- mass matrix in the form:

$$\mathcal{M}^2_{\tilde{d}} = \begin{pmatrix} \mathcal{M}^2_{\tilde{d},LL} & \mathcal{M}^2_{\tilde{d},LR} \\ \mathcal{M}^2_{\tilde{d},RL} & \mathcal{M}^2_{\tilde{d},RR} \end{pmatrix} \equiv M_{ij} = \begin{pmatrix} M^{LL}_{11} & 0 & 0 & 0 & 0 & 0 \\ 0 & M^{LL}_{22} & M^{Q}_{23} & 0 & 0 & \hat{v}_1 T^D_{32} \\ 0 & M^{Q}_{23} & M^{LL}_{33} & 0 & \hat{v}_1 T^D_{23} & M^{RL}_{33} \\ 0 & 0 & 0 & M^{RR}_{11} & 0 & 0 \\ 0 & 0 & \hat{v}_1 T^D_{23} & 0 & M^{RR}_{22} & M^{D}_{23} \\ 0 & \hat{v}_1 T^D_{32} & M^{RL}_{33} & 0 & M^{D}_{23} & M^{RR}_{33} \end{pmatrix}$$

gluino contribution to $h^0 \to b\bar{b}$

- The approximated result for the bottom self-energy contribution with gluino

$$m_b \Sigma_b^{LR,\tilde{g}} = -\frac{2\alpha_s}{3\pi} m_{\tilde{g}} (T_1^{FC} + T_2^{FV} + T_3^{FC} + T_3^{FV} + \dots)$$

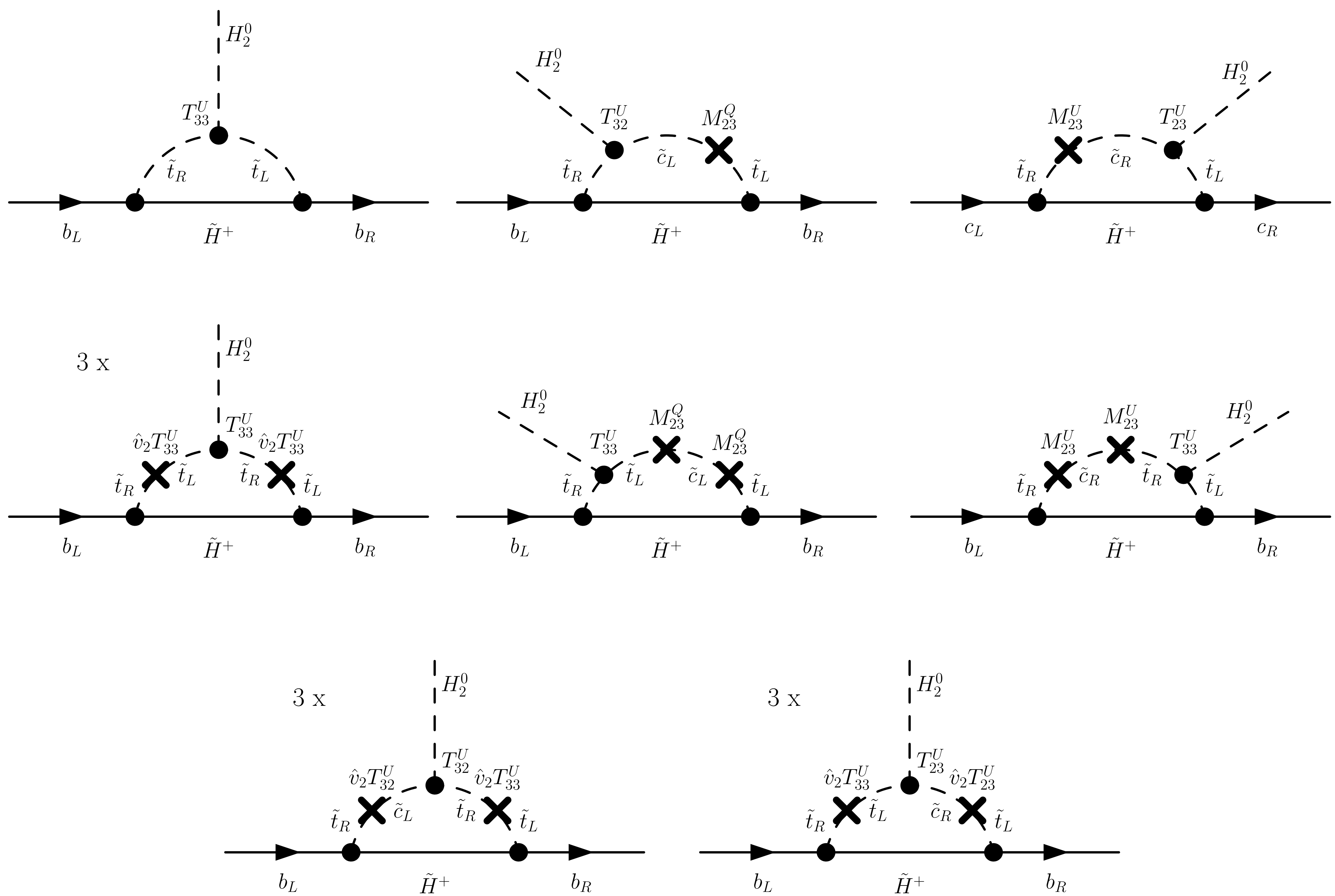
$$\begin{aligned}
T_1^{FC} &= \boxed{M_{33}^{RL}}\, b_0\big(1, m_{\tilde{g}}^2, \{M_{33}^{RR}, M_{33}^{LL}\}\big) \\
T_2^{FV} &= \hat{v}_1 T_{32}^D M_{23}^Q\, b_0\big(2, m_{\tilde{g}}^2, \{M_{33}^{RR}, M_{22}^{LL}, M_{33}^{LL}\}\big) \\
&+ \hat{v}_1 T_{23}^D M_{23}^D\, b_0\big(2, m_{\tilde{g}}^2, \{M_{33}^{RR}, M_{22}^{RR}, M_{33}^{LL}\}\big) \\
T_3^{FC} &= 3^\rho\, (M_{33}^{RL})^3\, b_0\big(3, m_{\tilde{g}}^2, \{M_{33}^{RR}, M_{33}^{LL}, M_{33}^{RR}, M_{33}^{LL}\}\big) \\
T_3^{FV} &= (M_{23}^Q)^2 M_{33}^{RL}\, b_0\big(3, m_{\tilde{g}}^2, \{M_{33}^{RR}, M_{33}^{LL}, M_{22}^{LL}, M_{33}^{LL}\}\big) \\
&+ (M_{23}^D)^2 M_{33}^{RL}\, b_0\big(3, m_{\tilde{g}}^2, \{M_{33}^{RR}, M_{33}^{RR}, M_{22}^{RR}, M_{33}^{LL}\}\big) \\
&+ 3^\rho\, (\hat{v}_1)^2 (T_{32}^D)^2 M_{33}^{RL}\, b_0\big(3, m_{\tilde{g}}^2, \{M_{33}^{RR}, M_{22}^{LL}, M_{33}^{RR}, M_{33}^{LL}\}\big) \\
&+ 3^\rho\, (\hat{v}_1)^2 (T_{23}^D)^2 M_{33}^{RL}\, b_0\big(3, m_{\tilde{g}}^2, \{M_{33}^{RR}, M_{33}^{LL}, M_{22}^{RR}, M_{33}^{LL}\}\big)
\end{aligned}$$

chargino contribution to $h^0 \to b\bar{b}$

- The approximated result for the bottom self-energy contribution with chargino

$$
\begin{aligned}
m_b \Sigma_b^{LR,\tilde{\chi}^+} &= \frac{h_b h_t}{16\pi^2} \sum_{m=1}^{2} m_{\tilde{\chi}_m^+} U_{m2} V_{m2} \, \left(T_1^{FC} + T_2^{FV} + T_3^{FC} + T_3^{FV} + \ldots \right) \\
T_1^{FC} &= \hat{v}_2 T_{33}^U \, b_0\Big(1, m_{\tilde{\chi}_m^+}^2, \{M_{33}^{RR}, M_{33}^{LL}\}\Big) \\
T_2^{FV} &= \hat{v}_2 T_{32}^U M_{23}^Q \, b_0\Big(2, m_{\tilde{\chi}_m^+}^2, \{M_{33}^{RR}, M_{22}^{LL}, M_{33}^{LL}\}\Big) \\
&+ \hat{v}_2 T_{23}^U M_{23}^U \, b_0\Big(2, m_{\tilde{\chi}_m^+}^2, \{M_{33}^{RR}, M_{22}^{RR}, M_{33}^{LL}\}\Big) \\
T_3^{FC} &= 3^\rho \, (\hat{v}_2 T_{33}^U)^3 \, b_0\Big(3, m_{\tilde{\chi}_m^+}^2, \{M_{33}^{RR}, M_{33}^{LL}, M_{33}^{RR}, M_{33}^{LL}\}\Big) \\
T_3^{FV} &= \hat{v}_2 T_{33}^U (M_{23}^Q)^2 \, b_0\Big(3, m_{\tilde{\chi}_m^+}^2, \{M_{33}^{RR}, M_{33}^{LL}, M_{22}^{LL}, M_{33}^{LL}\}\Big) \\
&+ \hat{v}_2 T_{33}^U (M_{23}^U)^2 \, b_0\Big(3, m_{\tilde{\chi}_m^+}^2, \{M_{33}^{RR}, M_{33}^{RR}, M_{22}^{RR}, M_{33}^{LL}\}\Big) \\
&+ 3^\rho \, (\hat{v}_2)^3 (T_{32}^U)^2 \, T_{33}^U \, b_0\Big(3, m_{\tilde{\chi}_m^+}^2, \{M_{33}^{RR}, M_{22}^{LL}, M_{33}^{RR}, M_{33}^{LL}\}\Big) \\
&+ 3^\rho \, (\hat{v}_2)^3 (T_{23}^U)^2 \, T_{33}^U \, b_0\Big(3, m_{\tilde{\chi}_m^+}^2, \{M_{33}^{RR}, M_{33}^{LL}, M_{22}^{RR}, M_{33}^{LL}\}\Big)
\end{aligned}
$$

chargino contribution to $h^0 \to b\bar{b}$



Numerical results

- Parameter variations of

Scan 1

(8750000p, 17% survived)

$$
\begin{aligned}
\{M^2_{U11}, M^2_{U22}, M^2_{U33}\}\ [\mathrm{GeV}^2] &= \text{ in sets of } \Big\{\{2400^2, 2300^2, 1800^2\}, \\
&\quad \{3000^2, 2800^2, 2000^2\}, \{3200^2, 3000^2, 2200^2\}, \\
&\quad \{2400^2, 1100^2, 1000^2\}, \{3200^2, 2200^2, 2000^2\}\Big\}; \\
\{M^2_{Q11}, M^2_{Q22}, M^2_{Q33}\} &= \{M^2_{U11}, M^2_{U22}, M^2_{U33}\}; \\
\tan\beta &= \{15 \div 30\} \text{ with step size } 2.5; \\
\mu\ [\mathrm{GeV}] &= \{1200 \div 2200\} \text{ with step size } 250; \\
\{M_1, M_2, M_3\}\ [\mathrm{GeV}] &= \text{ in sets of } \Big\{\{300, 600, 1800\}, \{400, 800, 2000\}, \\
&\quad \{500, 1000, 2200\}, \{600, 1200, 2200\}, \\
&\quad \{700, 1400, 2400\}\Big\}; \\
M^2_{U23}\ [\mathrm{GeV}^2] &= \{-2430^2 \div 2430^2\} \text{ with step size } \approx 1 \times 10^6; \\
M^2_{Q23}\ [\mathrm{GeV}^2] &= \{-1140^2 \div 1140^2\} \text{ with step size } \approx 2.9 \times 10^5; \\
T_{U23}\ [\mathrm{GeV}] &= \{-3000 \div 3000\} \text{ with step size } 400; \\
T_{U32}\ [\mathrm{GeV}] &= \{-3000 \div 3000\} \text{ with step size } 400.
\end{aligned}
$$

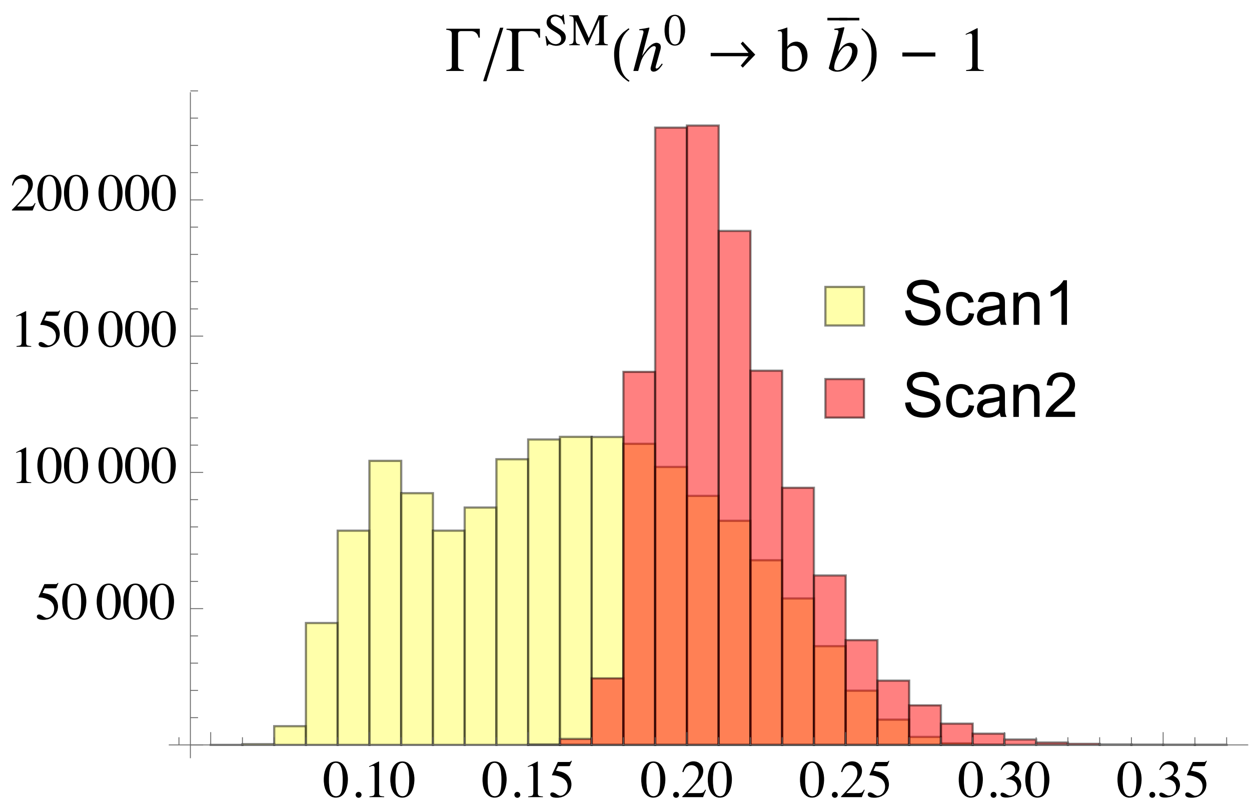
Scan2

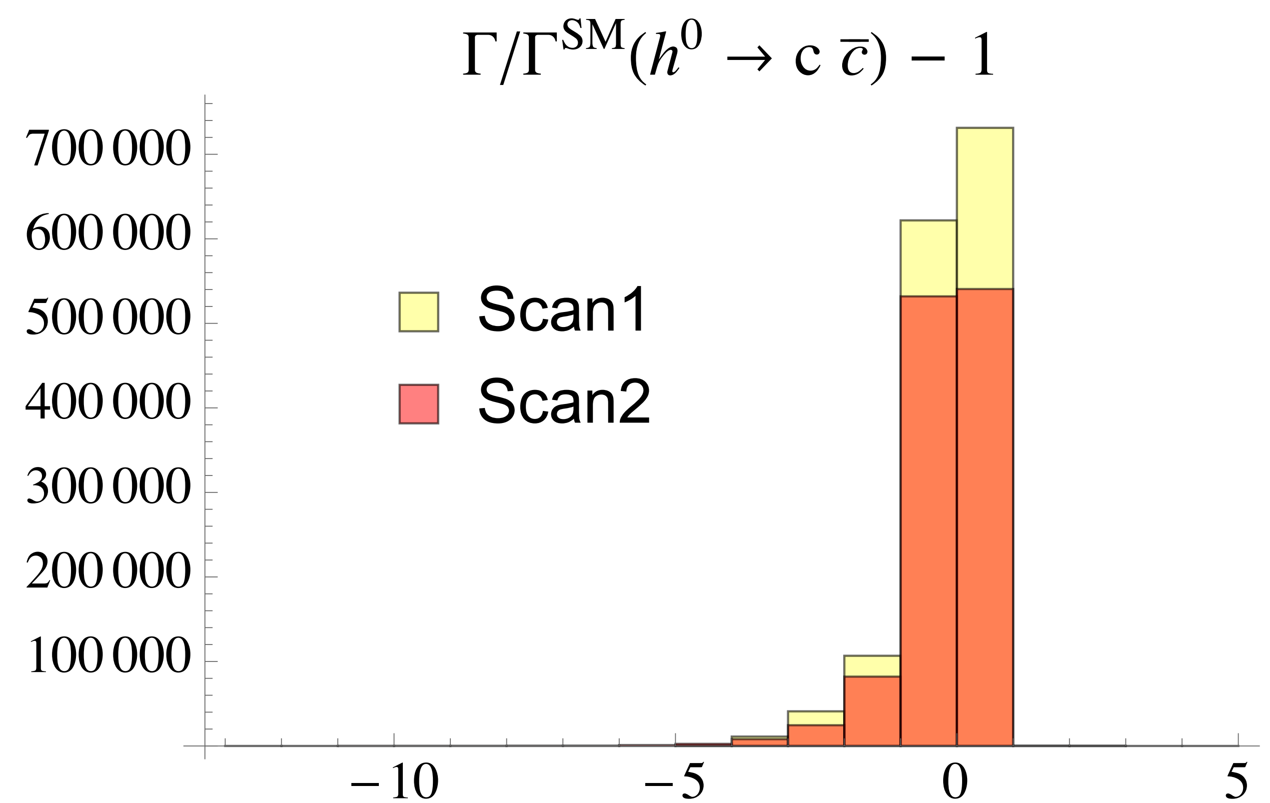
(9834496p, 12% survived)

$$
\begin{aligned}
M^2_{U22}\ [\mathrm{GeV}^2] &= \{1000^2 \div 3200^2\} \text{ with step size } \approx 1.3 \times 10^6; \\
M^2_{U33}\ [\mathrm{GeV}^2] &= \{970^2 \div 3100^2\} \text{ with step size } 1.2 \times 10^6; \\
M^2_{Q22}\ [\mathrm{GeV}^2] &= \{950^2 \div 3150^2\} \text{ with step size } \approx 1.5 \times 10^6; \\
M^2_{Q33}\ [\mathrm{GeV}^2] &= \{1100^2 \div 3100^2\} \text{ with step size } 1.4 \times 10^6; \\
M^2_{U23}\ [\mathrm{GeV}^2] &= \{-2400^2 \div 2400^2\} \text{ with step size } \approx 1.6 \times 10^6; \\
M^2_{Q23}\ [\mathrm{GeV}^2] &= \{-1150^2 \div 1150^2\} \text{ with step size } \approx 4.4 \times 10^5; \\
T_{U23}\ [\mathrm{GeV}] &= \{-3000 \div 3000\} \text{ with step size } \approx 1 \times 10^3; \\
T_{U32}\ [\mathrm{GeV}] &= \{-3000 \div 3000\} \text{ with step size } \approx 850.
\end{aligned}
$$

Numerical results

- Distribution of the results from the parameter scans for the deviation from the SM of the widths of $h^0 \to b\bar{b}$ and $h^0 \to c\bar{c}$





Numerical results

Reference scenario

M_1	M_2	M_3
400 GeV	800 GeV	2000 GeV

μ	$\tan\beta$	m_{A^0}
500 GeV	30	1500 GeV

	$\alpha = 1$	$\alpha = 2$	$\alpha = 3$
$M^2_{Q\alpha\alpha}$	3200^2 GeV^2	1550^2 GeV^2	1100^2 GeV^2
$M^2_{U\alpha\alpha}$	3200^2 GeV^2	2800^2 GeV^2	2050^2 GeV^2
$M^2_{D\alpha\alpha}$	3200^2 GeV^2	3000^2 GeV^2	2500^2 GeV^2

δ^{LL}_{23}	δ^{uRR}_{23}	δ^{uRL}_{23}	δ^{uLR}_{23}
0	0.8	0.02	0.02

Physical masses

$m_{\tilde{\chi}^0_1}$	$m_{\tilde{\chi}^0_2}$	$m_{\tilde{\chi}^0_3}$	$m_{\tilde{\chi}^0_4}$	$m_{\tilde{\chi}^+_1}$	$m_{\tilde{\chi}^+_2}$
395	507	511	845	501	845

m_{h^0}	m_{H^0}	m_{A^0}	m_{H^+}
125	1500	1500	1503

$m_{\tilde{g}}$	$m_{\tilde{u}_1}$	$m_{\tilde{u}_2}$	$m_{\tilde{u}_3}$	$m_{\tilde{u}_4}$	$m_{\tilde{u}_5}$	$m_{\tilde{u}_6}$
2103	996	1176	1578	3214	3217	3327

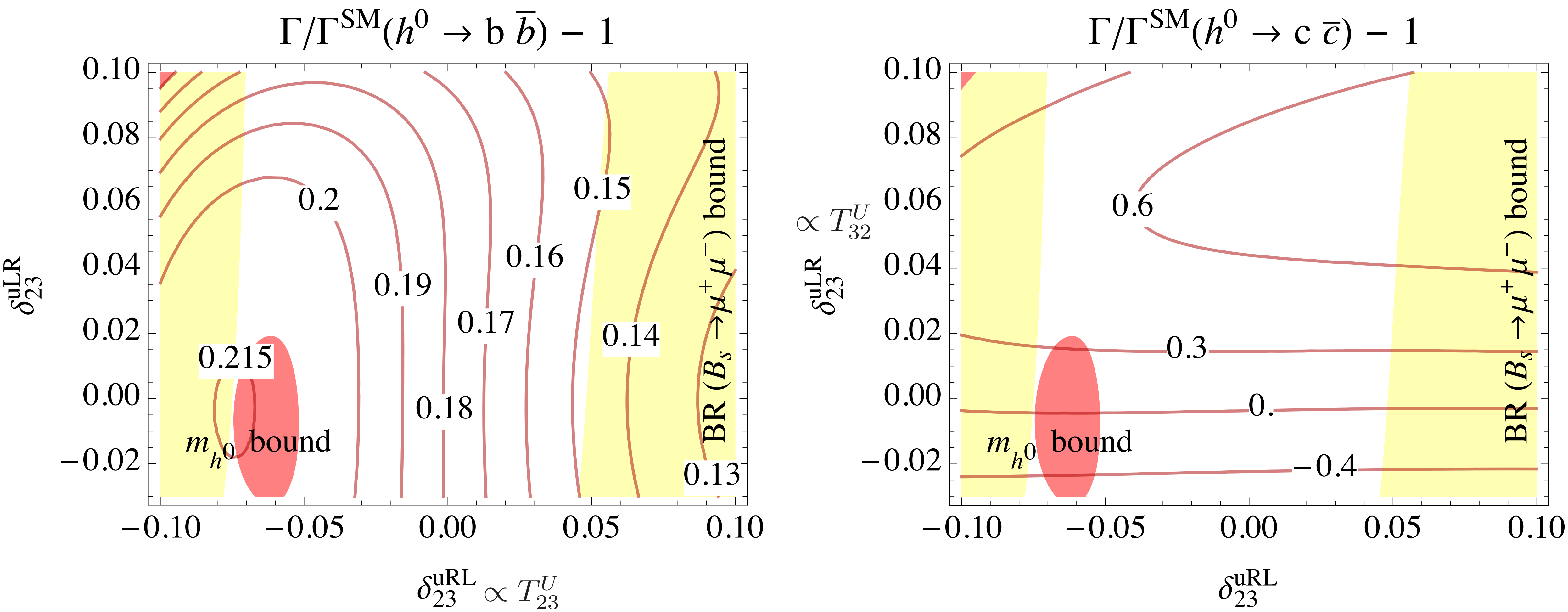
$m_{\tilde{d}_1}$	$m_{\tilde{d}_2}$	$m_{\tilde{d}_3}$	$m_{\tilde{d}_4}$	$m_{\tilde{d}_5}$	$m_{\tilde{d}_6}$
1128	1579	2515	3012	3211	3218

Flavour decomposition

	$\tilde{u}_L$	$\tilde{c}_L$	$\tilde{t}_L$	$\tilde{u}_R$	$\tilde{c}_R$	$\tilde{t}_R$
$\tilde{u}_1$	0	0.002	0.25	0	0.228	0.52
$\tilde{u}_2$	0	0	0.749	0	0.086	0.165
$\tilde{u}_3$	0.051	0.946	0.001	0	0	0
$\tilde{u}_4$	0.95	0.05	0	0	0	0
$\tilde{u}_5$	0	0	0	1	0	0
$\tilde{u}_6$	0	0	0	0	0.69	0.31

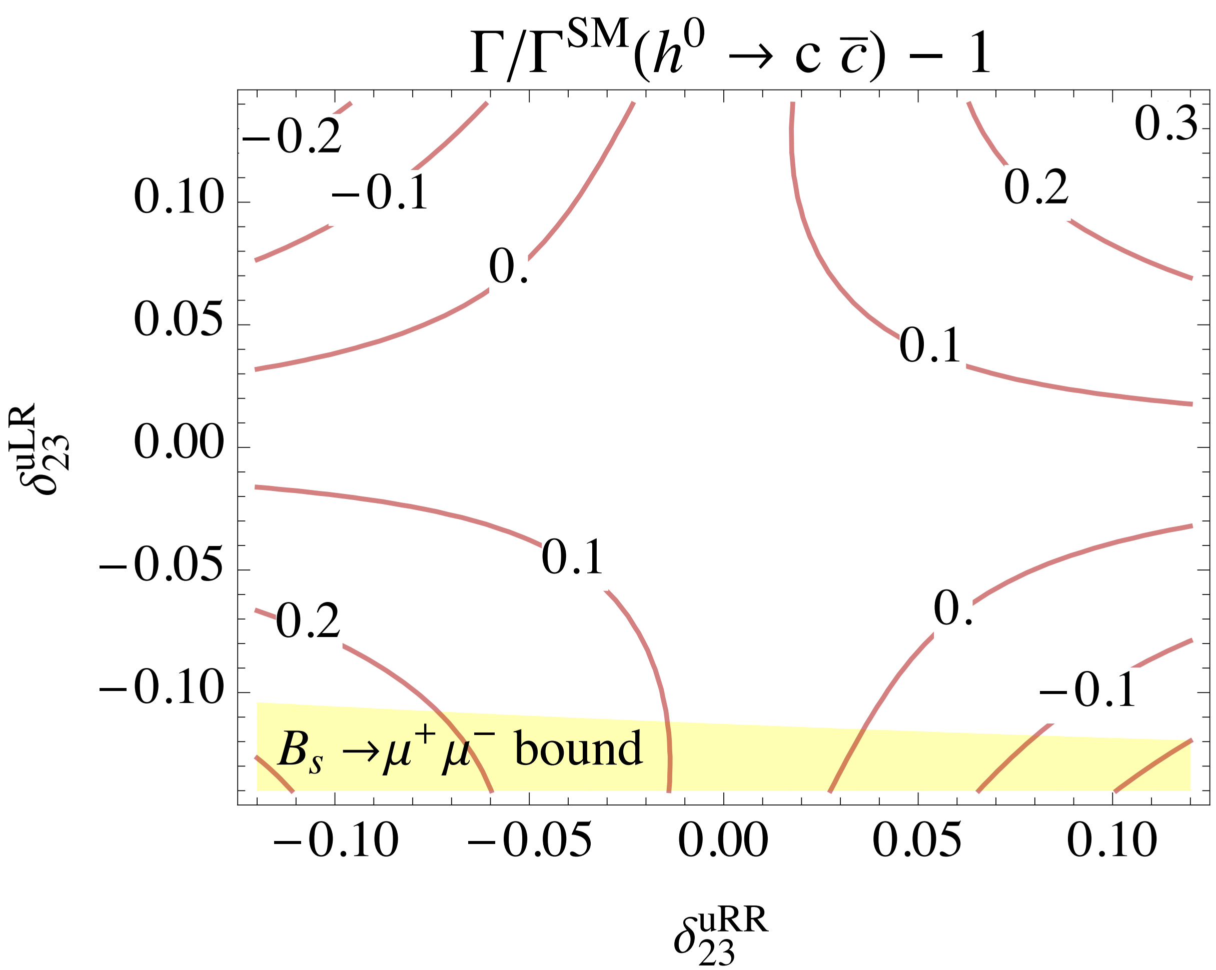
Numerical results

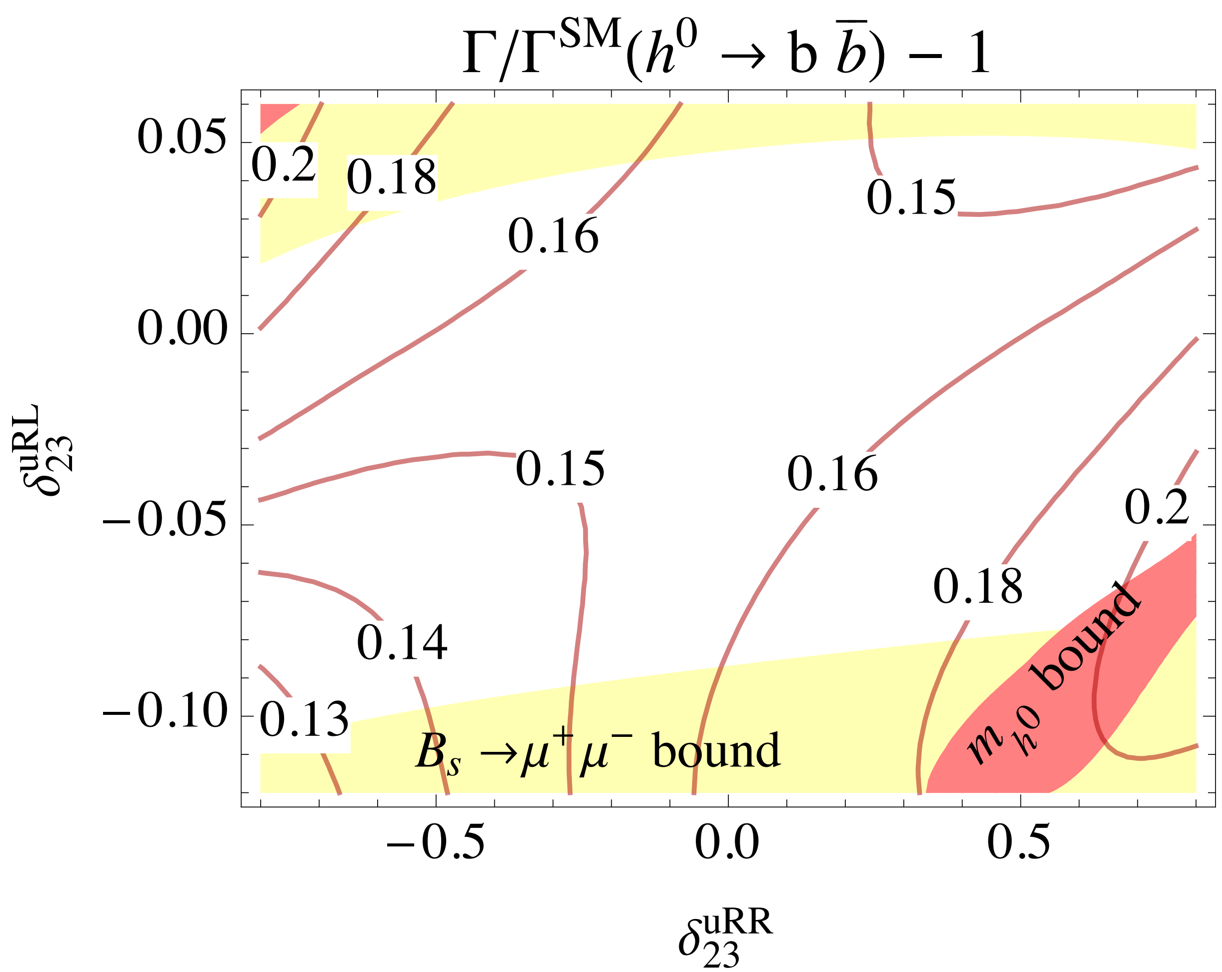
- Contours of the deviation from the SM of the widths of $h^0 \to b\bar{b}$ and $h^0 \to c\bar{c}$ in the $\delta_{23}^{uRL} - \delta_{23}^{uLR}$ plane



Numerical results

- Contours of the deviation from the SM of the widths of $h^0 \to b\bar{b}$ and $h^0 \to c\bar{c}$ in the $\delta_{23}^{uRR} - \delta_{23}^{uLR}$ plane

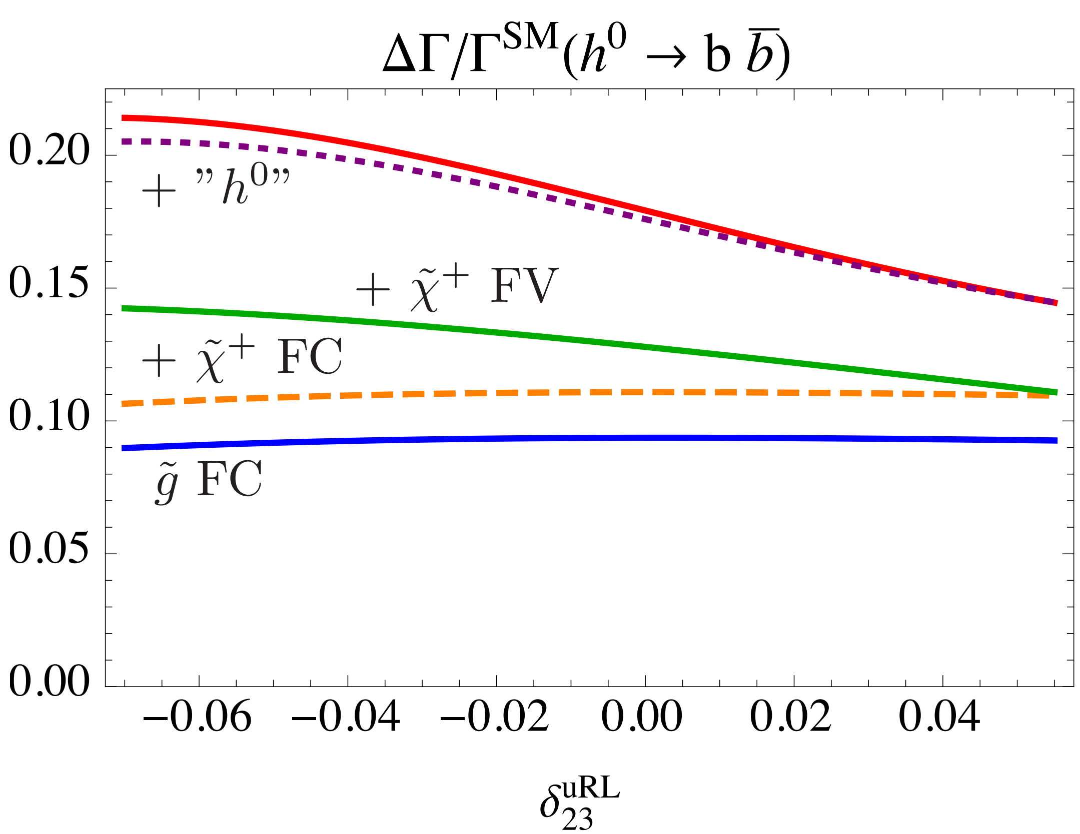


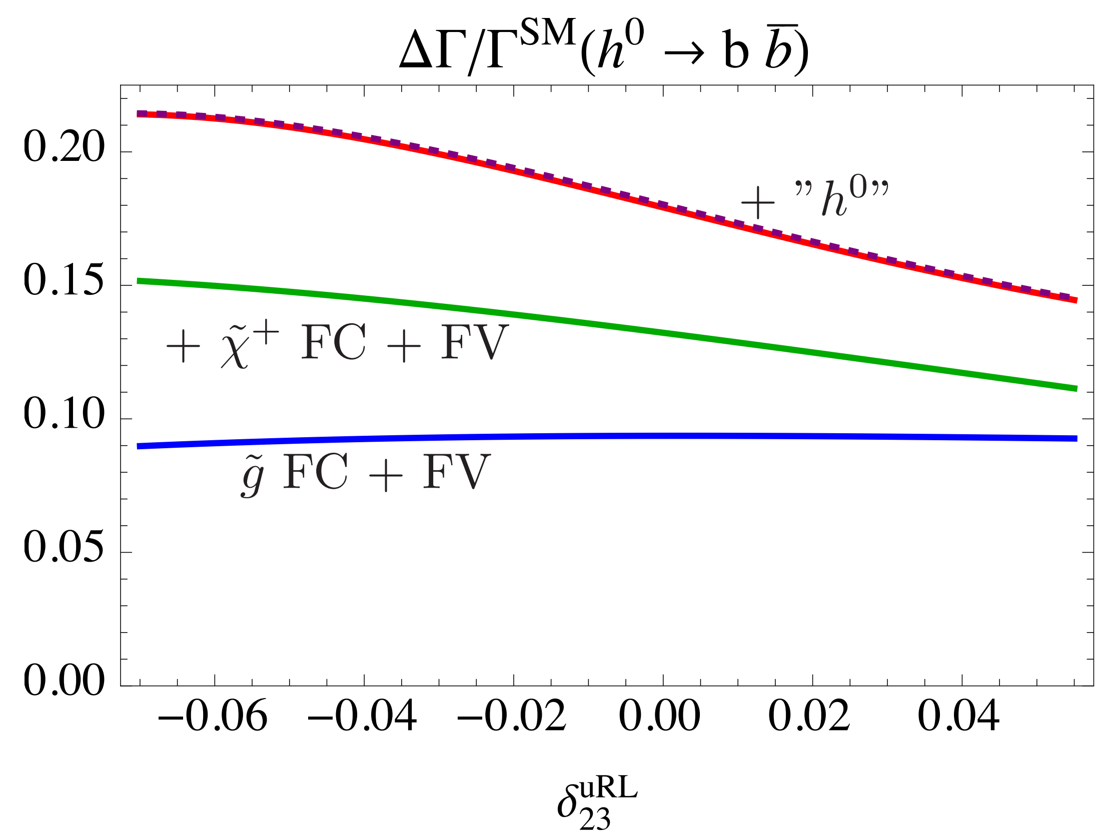


Numerical results

- The individual 1-loop QFV and QFC gluino and chargino contributions to the width of $h^0 \to b\bar{b}$ relative to the SM width, calculated in the MI approximation, as well as m_{h^0} and α dependence on the QFV parameters

$$\Gamma^{\rm appr}(h^0 \to b\bar{b}) = \Gamma^{g,{\rm impr}} - 2\left(\Sigma_b^{LR,\tilde{g}} + \Sigma_b^{LR,\tilde{\chi}^+}\right)\Gamma^{\rm tree}(m_b)$$

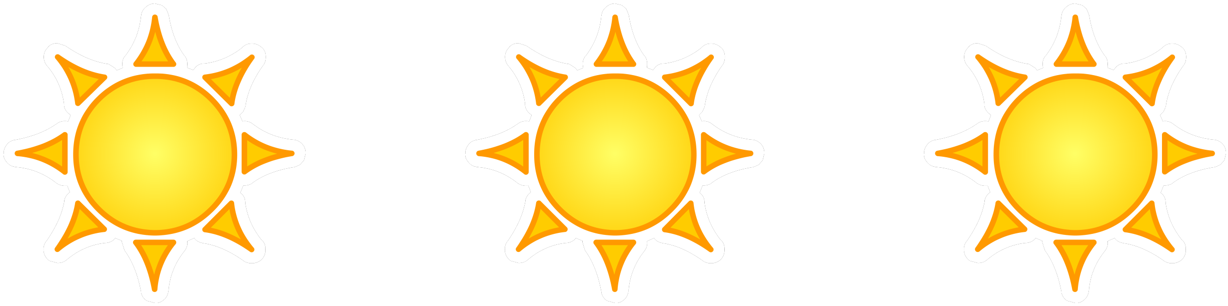




Conclusions

- We have studied the decays $h^0 \to b\bar{b}$ and $h^0 \to c\bar{c}$ at full one-loop level in the MSSM with flavour mixing in the heavy sup sector
- We have calculated the main gluino and chargino contributions using the Flavour Expansion Theorem
- Both widths can deviate from the SM essentially within the allowed from B-physics constraints parameter region
- $h^0 \to c\bar{c}$: mainly due to the QFV part of the MSSM, may also break perturbation due to contribution proportional to the unconstrained product $M^U_{23} T^U_{32}$
- $h^0 \to b\bar{b}$: mainly due to the QFC part, but nevertheless, the QFV contribution may reach ~7% at certain parameter regions, with a fair contribution coming from the Higgs parameters dependence

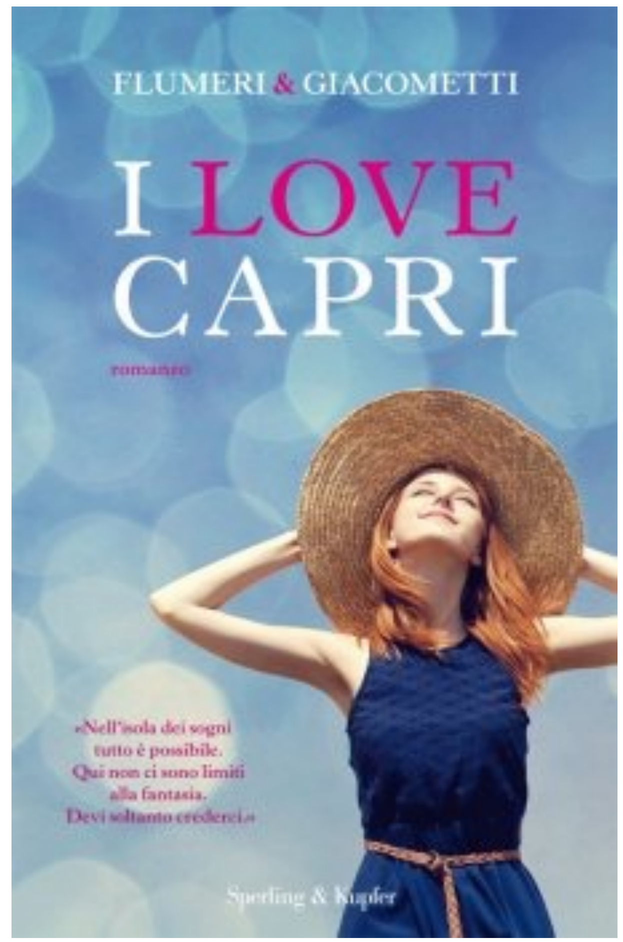
Thank you!:)



Now, the workshop is over so you can just

and go to see the blue cave!!:)

you may also consider reading this book:



and come back next year for some flavour physics!:)