Higgs to tau muon in a MSSM flavor extended model

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Overview

Reports of Flavour Violation in CMS and ATLAS

CMS

2014/07/05

Standard desviation of the Branching Ratio $BR(h^0 -> \tau\mu)$: 3.0 σ of the Standard Model Prediction

Experimental Branching Ratio: $(0.89^{+0.4}_{-0.37})x10^{-2}$

2015/08/21

Standard desviation of the Branching Ratio $BR(h^0 -> \tau\mu)$: 2.4 σ of the Standard Model Prediction

Experimental Branching Ratio: $(0.84^{+0.39}_{-0.37})x10^{-2}$

ATLAS

Upper limit BR($h^0 \rightarrow \tau\mu$) $< 1,87x10^{-2}$

The Standard Model

The Model explains three of the fundamental forces of Nature (weak, strong and electromagnetic). It is used in all experimental calculations.

$$\mathscr{L} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + i\bar{\Psi}\not{D}\Psi + hc. + \Psi_i Y_{ij}\Psi_j\Phi + hc. + |D_\mu\Phi|^2 - V(\Phi) \quad (1)$$

where $-\frac{1}{4}F_{\mu\nu}F^{\mu\nu}$ represents the electromagnetic interaction, $i\bar{\Psi}\not{D}\Psi + hc.$ represents the interaction of fermionic fields, $\Psi_i Y_{ij}\Psi_j\Phi + hc.$ represents the interaction of the bosonic field with the fermionic field,$|D_\mu\Phi|^2$ represents the interaction of the Higgs field with the fermionic field and $V(\Phi)$ is the Higgs Potential.

SUSY

Transformations from bosonic fields to fermionic fields and viceversa.

$$\delta\phi = \epsilon\psi, \delta\phi^* = \epsilon^\dagger\psi^\dagger \quad (2)$$

$$\delta S = \int d^4x\delta L = 0 \quad (3)$$

where where ϵ is an infinitesimal, anticommuting, two-component Weyl fermion object parameterizing the supersymmetry transformation

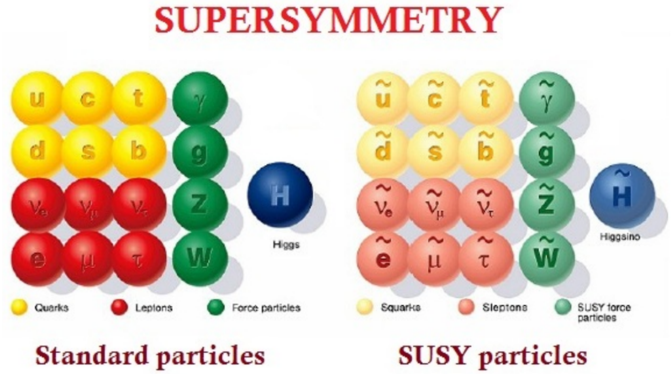

Figure : The super-partner particles

Minimum number of Higgs doblets for Supersymmetrize the Standard Model.

1)It can explain Dark Matter

2)Radiative Higgs boson mass correction quadratic divergences vanish. m_H receives enormous quantum corrections from the virtual effects of every particle that couples, directly or indirectly, to the Higgs field

3)It could be considered that it extends the Standard Model naturally.(Requiring the SUSY transformation)

4) It could join gravity (super-gravity)

MSSM soft Supersymmetry-Breaking

Within the MSSM, this soft Lagrangian includes the following terms

$$\mathcal{L}_{soft} = \mathcal{L}^{mass}_{sfermion} + \mathcal{L}^{mass}_{bino} + \mathcal{L}^{mass}_{wino} + \mathcal{L}^{mass}_{gluino} + \mathcal{L}_{Higgsino} + \mathcal{L}_{h^0 \tilde{f}_j \tilde{f}_k} \quad (4)$$

In order to establish the free parameters of the model coming from this Lagrangian, we write down the form of the slepton masses and the Higgs- slepton-slepton couplings, the first and last term of eq. 4 , which are given as

$$\mathcal{L}^{\tilde{l}}_{soft} = -m^2_{\tilde{\bar{E}}_{jk}} \tilde{\bar{E}}^j \tilde{\bar{E}}^{k\dagger} - m^2_{\tilde{L},j,k} \tilde{L}^{j\dagger} \tilde{L}^k - (A_{e,jk} \tilde{E}^j \tilde{\bar{L}}^k H_1 + h.c) \quad (5)$$

MSSM extended in Flavour Ansatz

In principle, any scalar with the same quantum numbers could mix through the soft SUSY parameters. This general mixing includes the parity superpartners fermionic labels, and leads us to a sfermion mass matrix given as a squared 6×6 matrix, which can be written as a block matrix as

$$\tilde{M}_{\tilde{f}}^2 = \begin{pmatrix} M_{LL}^2 & M_{LR}^2 \\ M_{LR}^{2\dagger} & M_{RR}^2 \end{pmatrix} \tag{6}$$

where

$$M_{LL}^2 = m_{\tilde{L}}^2 + M_l^{(0)2} + \frac{1}{2}\cos 2\beta(2m_W^2 - m_Z^2)\mathbf{I}_{3\times 3}, \tag{7}$$

$$M_{RR}^2 = M_{\tilde{E}}^2 + M_l^{(0)2} - \cos 2\beta \sin^2\theta_W m_Z^2 \mathbf{I}_{3\times 3}, \tag{8}$$

$$M_{LR}^2 = \frac{A_l v \cos\beta}{\sqrt{2}} - M_l^{(0)}\mu\tan\beta. \tag{9}$$

where $M_l^{(0)}$ is the lepton mass matrix.

MSSM extended in Flavour Ansatz

Current data mainly suppress the Flavour mixing associated with the first two slepton families, but allow considerable mixing between the second and third slepton families Thus, our proposal includes dominant terms that mix the second and third families, as follows

$$A_{LO} = A'_l = \begin{pmatrix} 0 & 0 & 0 \\ 0 & w & z \\ 0 & y & 1 \end{pmatrix} A_0, \tag{10}$$

The dominant terms give a 4×4 decoupled block mass matrix, in the basis $\tilde{e}_L, \tilde{e}_R, \tilde{\mu}_L, \tilde{\mu}_R, \tilde{\tau}_L, \tilde{\tau}_R$, as

$$\tilde{M}^2_{\tilde{l}} = \left(\begin{array}{cc|cccc} \tilde{m}_0^2 & 0 & 0 & 0 & 0 & 0 \\ 0 & \tilde{m}_0^2 & 0 & 0 & 0 & 0 \\ \hline 0 & 0 & \tilde{m}_0^2 & X_\tau & 0 & A_z \\ 0 & 0 & X_\tau & \tilde{m}_0^2 & A_y & 0 \\ 0 & 0 & 0 & A_y & \tilde{m}_0^2 & X_\mu \\ 0 & 0 & A_z & 0 & X_\mu & \tilde{m}_0^2 \end{array}\right), \tag{11}$$

with $X_3 = \frac{1}{\sqrt{2}} A_0 v \cos\beta - \mu m_\tau \tan\beta$ and $X_2 = A_w - \mu m_\mu \tan\beta$. Where μ is the $SU(2) - invariant$ coupling of two different Higgs superfield doublets, A_0 is the trilinear coupling scale and $\tan\beta = \frac{v_2}{v_1}$ is the ratio of the two vacuum expectation values coming from the two neutral Higgs fields, these three are MSSM parameters

In order to obtain the physical slepton eigenstates, we diagonalize the 4×4 mass sub-matrix given in (11).For simplicity we consider that $z = y$, which represent that the mixtures $\tilde{\mu}_L\tilde{\tau}_R$ and $\tilde{\mu}_R\tilde{\tau}_L$ are of the same order . The rotation will be performed to this part using an hermitian matrix Z_l, such that

$$Z_l^\dagger M_{\tilde{l}}^2 Z_l = \tilde{M}_{Diag}^2, \tag{12}$$

where

$$M_{\tilde{l}}^2 = \begin{pmatrix} \tilde{m}_0^2 & X_\tau & 0 & A_y \\ X_\tau & \tilde{m}_0^2 & A_y & 0 \\ 0 & A_y & \tilde{m}_0^2 & X_\mu \\ A_y & 0 & X_\mu & \tilde{m}_0^2 \end{pmatrix}. \tag{13}$$

$$\boxed{\begin{aligned} A_z &= \frac{1}{\sqrt{2}} z A_0 v \cos\beta \\ A_y &= \frac{1}{\sqrt{2}} y A_0 v \cos\beta \\ A_w &= \frac{1}{\sqrt{2}} w A_0 v \cos\beta \end{aligned}}$$

Table : *Explicit terms of the sfermion mass matrix ansatz.*

Masses to the supersymmetric particles

Having new general physical non-degenerate slepton masses

$$\begin{aligned} m^2_{\tilde{\mu}_1} &= \frac{1}{2}(2\tilde{m}_0^2 + X_\tau + X_\mu - R) \\ m^2_{\tilde{\mu}_2} &= \frac{1}{2}(2\tilde{m}_0^2 - X_\tau - X_\mu + R) \\ m^2_{\tilde{\tau}_1} &= \frac{1}{2}(2\tilde{m}_0^2 - X_\tau - X_\mu - R) \\ m^2_{\tilde{\tau}_2} &= \frac{1}{2}(2\tilde{m}_0^2 + X_\tau + X_\mu + R) \end{aligned} \tag{14}$$

where $R = \sqrt{4A_y^2 + (X_\tau - X_\mu)^2}$, $X_\tau = \frac{1}{\sqrt{2}} A_0 v cos(\beta) - \mu_{susy} m_\tau$, $X_\mu = A_0 v cos(\beta) - \mu_{susy} m_\mu tan(\beta)$

Flavour Violation

$$\begin{pmatrix} \tilde{e}_L \\ \tilde{\mu}_L \\ \tilde{\tau}_L \\ \tilde{e}_R \\ \tilde{\mu}_R \\ \tilde{\tau}_R \end{pmatrix} = \frac{1}{\sqrt{2}} \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\sin\frac{\varphi}{2} & -\cos\frac{\varphi}{2} & 0 & \sin\frac{\varphi}{2} & \cos\frac{\varphi}{2} \\ 0 & \cos\frac{\varphi}{2} & -\sin\frac{\varphi}{2} & 0 & -\cos\frac{\varphi}{2} & \sin\frac{\varphi}{2} \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & -\sin\frac{\varphi}{2} & \cos\frac{\varphi}{2} & 0 & -\sin\frac{\varphi}{2} & \cos\frac{\varphi}{2} \\ 0 & \cos\frac{\varphi}{2} & \sin\frac{\varphi}{2} & 0 & \cos\frac{\varphi}{2} & \sin\frac{\varphi}{2} \end{pmatrix} \begin{pmatrix} \tilde{e}_1 \\ \tilde{l}_1 \\ \tilde{l}_2 \\ \tilde{e}_2 \\ \tilde{l}_3 \\ \tilde{l}_4 \end{pmatrix} \tag{15}$$

where

$$sin\varphi = \frac{2A_y}{\sqrt{4A_y^2 + (X_2 - X_3)^2}}, \tag{16}$$

$$cos\varphi = \frac{(X_2 - X_3)}{\sqrt{4A_y^2 + (X_2 - X_3)^2}} \tag{17}$$

Supersymmetric Lagrangians for the interaction

The Supersymmetric Lagrangian which models the interaction of the Higgs boson with the $\tilde{\mu}_j, \tilde{\tau}_j$, where $j = 1, 2$ is given by

$$\mathcal{L}_{h^0\tilde{f}\tilde{f}} = [Q_\mu + G(-\frac{1}{2} + s_w^2)]\tilde{\mu}_L^*\tilde{\mu}_L h^0 + [Q_\mu - Gs_w^2]\tilde{\mu}_R^*\tilde{\mu}_R h^0 - H_\mu[\tilde{\mu}_L^*\tilde{\mu}_R h^0 + \tilde{\mu}_R^*\tilde{\mu}_L h^0]$$
$$+ [Q_\tau + G(-\frac{1}{2} + s_w^2)]\tilde{\tau}_L^*\tilde{\tau}_L h^0 + [Q_\tau - Gs_w^2]\tilde{\tau}_R^*\tilde{\tau}_R h^0 - H_\tau[\tilde{\tau}_L^*\tilde{\tau}_R h^0 + \tilde{\tau}_R^*\tilde{\tau}_L h^0]$$

where

$Q_{\mu,\tau} = \frac{gm_{\mu,\tau}^2 sin\alpha}{M_w cos\beta}$, $G = g_z M_z sin(\alpha + \beta)$, $H_{\mu,\tau} = \frac{gm_{\mu,\tau}}{2M_w cos\beta}(A_{\mu,\tau} sin\alpha - \mu_{susy} cos\alpha)$

The Lagrangian that modelates the interaction of $\tilde{B}\tilde{f}f$ is , where $\tilde{f} = \tilde{\mu}, \tilde{\tau}$

$$\mathcal{L}_{\tilde{B}^0\tilde{f}f} = -\frac{g}{\sqrt{2}}\bar{\tilde{B}}^0\Big\{[-tan\theta_w P_L]\tilde{\mu}_L^*\mu + [2tan\theta_w P_R]\tilde{\mu}_R^*\mu + [-tan\theta_w P_L]\tilde{\tau}_L^*\tau + [2tan\theta_w P_R]\tilde{\tau}_R^*$$

One-loop Diagrams

We calculate the branching ratio of the decay with one loop correction. The Branching Ratio will be given by the sum of the different contributions of the possible Feynman diagrams, with one loop quantum correction.

$$\mathcal{BR}(h^0->\tau\mu)=\frac{\Gamma(h^0->\mu\tau)}{\Gamma_{tot}} \tag{19}$$

where

$$\Gamma(h^0->\mu\tau)=\sum_{j,k}\left\{\frac{1}{8\pi\hbar m_{h^0}}\int_{(m_\tau+m_\mu)c^2}|M_{jk}|^2\frac{\delta(m_{h^0}c-\frac{E_T}{c})\rho}{E_T}dE_T\right\} \tag{20}$$

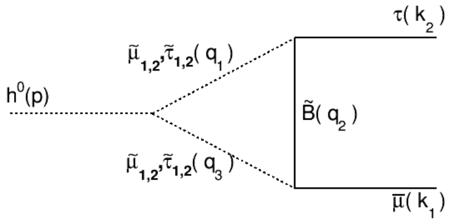

Figure : Generalized Decay of $h^0->\tau\mu$, where $\mu_1,\mu_2,\tau_1,\tau_2$ are the s-leptons

Lagrangian $h^0\tilde{f}\tilde{f}$ with the Matrix Ansatz

$$
\begin{aligned}
\mathcal{L}_{h^0\tilde{f}\tilde{f}} &= \{s_\varphi^2(Q_\tau + H_\tau) + c_\varphi^2(Q_\mu + H_\mu) - \frac{1}{4}G\}h^0\tilde{\mu}_1\tilde{\mu}_1 \\
&+ \{s_\varphi^2(Q_\tau - H_\tau) + c_\varphi^2(Q_\mu - H_\mu) - \frac{1}{4}G\}h^0\tilde{\mu}_2\tilde{\mu}_2 \\
&+ \{s_\varphi^2(Q_\mu - H_\mu) + c_\varphi^2(Q_\tau - H_\tau) - \frac{1}{4}G\}h^0\tilde{\tau}_1\tilde{\tau}_1 \\
&+ \{s_\varphi^2(Q_\mu + H_\mu) + c_\varphi^2(Q_\tau + H_\tau) - \frac{1}{4}G\}h^0\tilde{\tau}_2\tilde{\tau}_2 \\
&+ \frac{1}{4}G(1-4s_w^2)h^0\tilde{\mu}_1\tilde{\mu}_2 + c_\varphi s_\varphi(Q_\tau - Q_\mu + H_\tau - H_\mu)h^0\tilde{\mu}_1\tilde{\tau}_2 \\
&+ \frac{1}{4}G(1-4s_w^2)h^0\tilde{\mu}_2\tilde{\mu}_1 \\
&+ c_\varphi s_\varphi(Q_{\tilde{\tau}} - Q_{\tilde{\mu}} + H_\mu - H_\tau)h^0\tilde{\mu}_2\tilde{\tau}_1 \\
&+ c_\varphi s_\varphi(Q_\tau - Q_{\tilde{\mu}} + H_\mu - H_\tau)h^0\tilde{\tau}_1\tilde{\mu}_2 + \frac{1}{4}G(1-4s_w^2)h^0\tilde{\tau}_1\tilde{\tau}_2 \\
&+ c_\varphi s_\varphi(Q_\tau - Q_\mu + H_\tau - H_\mu)h^0\tilde{\tau}_2\tilde{\mu}_1 \\
&+ \frac{1}{4}G(1-4s_w^2)h^0\tilde{\tau}_2\tilde{\tau}_1 \qquad (21)
\end{aligned}
$$

Lagrangian $\tilde{\bar{B}}\tilde{f}\tilde{f}$ with the Matrix Ansatz

$$
\begin{aligned}
\mathcal{L}_{\tilde{B}\tilde{f}f} = & - \frac{g}{4}\bar{\tilde{B}}tan\theta_w \Big\{ c_\varphi(3+\gamma_5)\tilde{\mu}_1\mu \\
& + s_\varphi(3+\gamma_5)\tilde{\mu}_1\tau \\
& + c_\varphi(1+3\gamma_5)\tilde{\mu}_2\mu \\
& + s_\varphi(1+3\gamma_5)\tilde{\mu}_2\tau \\
& - s_\varphi(1+3\gamma_5)\tilde{\tau}_1\mu \\
& + c_\varphi(1+3\gamma_5)\tilde{\tau}_1\tau \\
& - s_\varphi(3+\gamma_5)\tilde{\tau}_2\mu \\
& + c_\varphi(3+\gamma_5)\tilde{\tau}_2\tau \Big\}
\end{aligned}
$$

$$|M_{jk}|^2 = |\alpha_{jk}|^2\Big\{\Big(\frac{|S_{jk}|^2}{c^2}+\frac{|P'_{jk}|^2}{c^2}\Big)(E_\tau E_\mu+\rho^2)+(|P'_{jk}|^2-|S_{jk}|^2)m_\tau m_\mu\Big\} \tag{22}$$

We have that

$$\Gamma(h^0->\mu\tau)=\sum_{jk}\frac{1}{8\pi\hbar m_{h^0}}\int_{(m_\tau+m_\mu)c^2}|M_{jk}|^2\frac{\delta(m_{h^0}c-\frac{E_T}{c})\rho}{E_T}dE_T \tag{23}$$

Substituing $|M|^2$, we obtain.

$$\Gamma(h^0->\mu\tau)=\sum_{jk}\frac{c}{8\pi^2\hbar m_{h^0}}|\alpha_{jk}|^2\Big\{\Big(\frac{|S_{jk}|^2}{c^2}+\frac{|P'_{jk}|^2}{c^2}\Big)(E_\tau E_\mu+\rho^2)$$
$$+(|P'_{jk}|^2-|S_{jk}|^2)m_\tau m_\mu\Big\}\int_{(m_\tau+m_\mu)c^2}\frac{\delta(E_T-m_{h^0}c^2)\rho}{E_T}dE_T \tag{24}$$

$$\Gamma(h^0->\mu\tau)=\sum_{jk}\frac{|\alpha_{jk}|^2\rho}{8\pi^2 m_{h^0}^2}\Big\{(|S_{jk}|^2+|P'_{jk}|^2)(E_\tau E_\mu+\rho^2)+(|P'_{jk}|^2-|S_{jk}|^2)m_\tau m_\mu\Big\}$$

(2

S_{jk} and P_{jk} terms

$\tilde{f}\tilde{f}$	S_{jk}	P_{jk}
$\tilde{\mu}_1\tilde{\mu}_1$	$-8\frac{i\pi^2}{C_{h^0\mu\tau}}\{\mathcal{B}_{jk}-F_{c0}[C_{jk}+C_{h^0\mu\tau}(\frac{10}{8}m_{\tilde{B}}+m_\tau)]\}$	$6i\pi^2 m_{\tilde{B}}F_{c0}\gamma_5$
$\tilde{\mu}_1\tilde{\mu}_2$	$6i\pi^2 m_{\tilde{B}}F_{C0}$	$8\frac{i\pi^2}{C_{h^0\mu\tau}}\{\mathcal{B}_{jk}-F_{c0}[C_{jk}+C_{h^0\mu\tau}(m_\tau-\frac{10}{8}m_{\tilde{B}}]\}\gamma_5$
$\tilde{\mu}_1\tilde{\tau}_1$	0	0
$\tilde{\mu}_1\tilde{\tau}_2$	$-8\frac{i\pi^2}{C_{h^0\mu\tau}}\{\mathcal{B}_{jk}-F_{c0}[C_{jk}+C_{h^0\mu\tau}(m_\tau+\frac{10}{8}m_{\tilde{B}})]\}$	$6i\pi^2 F_{c0}m_{\tilde{B}}\gamma_5$
$\tilde{\mu}_2\tilde{\mu}_1$	$6i\pi^2 m_{\tilde{B}}F_{c0}$	$-8\frac{i\pi^2}{C_{h^0\mu\tau}}\{\mathcal{B}_{jk}-F_{c0}[C_{jk}+C_{h^0\mu\tau}(\frac{10}{8}m_{\tilde{B}}+m_\tau)]\}$
$\tilde{\mu}_2\tilde{\mu}_2$	$8\frac{i\pi^2}{C_{h^0\mu\tau}}\{\mathcal{B}_{jk}-F_{c0}[C_{jk}+C_{h^0\mu\tau}(m_\tau-\frac{10}{8}m_{\tilde{B}})]\}$	$6i\pi^2 F_{c0}m_{\tilde{B}}\gamma_5$
$\tilde{\mu}_2\tilde{\tau}_1$	$8\frac{i\pi^2}{C_{h^0\mu\tau}}\{\mathcal{B}_{jk}-F_{c0}[C_{jk}+C_{h^0\mu\tau}(m_\tau-\frac{10}{8}m_{\tilde{B}})]\}$	$6i\pi^2 F_{c0}m_{\tilde{B}}\gamma_5$
$\tilde{\mu}_2\tilde{\tau}_2$	0	0
$\tilde{\tau}_1\tilde{\mu}_1$	0	0
$\tilde{\tau}_1\tilde{\mu}_2$	$8\frac{i\pi^2}{C_{h^0\mu\tau}}\{\mathcal{B}_{jk}-F_{c0}[C_{jk}+C_{h^0\mu\tau}(m_\tau-\frac{10}{8}m_{\tilde{B}})]\}$	$6i\pi^2 F_{c0}m_{\tilde{B}}\gamma_5$
$\tilde{\tau}_1\tilde{\tau}_1$	$8\frac{i\pi^2}{C_{h^0\mu\tau}}\{\mathcal{B}_{jk}-F_{c0}[C_{jk}+C_{h^0\mu\tau}(m_\tau-\frac{10}{8}m_{\tilde{B}})]\}$	$6i\pi^2 F_{c0}m_{\tilde{B}}\gamma_5$
$\tilde{\tau}_1\tilde{\tau}_2$	$6i\pi^2 m_{\tilde{B}}F_{c0}$	$-8\frac{i\pi^2}{C_{h^0\mu\tau}}\{\mathcal{B}_{jk}-F_{c0}[C_{jk}+C_{h^0\mu\tau}(\frac{10}{8}m_{\tilde{B}}+m_\tau)]\}$
$\tilde{\tau}_2\tilde{\mu}_1$	$-8\frac{i\pi^2}{C_{h^0\mu\tau}}\{\mathcal{B}_{jk}-F_{c0}[C_{jk}+C_{h^0\mu\tau}(m_\tau+\frac{10}{8}m_{\tilde{B}})]\}$	$6i\pi^2 F_{c0}m_{\tilde{B}}\gamma_5$
$\tilde{\tau}_2\tilde{\mu}_2$	0	0
$\tilde{\tau}_2\tilde{\tau}_1$	$6i\pi^2 m_{\tilde{B}}F_{C0}$	$8\frac{i\pi^2}{C_{h^0\mu\tau}}\{\mathcal{B}_{jk}-F_{c0}[C_{jk}+C_{h^0\mu\tau}(m_\tau-\frac{10}{8}m_{\tilde{B}}]\}\gamma_5$
$\tilde{\tau}_2\tilde{\tau}_2$	$-8\frac{i\pi^2}{C_{h^0\mu\tau}}\{\mathcal{B}_{jk}-F_{c0}[C_{jk}+C_{h^0\mu\tau}(\frac{10}{8}m_{\tilde{B}}+m_\tau)]\}$	$6i\pi^2 m_{\tilde{B}}F_{c0}\gamma_5$

Table : It is shown the Scalar and Pseudoscalar parts of M_{jk}.

α_{jk} Couplings

$\tilde{f}\ \tilde{f}$	α_{jk}
$\tilde{\mu}_1\tilde{\mu}_1$	$-g_{h^0\tilde{\mu}_1\tilde{\mu}_1}\frac{ig^2 s_\varphi c_\varphi}{16}tan^2\theta_w$
$\tilde{\mu}_1\tilde{\mu}_2$	$-\frac{ig_{h^0\tilde{\mu}_1\tilde{\mu}_2}g^2 c_\varphi s_\varphi}{16}tan^2\theta_w$
$\tilde{\mu}_1\tilde{\tau}_1$	0
$\tilde{\mu}_1\tilde{\tau}_2$	$-\frac{ig_{h^0\tilde{\mu}_1\tau_2}g^2 c_\varphi^2}{16}tan^2\theta_w$
$\tilde{\mu}_2\tilde{\mu}_1$	$-\frac{ig_{h^0\mu_2\mu_1}g^2 c_\varphi s_\varphi}{16}tan^2\theta_w$
$\tilde{\mu}_2\tilde{\mu}_2$	$-g_{h^0\mu_2\mu_2}\frac{ig^2 c_\varphi s\varphi}{16}tan^2\theta_w$
$\tilde{\mu}_2\tilde{\tau}_1$	$-\frac{ig_{h^0\tilde{\mu}_2\tilde{\tau}_1}g^2 c_\varphi^2}{16}tan^2\theta_w$
$\tilde{\mu}_2\tilde{\tau}_2$	0
$\tilde{\tau}_1\tilde{\mu}_1$	0
$\tilde{\tau}_1\tilde{\mu}_2$	$g_{h^0\tau_1\mu_2}\frac{ig^2 s^2\varphi}{16}tan^2\theta_w$
$\tilde{\tau}_1\tilde{\tau}_1$	$-\frac{ig_{h^0\tilde{\tau}_1\tilde{\tau}_1}g^2 c_\varphi s_\varphi}{16}tan^2\theta_w$
$\tilde{\tau}_1\tilde{\tau}_2$	$\frac{ig_{h^0\tilde{\tau}_1\tilde{\tau}_2}g^2 c_\varphi s_\varphi}{16}tan^2\theta_w$
$\tilde{\tau}_2\tilde{\mu}_1$	$-\frac{ig_{h^0\tilde{\tau}_2\tilde{\mu}_1}g^2 s_\varphi^2}{16}tan^2\theta_w$
$\tilde{\tau}_2\tilde{\mu}_2$	0
$\tilde{\tau}_2\tilde{\tau}_1$	$-\frac{ig_{h^0\tilde{\tau}_2\tilde{\tau}_1}g^2 s_\varphi^2}{16}tan^2\theta_w$
$\tilde{\tau}_2\tilde{\tau}_2$	$-\frac{ig_{h^0\tilde{\tau}_2\tilde{\tau}_2}g^2 c_\varphi s_\varphi}{16}tan^2\theta_w$

Table : α_{jk}

$g_{\tilde{h}^0\tilde{f}\tilde{f}}$ Couplings

$g_{h^0\tilde{f}\tilde{f}}$	$\tilde{\mu}_1$	$\tilde{\mu}_2$	$\tilde{\tau}_1$	$\tilde{\tau}_2$
$\tilde{\mu}_1$	$s_\varphi^2(Q_\tau+H_\tau)+c_\varphi^2(Q_\mu+H_\mu)-\frac{1}{4}G$	$\frac{1}{4}G(1-4s_W^2)$	0	$c_\varphi s_\varphi(Q_\tau-Q_\mu+H_\tau-H_\mu)$
$\tilde{\mu}_2$	$\frac{1}{4}G(1-4s_W^2)$	$s_\varphi^2(Q_\tau-H_\tau)+c_\varphi^2(Q_\mu-H_\mu)-\frac{1}{4}G$	$c_\varphi s_\varphi(Q_\tau-Q_\mu+H_\mu-H_\tau)$	0
$\tilde{\tau}_1$	0	$c_\varphi s_\varphi(Q_\tau-Q_\mu+H_\mu-H_\tau)$	$s_\varphi^2(Q_\mu-H_\mu)+c_\varphi^2(Q_\tau-H_\tau)-\frac{1}{4}G$	$\frac{1}{4}G(1-4s_W^2)$
$\tilde{\tau}_2$	$c_\varphi s_\varphi(Q_\tau-Q_\mu+H_\tau-H_\mu)$	0	$\frac{1}{4}G(1-4s_W^2)$	$s_\varphi^2(Q_\mu+H_\mu)+c_\varphi^2(Q_\tau+H_\tau)-\frac{1}{4}G$

Table : Expressions of the respective interactions of the Higgs boson h^0 with the s-fermions

B0 and C0 Functions

$$\begin{aligned}\mathcal{B}_{jk} &= m_{h^0}^2 m_\mu [B_{0hjk} - B_{0mbj}] + m_{h^0}^2 m_\tau [B_{0hjk} - B_{0tbk}] \\ &- m_\mu^3 [B_{0hjk} - B_{0mbj}] - m_\tau^3 [B_{0hjk} - B_{0tbk}] + m_\mu m_\tau^2 [B_{0hjk} + B_{0mbj} - 2B_{0tbk}] \\ &+ m_\tau m_\mu^2 [B_{0hjk} - 2B_{0mbj} + B_{0tbk}]\end{aligned} \quad (26)$$

$$\begin{aligned}B_{0tbk} &= B_0(m_\tau^2, m_{\tilde{B}}^2, m_{\tilde{f}_k}^2) \\ B_{0hjk} &= B_0(m_{h^0}^2, m_{\tilde{f}_j}^2, m_{\tilde{f}_k}^2) \\ B_{0mbj} &= B_0(m_\mu^2, m_{\tilde{B}}^2, m_{\tilde{f}_j}^2) \\ F_{c0} &= C0(m_{h^0}^2, m_\mu^2, m_\tau^2, m_{\tilde{f}_k}^2, m_{\tilde{f}_j}^2, m_{\tilde{B}}^2)\end{aligned} \quad (27)$$

where $i\pi^2 F_{C0} = \int \frac{d^4 q_1}{(2\pi)^4((q_1+k_2)^2 - m_{\tilde{B}}^2)(q_1^2 - m_{\tilde{f}_k}^2)((q_1+k_2+k_1)^2 - m_{\tilde{f}_j}^2))}$

And in general the substraction in terms function B0 where $\Lambda_{i,j} = \sqrt{[m_{i,j}^2 - (m_1^2 + m_2^2)]^2 - 4m_1^2 m_2^2}$

$$B0(m_i^2, m_1^2, m_2^2) - B0(m_j^2, m_1^2, m_2^2) = (m_1^2 - m_2^2)\frac{m_i^2 - m_j^2}{m_i^2 m_j^2} ln[\frac{m_1}{m_1}]$$

$$+\frac{\Lambda_j}{m_j^2}\{ln[2m_1 m_2] - ln[m_1^2 + m_2^2 - m_j^2 + \Lambda_j]\}$$

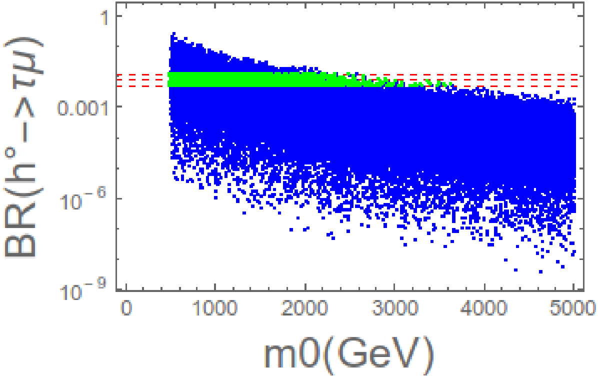

Figure : Plot Branching Ratio and m_0 variating. All the values of $A0$,μ_{susy},$tan(\beta)$, m_b are variated.

Results

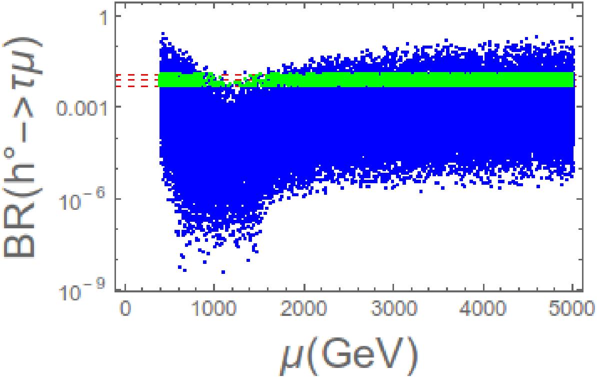

Figure : Plot Branching Ratio and μ_{susy}. All the values of $A0$,m_0,$tan(\beta)$, m_b are variated.

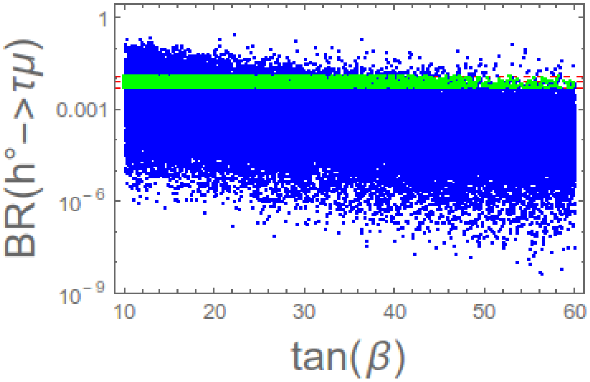

Figure : Plot Branching Ratio and $tan(\beta)$. All the values of $A0$,m_0,μ_{susy}, m_b are variated.

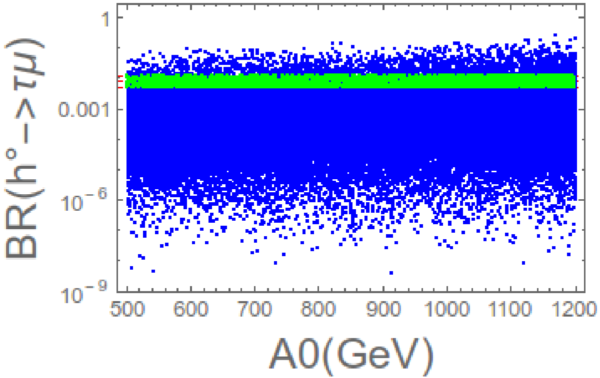

Figure : Plot Branching Ratio and $A0$. All the values of $tan(\beta)$,m_0,μ_{susy}, m_b are variated.

Results

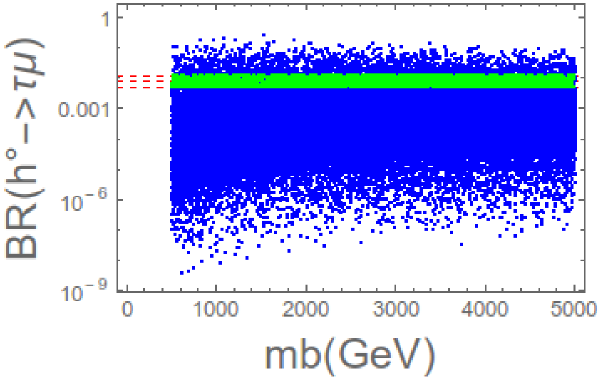

Figure : Plot Branching Ratio and mb. All the values of $tan(\beta)$,m_0,μ_{susy}, $A0$ are variated.

Conclusions

1) The *Ansatz* proposed of the mixing third and second family whitin MSSM can predict the Branching Ratio given by the experiment CMS.

2)The range of the free parameters for solving the range of Branching Ratio given by CMS would be

- $400 \lesssim m0 \lesssim 3800$ [GeV]
- $(600[GeV] < \mu_{susy} \lesssim 1150[GeV]) \cup (1350[GeV] \lesssim \mu_{susy} < 5000[GeV])$
- Restricted for $tan(\beta) > 48$
- No trilinear restriction (A0)
- No bino mass restriction (mb)

3) We need to overlap with other processes to find more restrictions to our free parameters. Specifically with $BR(\tau \rightarrow \mu\mu\gamma)$

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